OECD Information Technology Outlook

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Information and Communications Technologies

OECD Information Technology Outlook

2008

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Foreword

The OECD Information Technology Outlook 2008 *has been prepared by the OECD under the guidance of its Committee for Information, Computer and Communications Policy (ICCP), and in particular the Working Party on the Information Economy (WPIE). This edition is the ninth 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, analysis of the growing impact of IT on the economy and society, developments and emerging applications in selected areas of information technology, and a review of IT policies and new policy directions. The 2008 edition builds on previous editions to further extend the economic and policy analysis. This edition has been extensively updated through mid-November 2008 to take account of rapidly worsening macroeconomic conditions.*

The first two chapters provide an overview of the importance and growth of information and communication technologies (ICTs) in national economies, describe recent market dynamics, give a detailed overview of the globalisation of the ICT sector, and provide a thorough analysis of the ongoing shift of production, trade and markets to non-OECD economies, particularly China and India. The third chapter provides an overview of the importance of ICT R&D and innovation, the leading role of the ICT sector in developing new sources of innovation and the growing importance of ICT-related R&D in other sectors. Some of this activity is driven by changing use of the Internet and broadband by consumers and users, which is analysed in the following chapter; the rise of digital content and increasing online delivery in a range of content-rich industries are analysed in Chapter 5. This is followed by a review of some of the economic implications of broadband adoption and use. The last chapter provides a critical overview of IT policy developments and priorities in OECD countries. National information technology policy profiles are also posted on the OECD website to enable their widespread use (www.oecd.org/sti/information-economy).

The OECD Information Technology Outlook 2008 *was drafted under the direction of Graham Vickery, with Cristina Serra-Vallejo and Sacha Wunsch-Vincent of the Information, Computer and Communications Policy Division of the Directorate for Science, Technology and Industry (DSTI); Pierre Montagnier and Desirée van Welsum of DSTI, John Houghton of Victoria University (Australia) and Arthur Mickoleit (consultants), with contributions from Verena Kroth and Adam Masser (consultants). It benefited from review and valuable contributions by delegates to the Working Party on the Information Economy, under the chairmanship of Jean-Jacques Sahel (United Kingdom) and Daniela Battisti (Italy), particularly regarding national IT policy developments and up-to-date national statistics on the production and use of IT goods and services. This report has been recommended for wider distribution by the ICCP Committee.*

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OECD Information Technology Outlook 2008 Highlights

The ICT industry has slowed with the world economic slowdown but growth continues in some markets and products

The outlook for the ICT sector has weakened with the turmoil in the world economy…

The outlook for the information and communications technology (ICT) sector is much less favourable than in recent years. With economic conditions deteriorating, recession in the OECD area and business and consumer confidence falling sharply, global projections for ICT spending have been revised sharply downwards. Macroeconomic forecasts, short-term cyclical output indicators and business and consumer activity show ICT growth in OECD countries to be slower in 2008 than in 2007 at around 4%. But growth has not yet collapsed as it did in 2001-02 with the ending of the ICT bubble, and so far it has remained somewhat stronger than OECD economies' performance as a whole.

Over the next 18 months, ICT growth is likely to be below zero for the OECD with considerable turbulence as the financial services sector restructures and the real economy experiences a deep economic downturn. However, IT services and software will generally grow, along with new Internet and communications-related products and infrastructure as they are an essential part of spending and partly recession-proof. A general upturn cannot be expected before the end of 2009 in parallel with renewed GDP growth. Growth after 2009 will potentially be at a somewhat higher level than GDP as new broadband infrastructures and products develop, although financing new ICT investments will be a continuing business and policy challenge.

… but medium-term growth is partly underpinned by new products and growth in non-OECD markets

The longer-term prospects for the ICT sector depend on whether businesses and consumers continue investing in new ICT goods and services at a relatively high rate, and whether non-OECD economies maintain growth paths that, while slowing, in part compensate for recession and uncertainties in OECD economies. Non-OECD economies make up over 20% of the global ICT market, with ICT spending in Brazil, China, India, Indonesia and Russia all growing in 2003-07 at more than 20% annually in current terms. Around 50% of ICT goods production now comes from non-OECD countries, and these countries, notably China and India, are increasingly the home of top ICT firms. But in the medium term, developing country exports and business activity will be curtailed, and commodity price rises and inflation have squeezed consumer spending in non-OECD countries. ICT employment in OECD countries will contract as business and consumer expenditures drop, and as competition from non-OECD economies and industrial restructuring accelerate.

Over the longer term the ICT industry is expanding, ICT-related employment is increasingly important and one half of venture capital goes to ICTs

Looking at developments before the current financial crisis, the ICT sector put in a strong performance since 2002, underpinning real growth and supported at global level by the dynamic performance in non-OECD countries, partly through ICT production and exports and partly through domestic market growth. Currently the ICT sector makes up over 8% of OECD business GDP, and employs over 15 million people. The top 250 ICT firms (making up around 70% of OECD ICT employment) grew by 12% in current terms in 2007 and their worldwide revenues reached USD 3.8 trillion. OECD countries specialised in ICT manufacturing such as Korea, Finland, Japan and Hungary maintained their competitiveness and ICT goods trade surpluses in recent years and will continue to do so.

ICT skills are an important contributor to growth and they are spread widely across the economy. Over 4% of total employment is in ICT specialist occupations and this share is growing rapidly, and over 20% of employment is in intensive ICT-using occupations. The industry has been underpinned by steady flows of venture capital, with US ICT venture investments in the first half of 2008 running at the same level as in 2007. Around half of the US total goes into ICTs, particularly in software and Web 2.0 applications, with increasing investment in ICT-intensive environmental and energy technologies. However, exit strategies have been constrained by the credit crunch and new venture financing faces severe challenges over the medium term.

Global restructuring continues apace

Global restructuring continues, and after expanding strongly, ICT trade slowed in 2008

Global ICT trade expanded strongly to more than USD 3.5 trillion in 2006 while the share of the OECD area in total world ICT trade decreased steadily to 56%. Weakening economic conditions slowed ICT trade in 2007 and it slowed further in the first half of 2008, due to lower growth in both US imports and Asian exports. Nevertheless, ICT exports remained resilient in the first half of 2008, with exports continuing to grow in some countries (*e.g.* China, Korea, Malaysia, Mexico, Thailand, and Eastern European countries), due to continuing, albeit slowing, demand from OECD countries and strong demand from emerging markets (especially in the Middle East, Latin America and Africa). With the sharp economic downturn in OECD countries and increasingly elsewhere, ICT trade is bound to slow further.

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China remains by far the leading exporter of ICT goods…

China's ICT exports rose to USD 360 billion in 2007, surpassing the combined ICT exports of the EU15 and the United States. However, China's export growth slowed to around 10% in the first half of 2008 and continues to drop. Among OECD countries, Korean exports more than doubled from 2001 to reach almost USD 100 billion in 2007, very close to those of Japan.

… and ICT-related FDI expanded to new highs before falling sharply in 2008

ICT-related foreign direct investment reached an historic high in 2007, but has fallen sharply in 2008 with a possible recovery projected after 2009. In 2007 about one-fifth of all cross-border mergers and acquisitions were ICT-related (USD 170 billion). Such deals have been increasingly targeting *and* originating in non-OECD economies, with firms in the BRICS countries particularly active. There has been a very marked slowdown in global merger and acquisition activity in 2008 along with the slowdown in foreign direct investment and this will persist due to constrained business funding.

ICT R&D and innovation as drivers of growth

The ICT sector is by far the largest R&D spender…

The ICT industry in OECD countries spends about two and a half times as much on R&D (USD 130 billion in 2000 prices) as the automotive sector and more than triple that of the pharmaceutical sector. R&D spending is especially strong in services and software as these areas have expanded rapidly. The United States accounts for 40% of all OECD ICT-related business R&D expenditures, the EU-15 for a little under 25%, Japan for 22% and Korea for 9%. The ICT business sector has close to one million researchers; of these around half are in the United States. ICT research priorities are focusing on developing the basic technologies for the next generations of products and a new development has been interest in addressing major challenges including climate change and healthcare.

… the top ICT firms are R&D-intensive and the organisation of R&D is changing

R&D expenditures of major ICT firms rose to USD 151 billion in 2006, and growth continued in 2007. The top 100 R&D companies spend an average of nearly 7% of revenue on R&D. ICT firms from the United States and Japan still lead by a wide margin, but Korean firms have been closing the gap. ICT R&D expenditures of non-OECD ICT firms (China and India, and other emerging economies) are moderate by comparison, although rising fast.

Publicly funded research, globalised research networks and inter-firm R&D partnerships and alliances are important factors driving innovation. R&D partnerships and alliances have spread across new geographical and interdisciplinary domains. While the trend is toward globalised research networks, the centres of these networks are highly concentrated in a few regions in OECD countries. A few new locations are growing in importance, including Shanghai, Haifa and Bangalore, and to a lesser extent Chinese Taipei, Malaysia and Singapore.

Non-ICT industries are increasingly undertaking ICT-related research, and ICT patenting is expanding

In some OECD countries the share of R&D conducted by non-ICT firms has risen to 25% of total industry ICT R&D spending. This R&D is conducted in a wide range of sectors, notably in automobiles, financial services and defence, and is linked with the growing importance of embedded systems and software in ICT and non-ICT products. The number of ICT-related patents grew strongly from the mid-1990s to 2005. The United States, Europe and Japan continue to lead in the number of international patent applications, but the proportion of ICT patents in total Chinese filings tripled in a decade, and Korea's patent output is also rising.

Broadband is changing household Internet use

Broadband is one of the fastest diffusing technologies…

Broadband is diffusing more rapidly than narrowband Internet at home and catching up with the PC installed base. In 2007, more than two-thirds of all households had access to broadband Internet in countries such as Denmark, Finland, Iceland and the Netherlands; and in Korea, more than eight out of ten households have broadband access.

… accelerating online activities…

People with broadband access use the Internet more often and more intensively, and broadband drives online shopping, education, use of government services, playing or downloading digital content and video telephony.

… but a new digital use divide is surfacing based on socio-economic characteristics

The pattern of broadband use is shaped by socio-economic characteristics including education, income, age, gender, or place of access. Young, highly educated, higher-income males tend to access the internet more frequently and for different types of online activities. Having children in the house increases broadband use. But as the digital access divide decreases a digital use divide is emerging.

Digital content is developing rapidly, driven by consumer use

Digital content is transforming ICT and creative industries…

Digital content is a key factor behind the rapid growth of OECD broadband subscribers to 251 million in 2008, up from 68 million in 2003, and the growing number of users has spurred the creation of new content. Mobile broadband is also beginning to boost content creation and demand. Finally, management and distribution technologies are increasing the supply of broadband content, including from users.

An increasing share of content industry revenues is derived from products delivered via the Internet, but with marked differences across sectors. Advertising is the biggest online market, with revenues of over USD 30 billion in 2007 and annual growth of 30%. Online revenues are around one-sixth of the total for computer and video games and music, and they are growing fastest for films, albeit from low levels. The development of user-created content has been rapid, with for example 40% of Korean Internet users being members of online communities. Video and social networking sites are leading the development, and virtual worlds have become a major centre of activity.

There are significant impacts on value chains and business models beyond the ICT sector…

Cross-industry collaboration and new business partnerships are emerging, for example, for content aggregation and distribution. Some online business models mirror offline models (*e.g.* pay-per-item) and some are new (*e.g.* sale of virtual items). Digital content has also been increasingly used to organise users around non-media industries such as banking, and non-entertainment applications are emerging in government services and health.

… although barriers hamper uptake

Industry's goal of digital content "anywhere, anytime and on any device" is still remote. Challenges include access speeds, service quality and pricing. Online content catalogues are still limited and interoperability, geographic access limitations and the availability of unauthorised digital content hamper uptake. Widespread use of advanced mobile broadband content services has not yet emerged.

The potential and actual impacts of broadband

Broadband networks are an integral part of the economy…

Broadband is an enabler of structural change, the creation of new digital services, and it boosts firm efficiency, improves competition and underpins globalisation. Broadband spurs ICT innovation and ICT-enabled innovation, for example in developing collaborative R&D, making cloud computing possible and enabling new ways of organising research.

… but measuring broadband impacts is an ongoing challenge

Despite the rapid take-up of broadband, its diffusion is relatively recent and its impacts are difficult to disentangle from those of established ICTs. Nevertheless, firms use fast connections to make existing processes more efficient and productive, develop new e-business value chains and business models, and transform business activities. There is evidence that broadband increases the number of businesses and employment particularly in knowledge-intensive sectors.

Broadband and associated applications are contributing to the transformation of economic activity as did other general purpose technologies such as electricity and the internal combustion engine. Broadband impacts may be greater as the price of ICTs has fallen more dramatically. However necessary, complementary investments in skills and organisational innovations may take time to materialise to enable broadband's contribution to growth and job creation. It is generally accepted that considerably higher levels of investment in intangibles, human and organisational capital are needed to complement ICT and broadband investments.

Rising to the challenges? ICT policies in demanding times

ICT policies are widening their focus…

OECD governments are continuing to integrate ICT policies into national strategies for enhancing economic growth, employment, welfare and achieving wider socio-economic objectives. There is a greater need for a coordinated, horizontal government approach since ICTs are increasingly addressing policy challenges in areas as diverse as education, healthcare, climate change, and energy efficiency. Around one-third of OECD countries are attempting to centralise formulation and co-ordination of ICT-related policies to improve policy coherence. Efforts to improve coordination and reduce duplication are likely to intensify with the economic decline, greater strains on government budgets, and pressures on long-term investments.

… and priorities are shifting…

In 2008, the top 10 ICT policy priorities of OECD governments are a mixture of traditional targets (*e.g.* government online, ICT R&D) and newer areas (*e.g.* digital content and public sector information). Some governments are introducing policies to meet challenges beyond technology uptake. These include R&D programmes and fostering innovation; government online policies to target public sector efficiency; and broadband policies to bridge geographic and social divides. Policies to enhance trust online are gaining in importance; and while policies to improve technology diffusion to business are still a priority, policies focused on the general ICT business environment decreased.

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Top ten ICT policy priorities, 2008

1	Government on line, government as model users
2	Broadband
3	ICT R&D programmes
4	Promoting IT education
5	Technology diffusion to business
6	Technology diffusion to individuals and households
7	Industry-based and on-the-job training
8	General digital content development
9	Public sector information and content
10	ICT innovation support

.... while better policy assessment and coordination are needed

Assessment and evaluation are more widespread, but further efforts are needed to more effectively measure and subsequently improve the efficiency of ICT polices and their coordination.

ICT policies have evolved to meet new priorities while continuing to focus on core activities. These policies will be tested in terms of their contributions to long-run competitiveness, growth and employment. Non-OECD economies are also developing comprehensive ICT policies which both complement and challenge the development of policies in OECD countries. To safeguard the future, it is crucial in light of the economic downturn which began in 2008 to maintain long-term priorities and investments in research, innovation and human resources.

ISBN 978-92-64-05553-7
OECD Information Technology Outlook 2008

Chapter 1

The IT Industry: Recent Developments and Outlook

The current outlook for the ICT sector is much less favourable than at the time of the last edition of this publication, in 2006. The macroeconomic outlook has progressively worsened and both business and consumer confidence in OECD countries have fallen sharply. Projections both in general and for the ICT sector have been successively revised sharply downwards. Macroeconomic forecasts combined with business and consumer sentiment suggest that ICT growth in OECD countries slowed rapidly in 2008 but is unlikely to collapse as it did in 2001. Overall, the near-term outlook for OECD countries is for a maximum of 4% ICT growth in 2008 and zero or below until the end of 2009, with very different performances across segments and markets. As in the last downturn, there is also likely to be considerable pressure on OECD ICT employment owing to increasing competition from non-OECD economies and global industrial restructuring in ICT goods and services. Global ICT markets are also shifting to non-OECD economies, and the top 250 ICT firms include increasing numbers of non-OECD firms. The long-term performance of the ICT sector will depend on whether new goods and services will continue to prompt businesses and consumers to keep investing in and buying ICT output and the extent to which non-OECD economies maintain their more dynamic growth paths.

Introduction

The performance of the information and communication technology (ICT) sector, ICT investment and ICT markets remained moderately good until mid-2008, but the outlook is much worse than in previous editions of the *IT Outlook* due to unprecedented turbulence and the deep economic downturn in OECD economies. Macroeconomic prospects for OECD countries have fallen sharply since 2005-06, with global turmoil in financial markets and weaknesses in business investment, beginning in banking and finance and spreading to the real economy world-wide, and in consumer spending, with the downturn in housing markets, rising food and commodity prices, and rapidly weakening labour markets. Continuing global weaknesses have reduced the ICT sector's prospects owing to the rapid slowdown in growth and the onset of recession in the OECD area.

In macroeconomic terms the leading role of the United States has diminished somewhat, with the euro area growing somewhat more strongly than the United States and Japan over 2006-07, but with the United States looking a little stronger in 2008 (OECD, 2008c). Real GDP growth was forecast at around 1.1% in the euro area for 2008 and –0.5% for 2009, somewhat stronger in the United States for 2008, and in Japan lower than in the euro area (OECD, 2008c). OECD countries overall were forecast to have lower real GDP growth in 2008, negative in 2009, and there have been considerable downward revisions from projections in mid-2008 (OECD, 2008a, 2008c). Large non-OECD countries have consistently maintained higher growth but are also slowing. Furthermore, there are few signs of other OECD countries decoupling from the United States. The shocks in the United States have spread via the financial crisis and currency movements to other OECD countries and other major economies.

Aggregate investment has followed the usual pattern, overshooting during expansions and declining markedly during slowdowns. Because of the collapse of housing and construction markets in many countries, gross fixed capital formation declined markedly in 2008 and is negative across the OECD area as a whole. However, business investment as captured in real gross private non-residential fixed capital formation performed somewhat better. It grew considerably faster than GDP, by 6.1% across the OECD zone in 2006 and by 5.1% in 2007, with the euro area leading in 2007. It was forecast to grow more slowly than GDP for the OECD area in 2008-09, but to remain reasonably strong in a few higher-growth countries and resource-based economies (Australia, Norway) (OECD, 2008a). However, some of these countries have also slowed sharply as the financial market crisis has continued and as business and consumer confidence has ebbed.

ICT investment is a large share of non-residential gross fixed capital formation (10-25%), and ICT investment will slow with the slow-down in aggregate investment. Nonetheless, some ICT investments will keep growing, owing to continued innovation in investment goods and services driving new investments across the economy. Many of these new goods and services will also have accompanying ICT capital expenditures themselves. The share of ICT in total investment is also likely to be underestimated as

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measurement is particularly difficult for software, and ICT components that are incorporated in products such as machine tools or motor vehicles are not included in ICT investment.[1]

Continuing long-term current account imbalances in OECD countries, and between OECD and non-OECD economies and particularly with China, also present continuing risks for the global economy. The current account balance for OECD countries declined from –1% of GDP in 2003 to –1.7% in 2006 and was forecast to be around –1.5% in 2008 or to worsen owing to peak high energy, commodity, and food prices (OECD, 2008c). The United States has a very large deficit (–5% of GDP in 2008), while Germany and Japan have large surpluses; some smaller countries have proportionally much larger deficits and surpluses. All countries with deficits in 2005 are forecast to have them in 2009, and more countries have entered this group (Canada and Korea). These pressures are also likely to constrain ICT expenditures.

General government financial imbalances are also a continuing cause of concern. The total OECD financial balance was declining only slowly from its peak of –4% of nominal GDP in 2003 and now is forecast to worsen in 2009 and 2010. Deficits tend to persist except in a few northern European countries. Budget constraints in most OECD countries are likely to affect public capital investment, including in ICT.

Recent developments in ICT supply

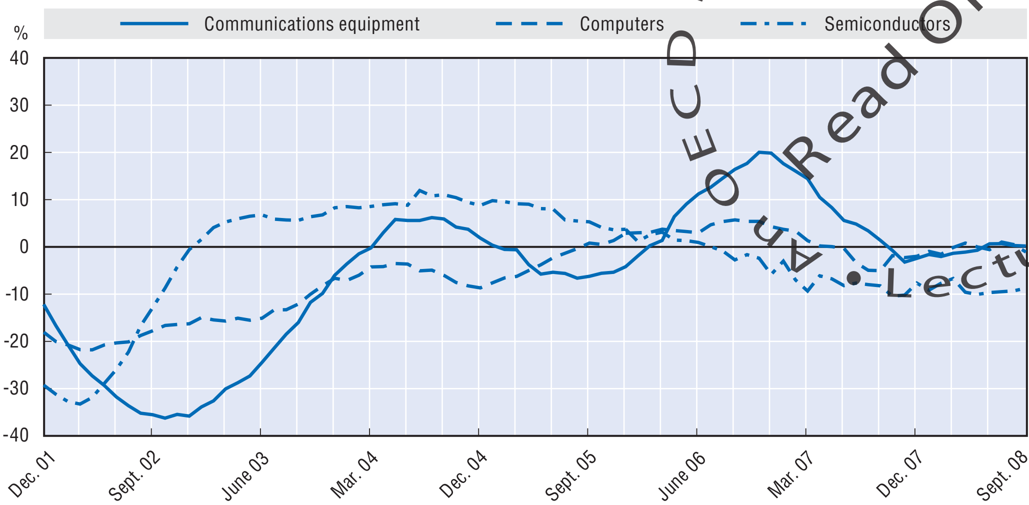
The ICT supply side remained rather resilient overall through the third quarter of 2008; if anything, performing better than projections of macroeconomic performance (both GDP and fixed capital formation) would suggest. In general it parallels macroeconomic performance and aggregate investment, but shows greater short-term cyclical fluctuation, particularly in ICT manufacturing. In 2003 production and markets were more robust in the United States than in Japan and Europe, owing to better macroeconomic performance, but the situation changed as growth increased in Japan (from 2004) and then in Europe (from 2006), driving domestic ICT production and investment. The relative strength of Europe and Japan *vis-à-vis* the United States persisted into the third quarter of 2008. Some of the smaller OECD countries (Finland, Korea and Sweden) have had dynamic performance in ICT manufacturing, and all countries have shown continuing dynamism in the supply of ICT services. Furthermore, the growing importance of consumers in total ICT sales (around 30% of total ICT markets and growing steadily, according to WITSA, 2008) suggests that the composition of ICT production will continue to change, with consumer products more important than in the past despite current weaknesses.

With the rapid weakening of the United States economy from the third quarter of 2007, United States ICT manufacturing shipments showed negative growth from September 2007 in all segments. This follows mostly positive growth after the trough in 2001-02. Shipments of semiconductor components led both the current decline and the preceding rebound by at least five quarters. The decline in the US dollar has helped exports of ICT goods, and these exports in part account for the nascent upturn from the end of 2007, with the exception of semiconductors, which remained in decline (see Figure 1.1).

In Europe, German computers and communication equipment production remained strong in mid-2008, and that of process control equipment strengthened somewhat, reflecting better than expected industrial production and exports in the first half of 2008 (see Figure 1.2). ICT manufacturing has shown positive year-on-year growth since 2003-04,

Figure 1.1. **Growth in monthly shipments of ICT goods by segment in the United States, December 2001-September 2008**

Year-on-year percentage change, domestic net selling values, seasonally adjusted, 12-month moving average

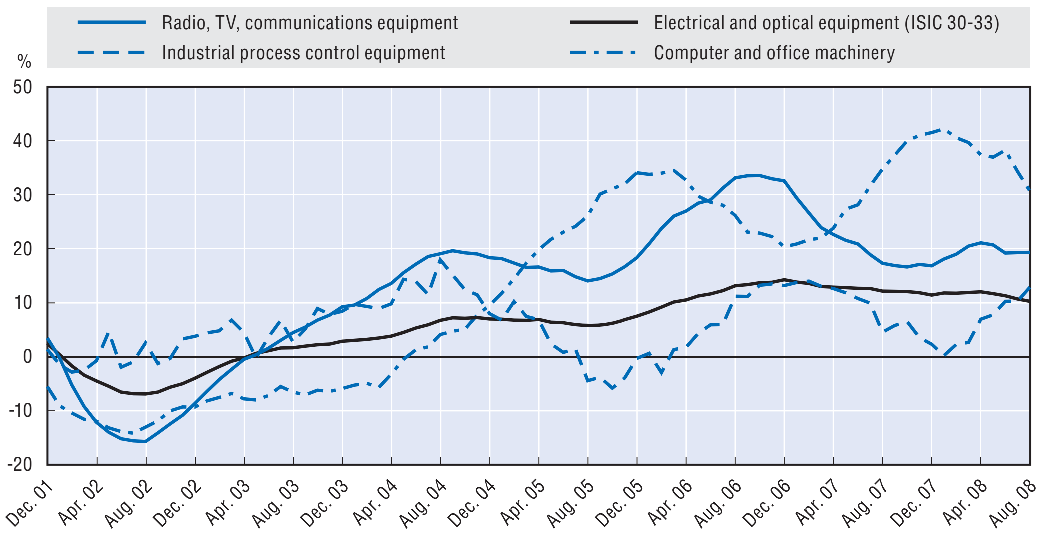


StatLink http://dx.doi.org/10.1787/472572826243

Source: OECD, based on US Bureau of the Census, Manufacturer's Shipments, Inventories and Orders (M3) survey, November 2008. *www.census.gov/indicator/www/m3/*.

Figure 1.2. **Growth in monthly production in selected ICT sectors in Germany, December 2001-September 2008**

Year-on-year percentage change, monthly volume index, seasonally adjusted, 12-month moving average



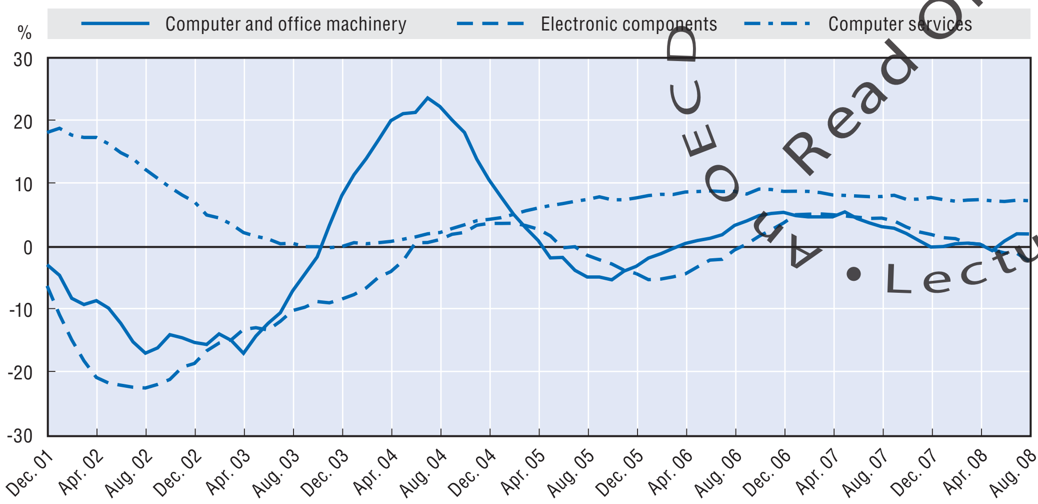
StatLink http://dx.doi.org/10.1787/472578032416

Source: Statistisches Bundesamt, Produktionsindex, November 2008.

with components (and communications equipment) leading although showing signs of weakening. In France there is a similar cyclical picture but with an earlier upturn in computer and office equipment and a later return to growth for electronic components. Growth of both in mid-2008 was around zero after being positive as of 2006. Computer services in France have grown consistently, with very strong growth earlier in the decade, and growth is holding up better than ICT goods (Figure 1.3). Relatively rapid growth in

Figure 1.3. **Growth in monthly turnover in selected ICT sectors in France, December 2001-August 2008**

Year-on-year percentage change, monthly value index, seasonally adjusted, 12-month moving average



StatLink http://dx.doi.org/10.1787/472635607502

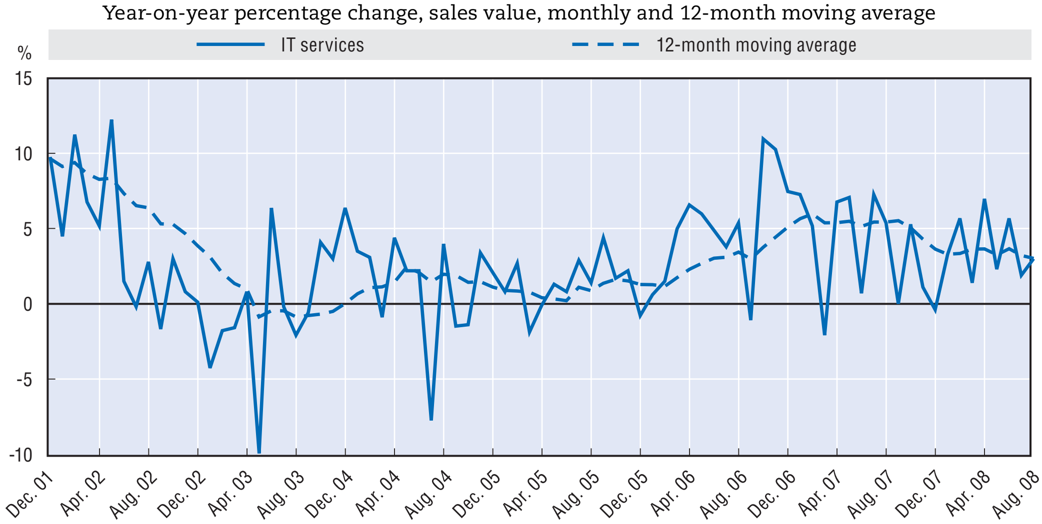
Source: *INSEE, Indice et séries statistiques*, November 2008.

computer and software services is part of structural transformation in the ICT industry, with software and IT services accounting for an increasing share of total ICTs.

ICT activity returned to growth earlier in Japan than in Europe but is also slowing (Figure 1.4). The Japanese IT services industries had consistent positive growth from early 2005 after a period of fluctuating and sometimes negative growth from 2003, a picture very similar to that of IT services in France (Figure 1.3). Because Japan's IT services are largely for domestic consumption, their performance more accurately reflects domestic ICT-related business investment than the highly export-orientated ICT manufacturing

Figure 1.4. **Growth of monthly sales of IT services industries in Japan, December 2001-August 2008**

Year-on-year percentage change, sales value, monthly and 12-month moving average



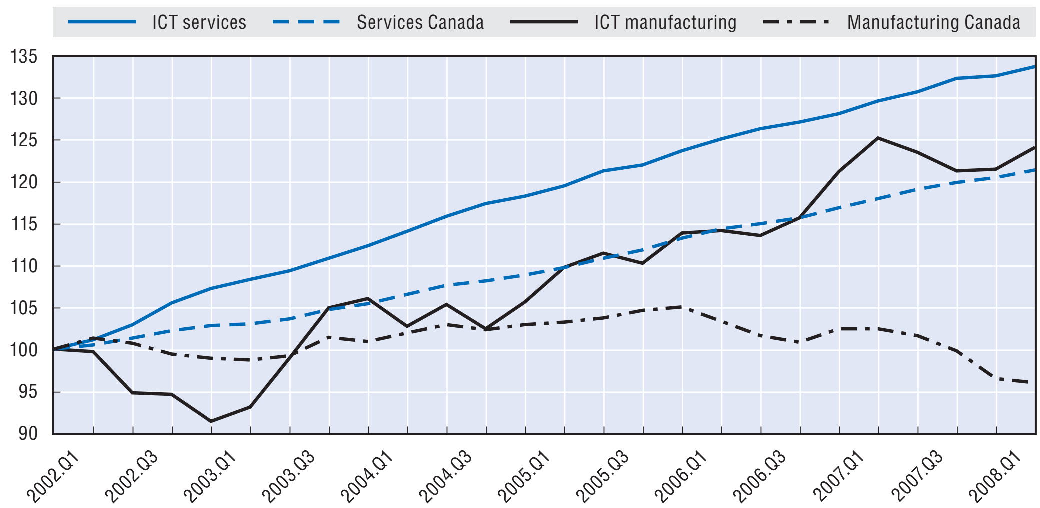
StatLink http://dx.doi.org/10.1787/472674750486

Source: *METI Monthly Survey on IT Services Market*, November 2008.

sector. Finally, the shift towards ICT services is apparent in Canada's aggregate data (Figure 1.5). Although ICT manufacturing and services have outstripped total manufacturing and total services respectively, ICT services have grown consistently while ICT manufacturing has been much more volatile, with ICT goods shipments slowing in mid-2008. For all of these countries, although ICT goods output was slowing or declining slightly and services slowing in mid-2008, the slowdown and declines so far are not as dramatic as the ICT crash in 2001-02 as the sector is markedly stronger and has not engaged in the excesses of the earlier period.

Figure 1.5. **Trends in real output (GDP) in the Canadian ICT sector, Q1 2002-Q2 2008**

Indexed growth, Q1 2002 = 100



StatLink http://dx.doi.org/10.1787/472682210731

Source: *Industry Canada, Quarterly Monitor of the Canadian ICT Sector*, Second Quarter 2008, September 2008.

Prospects in the near to medium term

In the first three quarters of 2008, ICT markets and the ICT industry were resilient in the face of financial market turbulence, rapidly weakening macroeconomic conditions, falling business and consumer confidence and the onset of recession in the OECD area. Reasons for resilience included less than expected falls in ICT demand in the United States and particularly in Europe, continuing demand in the Asia-Pacific region, Latin America, Eastern Europe and the Russian Federation, and the development of new products, particularly for consumers. However, rapidly declining OECD economies, investment and consumer expenditures and more subdued demand in emerging economies moderated ICT industry growth later in 2008.

Global ICT spending estimates have been revised downwards in the course of 2008, as the US slowdown and imminent recession spread.[2] Lower US growth is spilling over into US IT employment, with hiring at its lowest since 2004 as firms cease discretionary IT spending.[3] On the other hand, ICT spending continued to grow strongly in the Asia-Pacific region through mid-2008[4] and in other non-OECD regions, partly because the falling US dollar made ICT products cheaper. This partly offset lower growth in the United States, Japan and Europe. Western European ICT spending was expected to grow by 5% in 2008, but rapidly declining business and consumer confidence in mid-2008 suggested that this was too optimistic.

By product area, communications and computer equipment were growing more slowly or declining, software and IT services continued to grow, and, despite ebbing consumer confidence, some consumer products remained resilient.[5] The global semiconductor market was forecast to grow at around 2.2% in 2008 with a rather shaky start and poor finish, and investment in semiconductor production equipment dropped very sharply.[6] Global PC shipments were holding up at least in the first half of 2008, with growing volumes offsetting price declines, continuing demand for mobile computing devices and low-cost notebooks, and growth in some geographical markets.[7] Future growth in the PC market will depend on macroeconomic prospects, local demand and development of new products. The market for mobile phones is expected to drop in 2009. IT services continue to grow, driven by outsourcing and the development of new services such as utility computing.

Third-quarter 2008 results of major ICT firms have been mixed; they are positive overall, but with softening of revenues and some segments and firms performing poorly. By individual segments, third-quarter 2008 revenues show: new products performing well (games software and equipment, and new consumer equipment); semiconductor firms struggling with the global downturn, overcapacity and falling prices, and slashing investment (but some firms performing well); IT equipment generally growing (laptops, other IT equipment); telecommunications services firms slowing as core markets stagnate or even decline and looking to new services (3G services) and markets (developing countries) to boost growth; services generally growing (software, IT services); and established Internet businesses maintaining very high growth rates. Non-United States markets are increasing in importance and Asian firms are growing rapidly except in Japan, with the contrast in results between United States and Japanese firms partly due to currency movements.

While the first three quarters of 2008 showed moderately resilient output and markets, growth can be expected to deteriorate in 2009 as the economic downturn plays itself out and a broad recovery is unlikely before the end of 2009 at the earliest.[8] For example, the finance, insurance and retail sectors and suppliers will curtail ICT spending and seek to increase efficiency of existing investments, and rapidly falling consumer confidence and purchasing power will have a direct impact (consumers make up about 30% of ICT markets; see WITSA, 2008). The nature and length of slower or declining ICT growth will depend on how OECD countries are affected by the downturn (they have not decoupled from the United States; see OECD, 2008c), and how emerging economies (in particular China, but also other major countries) will cushion the declines in OECD markets.

If ICT production and markets in Asia depend on OECD imports and investment to continue to drive development, ICT supply is in for a bumpy ride. If these markets can limit the impact of the deep OECD downturn, outcomes will be different. Other factors are whether ICTs are now viewed as essential parts of long-term business operations and investment cuts will be resisted in poor times, and whether new consumer goods and services (new portables, new social networking activities) will maintain momentum for the ICT supply side.[9]

ICT firms

The top 250 ICT firms feature a mix of long-established firms, new entities and new entrants. The changing cohort reveals renewed merger and acquisition (M&A) activity in the ICT sector in 2007, most notably large deals in telecommunications, but also many hundreds of deals in electronics manufacturing, IT, software and services but with a marked drop in 2008. What was most notable is the rapid emergence of major indigenous firms in the emerging BRICS economies (Brazil, the Russian Federation, India, China and South Africa) and elsewhere. This was reflected in the rapid growth in both the number and size of ICT manufacturing firms in Chinese Taipei and China, IT services firms in India and South Africa, and telecommunication services firms in China, Brazil, the Russian Federation, South Africa, Egypt and elsewhere. The new wave of global restructuring in the ICT-producing sector is now clearly evident in the ranks of the top 250 ICT firms; it was first identified in the last edition of the *Information Technology Outlook* (OECD, 2006).

Box 1.1. **Methodology used to compile the 2006 ICT top 250**

Sources used to identify the top 250 ICT firms include the *Business Week*'s Information Technology 100, Software Magazine's Top 50, Forbes 2000, Washington Post 200, Forbes Largest Private Firms, Top 100 Outsourcing, World Top 25 Semiconductors, and a number of other Internet listings. Having identified the candidates for a top 250 listing, details were sourced from the latest annual reports, Securities Exchange Commission 10K and 20F forms, directly from company financial reports and from various Internet investor sources, including Google Finance, Yahoo! Finance, and Reuter's MultexInvestor. Details for private firms were sourced from the Forbes listing of the largest private firms and directly from company websites.

ICT activities are those that "process, deliver, and display information electronically". Hence, the ICT industries are those that produce the equipment, software and services that enable those activities. Each of the top 250 firms is classified by ICT industry sector: *i)* communication equipment and systems; *ii)* electronics; *iii)* specialist semiconductors; *iv)* IT equipment and systems; *v)* IT services; *vi)* software; *vii)* Internet; and *viii)* telecommunication services. Broadcast and cable media and content are excluded.

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 (primary SIC). Where that was not possible they have been classified according to their main ICT-related activity, on the basis of revenue derived from that activity. In some cases a firm's primary SIC does not fully reflect its activities (*e.g.* IBM, which now derives a majority of its revenues from services and software). However, primary SIC classifications are followed for consistency. Where conglomerates have substantial ICT-related activities they have been classified according to their major activities – principally electronics (*e.g.* Siemens). This necessarily involves a degree of judgement. Nevertheless, a consistent and workable framework has been established.

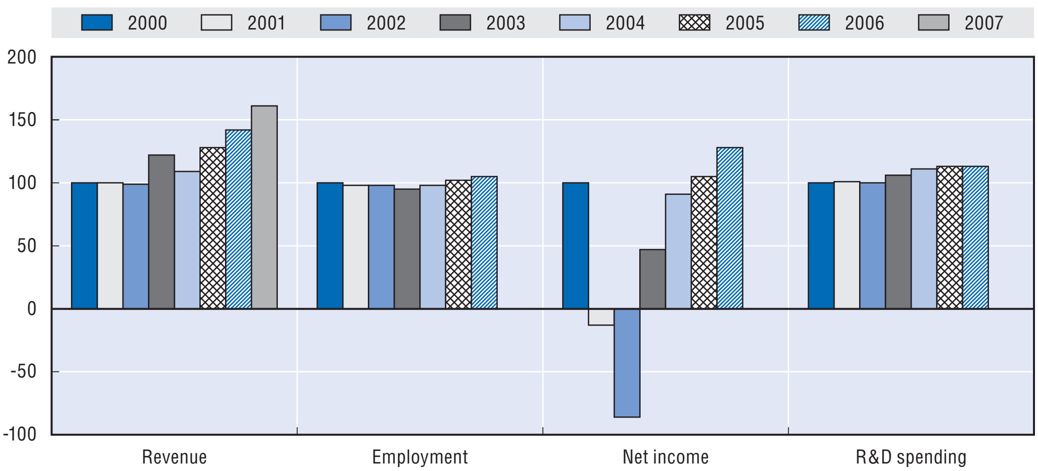
The top 250 ICT firms are ranked by 2006 total revenues, the most recent comprehensive financial year reported at the time of writing in 2008. Updates for 2007 reported revenues (*i.e.* fiscal year ending December 2007 and later) have been compiled after establishing the 2006 list, as most, but not all, companies had issued annual reports by mid-2008. Revenue updates for 2007 are provided where they add insight to the analysis but were not used to compile a new cohort of top 250 firms, *i.e.* the 2007 revenues reported here are for the ICT top 250 in 2006, which will be different from the top 250 firms in 2007. Historical data are drawn from company annual reports. In each case, company name, country, industry, revenue, employment, R&D expenditure, and net income are recorded. Financial data are reported using United States GAAP wherever possible. Time series data reflect current reporting and restatements of historical data relating to continuing operations. The country base is the place of company registration.

Top 250 ICT firms

The top 250 ICT firms employed around 12 million people worldwide and earned total revenues of USD 3 375 billion, some USD 325 billion (around 11%) more than in 2005 (in current USD tracking the same panel of 250 firms over time). In 2007, revenues of the same set of 250 ICT firms grew by 12% in current USD and reached USD 3 790 billion. Average revenue of the top 250 ICT firms increased by 6% a year between 2000 and 2006, and increased by 7% between 2000 and 2007. Average R&D expenditure between 2000 and 2006 increased by around 2% a year and average employment by almost 1% a year. Employment in the top 250 ICT firms in 2006 in OECD countries was equivalent to almost 70% of ICT sector employment (see section below on ICT sector employment), and because the top 250 data tracks successful firms, this share has increased over time. Net income fell dramatically in 2001 and 2002, but there was a strong recovery from this trough. Aggregate net income increased by 5% a year between 2000 and 2006 to more than USD 256 billion, while average net income increased by 4% a year to more than USD 1 billion. Not all firms are publicly listed, but the average recorded market capitalisation of the top 250 ICT firms increased from USD 26.3 billion in 2001 to USD 30.8 billion in late 2007, although there have since been sharp declines (see Figures 1.6 and 1.7).[10]

Figure 1.6. **Top 250 ICT firms' performance trends, 2000-07**[1]

Average number of employees and current USD, index 2000=100



StatLink http://dx.doi.org/10.1787/472683503145

Note: Based on averages for those firms reporting.

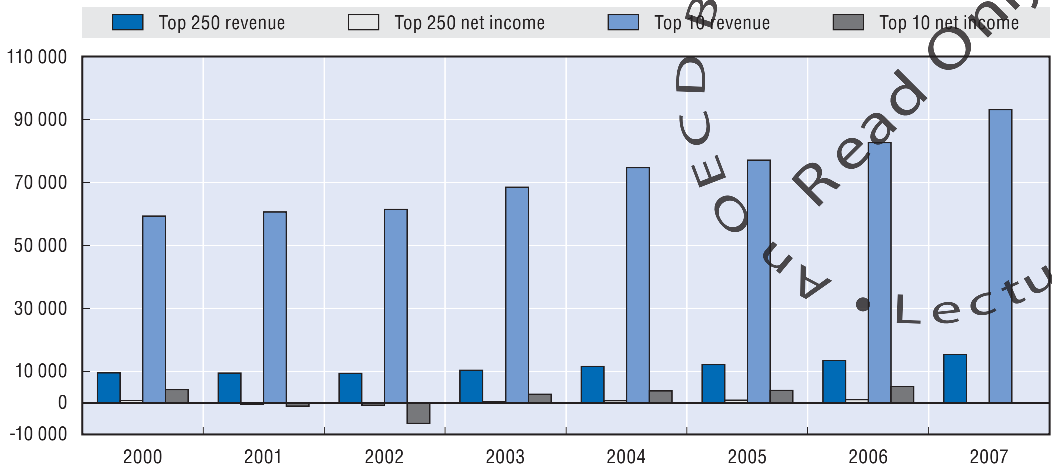
1. Data for 2007 only available for revenue.

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

The top 250 firms spent an average of around 6% of revenue on R&D during 2006, while the top 10 spent around 4%. This partly reflects incomplete reporting, the number of telecommunication services firms in the top 10, specialisation in some sectors, and the diversification of large conglomerate operations (see Chapter 3 for detailed discussion and comparisons with other sectors). It may also to some extent reflect the continuing adaptation of the organisation of R&D and innovation, the interest in collaboration and so-called open innovation, and the move away from centralised corporate laboratories (Chesbrough, 2003; Chesbrough *et al.*, 2006; Houghton, 2006). Nevertheless, the ICT-producing sector is relatively R&D-intensive across all firm sizes. The ICT top 250 average

Figure 1.7. **Top ICT firms' revenue and net income trends, 2000-07**[1]

Average USD millions in current prices



StatLink http://dx.doi.org/10.1787/472685800445

Note: Based on averages for those firms reporting.

1. Data for 2007 only available for revenue.

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

R&D spending was around 6% of average 2006 revenues compared to the 3.8% reported by the top 1 000 innovating firms in all sectors (Jaruzelski and Dehoff, 2007). Some of the largest ICT firms are major R&D spenders: Microsoft spent more than USD 7 billion on R&D in 2007, Samsung, IBM, Nokia and Siemens more than USD 6 billion, and Intel, Matsushita, Sony, Cisco Systems and Motorola between USD 4 and 6 billion (see also Chapter 3).

The top 100 ICT firms accounted for around 80% of top 250 revenues in 2006, the top 50 accounted for 63% and the top 10 for 25%. These shares have fallen a little since 2000. Shares of employment were similar throughout the period, with the top 100 accounting for 76% of top 250 employment in 2006, the top 50 for 58% and the top 10 for 20%. There is little difference in performance by firm size; average revenues, net incomes and employment increased evenly across size ranges. However, market capitalisation increased somewhat faster for larger firms than for smaller firms, with the average reported market capitalisation of the top 50 ICT firms increasing by 6% a year between 2001 and late 2007 to an average of USD 66 billion, compared with 2.6% a year to USD 31 billion for the top 250.

Top 250 ICT firms by country

Continuing globalisation and restructuring of the ICT sector is reflected in an increase in the number of top 250 ICT firms in Asia and in emerging economies elsewhere. There are fewer US-based firms in the 2006 top 250 panel than in previous years, and there are more firms from Chinese Taipei, India, China, Hong Kong (China), Korea, Singapore, Malaysia and Indonesia as well as from Brazil, South Africa, the Russian Federation, Egypt, Saudi Arabia and Venezuela.[11]

In all, 40 economies were reported as bases for the top 250 ICT firms in 2006 (*i.e.* place of registration): 99 (40%) were based in the United States, 40 were based in Japan and 19 in Chinese Taipei. Seven were based in Canada and France, six in Korea and the United Kingdom, and five in Germany and the Netherlands. Regionally, the 115 firms based in the Americas accounted for 39% of top 250 revenues in 2006 (USD 1 303 billion), 36% of

Table 1.1. **Economies represented in the top 250 ICT firms, 2000 and 2006**

By economy of registration, in employment numbers, USD millions in current prices, and percentages

	Firms	Revenue 2000	Revenue 2006	Employees 2000	Employees 2006	Net income 2000	Net income 2006	Annual growth % 2000-06
Australia	1	11 246	17 379	50 761	44 452	2 138	2 399	7.5
Austria	1	2 942	6 054	18 301	15 583	–13	780	12.8
Belgium	2	5 481	9 585	23 769	19 617	388	1 723	9.8
Bermuda	2	11 331	25 404	71 300	165 582	2 464	1 125	14.4
Brazil	3	11 970	19 360	..	61 157	575	2 212	8.3
Canada	7	57 296	56 432	221 252	218 818	441	3 830	–0.3
Cayman	1	6 448	9 206	42 800	60 000	310	840	6.1
China	4	20 976	46 600	114 717	307 438	3 211	3 400	14.2
Denmark	1	5 787	8 378	18 363	18 546	1 143	608	6.4
Egypt	1	626	4 401	..	..	11	786	38.4
Finland	1	27 868	51 660	58 708	109 871	3 613	2 992	10.8
France	7	89 444	127 038	547 214	547 328	5 130	10 083	6.0
Germany	5	118 316	203 303	677 343	714 309	14 067	10 019	9.4
Greece	3	7 156	17 784	38 149	31 020	1 207	1 709	16.4
Hong Kong, China	4	24 831	65 091	68 318	326 132	3 332	10 236	17.4
Hungary	1	1 580	3 190	14 380	12 262	236	340	12.4
India	4	1 025	10 053	18 830	260 482	103	2 137	46.3
Indonesia	1	1 587	5 600	..	34 021	419	1 322	23.4
Ireland	1	1 806	2 127	12 606	8 306	171	9	2.8
Italy	2	29 476	46 393	112 093	90 353	2 550	1 323	7.9
Japan	40	701 001	776 924	2 581 788	2 903 706	7 981	21 365	1.7
Korea	6	78 787	129 638	301 830	178 713	4 487	14 242	8.7
Malaysia	1	2 320	4 451	24 789	19 094	186	625	11.5
Mexico	2	13 693	37 534	80 378	127 406	3 012	6 147	18.3
Netherlands	5	50 598	63 070	296 295	222 783	15 918	8 096	3.7
New Zealand	1	2 562	3 774	7 298	6 677	292	–40	6.7
Norway	1	4 042	14 200	24 950	27 600	123	2 866	23.3
Portugal	1	4 721	7 969	18 539	27 780	495	809	9.1
Russian Federation	2	1 316	11 252	..	45 428	253	1 887	43.0
Saudi Arabia	1	4 515	9 010	..	..	1 054	3 413	12.2
Singapore	2	10 066	23 609	95 000	135 000	2 805	2 228	15.3
South Africa	4	8 722	20 436	16 970	52 731	466	3 180	15.2
Spain	1	27 306	66 459	145 730	232 996	1 693	7 966	16.0
Sweden	3	37 381	43 873	136 744	101 507	3 408	5 645	2.7
Switzerland	2	13 844	17 794	61 109	68 927	3 379	2 050	4.3
Chinese Taipei	19	36 777	152 118	45 820	789 900	4 493	10 267	26.7
Turkey	1	2 258	4 700	2 523	2 941	228	876	13.0
United Kingdom	6	71 193	98 716	339 553	258 831	7 530	–6 859	5.6
United States	99	800 823	1 151 408	3 175 008	3 594 142	91 033	113 300	6.2
Venezuela	1	5 227	3 166	..	9 199	..	525	–8.0
Total	250	2 314 344	3 375 137	9 463 228	11 850 638	190 332	256 459	6.5
OECD	216	2 129 595	3 032 724	8 668 211	10 469 104	168 609	218 935	6.1

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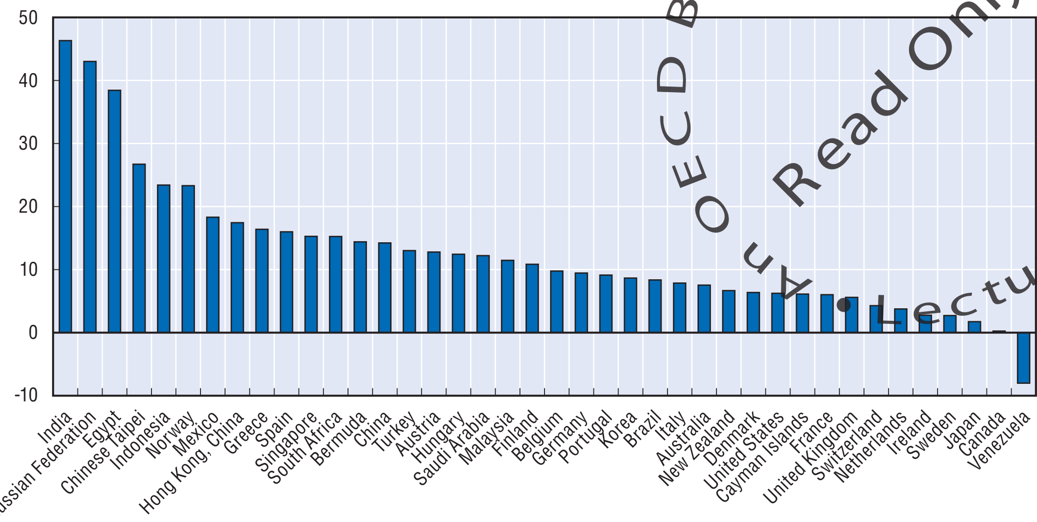
Note: Cohort data are necessarily incomplete for firms that did not exist and/or report in 2000. As a result these data marginally exaggerate growth for Bermuda, Chinese Taipei, Germany, India, the Netherlands and the United States.

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

employment and 50% of the overall net profit; the 83 firms based in the Asia-Pacific region accounted for 37% of revenue (USD 1 235 billion), 42% of employment and 27% of the overall net profit; and the 44 firms based in Europe accounted for 24% of revenue (USD 790 billion), 21% of employment and 20% of the overall net profit.

Figure 1.8. **Top 250 ICT firms' revenue growth by economy of registration, 2000-06**

Average annual growth, percentages



StatLink http://dx.doi.org/10.1787/472707062770

Note: Cohort data are necessarily incomplete for firms that did not exist and/or report in 2000. As a result these data marginally exaggerate growth for Bermuda, Chinese Taipei, Germany, India, the Netherlands and United States.

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

Firm performance across countries has been mixed. Regionally, revenues have grown faster over the last five years in Europe (8% a year) than elsewhere (6.2% a year in the Americas, and 5.6% a year in the Asia-Pacific). Top 250 firm revenues declined in Venezuela (a single firm) between 2000 and 2006 and were static in Canada but rose by more than 20%

Box 1.2. **ICT equipment manufacturing in Chinese Taipei and China**

Ongoing globalisation is leading to increasing regional specialisation, with ICT equipment and related electronics manufacturing gravitating to Asia. Of the top 250 ICT firms, ranked by 2006 revenue, no fewer than 19 are based in Chinese Taipei, and all but one are manufacturers.

Eleven of these Chinese Taipei-based firms are IT equipment manufacturers: Hon Hai Precision, ASUSTeK Computer, Quanta Computer, Acer, Compal Electronics, Inventec, Wistron, Benq, Lite-on Technology, High Tech Computer, and MiTAC International; and seven are electronics and component firms (including semiconductors): AU Optronics, Chi Mei Optoelectronics Corp, Chunghwa Picture Tubes, United Microelectronics (UMC), Taiwan Semiconductor, Advanced Semiconductor Engineering, and PCS (Powerchip Semiconductor). The sole Chinese Taipei-based telecommunications services firm in the top 250 is Chunghua Telecom.

Aggregate revenues in 2006 were more than USD 152 billion (average USD 8 billion), net income USD 10.3 billion (average USD 570 million) and total employment 790 000 (average 41 575). In 2007, aggregate revenues of these companies exceeded USD 200 billion, further extending their rapid growth since 2000, with aggregate revenues increasing by 28% a year between 2000 and 2007, and average revenue increasing by 26% a year. Some of these firms are also very active in patenting (*e.g.* Hon Hai Precision, which individually, with Tsinghua University and through holdings such as Hongfujin is assignee for more nanotube patent families than firms such as IBM, Intel or Motorola).

Three more IT equipment manufacturing firms were based in China and another essentially Chinese firm was registered in Bermuda. They are: Lenovo, Huawei Technologies, ZTE and TPV Technology. The aggregate revenue for these four firms was almost USD 39 billion during 2007 (average USD 9.7 billion).

a year in India, the Russian Federation, Egypt, Chinese Taipei, Indonesia and Norway. This reflects a number of factors, including the sectoral composition of firms, different levels of specialisation and roles in global production systems. It also reflects the emergence of new developing economies both as new growth markets and as locations for ICT production by indigenous as well as multinational firms.[12]

Top 250 ICT firms by sector[13]

Deregulation of telecommunications has allowed telecommunications firms to expand their operations internationally, and a number of major regional carriers have emerged as a result. By sector, 74 (30%) of the top 250 firms in 2006 were telecommunication services providers, 61 (24%) were electronics manufacturers, 39 (15%) were IT equipment and systems producers, 26 were IT services providers, 17 semiconductor firms, 15 communication equipment and systems producers, and there were nine software publishers and nine Internet firms.

Telecommunication services firms and electronics firms (including semiconductors) accounted for the largest shares of top 250 revenues, at around USD 1 100 billion. IT equipment firms accounted for 19% (USD 637 billion), communications equipment firms for around 7% (USD 219 billion), IT services firms for 5% (USD 171 billion), software firms for 3% (USD 89 billion) and Internet firms for 2% (USD 56 billion). Reflecting a recovery of hardware and systems revenues in recent years, average revenue in 2006 was highest among IT equipment firms, at USD 16.3 billion. Telecommunications firms averaged revenues of USD 15.4 billion, electronics firms USD 15.2 billion, and communications equipment firms USD 14.6 billion. Software and services firms tend to be smaller, averaging revenues of USD 9.8 billion and USD 6.6 billion, respectively. These differences are also reflected in reported market capitalisation; capitalisation of telecommunications services firms in the top 250 approached USD 2 000 billion in late 2007, while that of IT services firms was less than USD 200 billion.

Table 1.2. **Top 250 ICT firms by sector, 2000 and 2006**

USD millions in current prices and number of employees

	Revenue 2000	Revenue 2006	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006
Communications equipment	185 959	219 448	638 634	561 693	21 048	25 136	8 024	18 035
Electronics	750 161	929 470	3 555 322	3 674 729	39 517	50 729	37 754	52 977
Internet	18 322	56 073	47 539	93 360	466	3 195	273	8 514
IT equipment	434 458	636 933	1 401 089	2 256 384	24 183	28 839	21 422	31 877
Semiconductors	97 649	130 533	301 775	433 090	11 947	19 830	19 738	16 131
IT services	115 998	170 738	723 998	1 199 168	1 548	1 609	8 717	8 869
Software	52 390	88 737	157 551	262 345	7 907	13 396	18 043	20 125
Telecommunications	659 406	1 143 206	2 637 320	3 369 869	5 955	8 711	76 361	99 931
Total	2 314 344	3 375 137	9 463 228	11 850 638	112 571	151 447	190 332	256 459

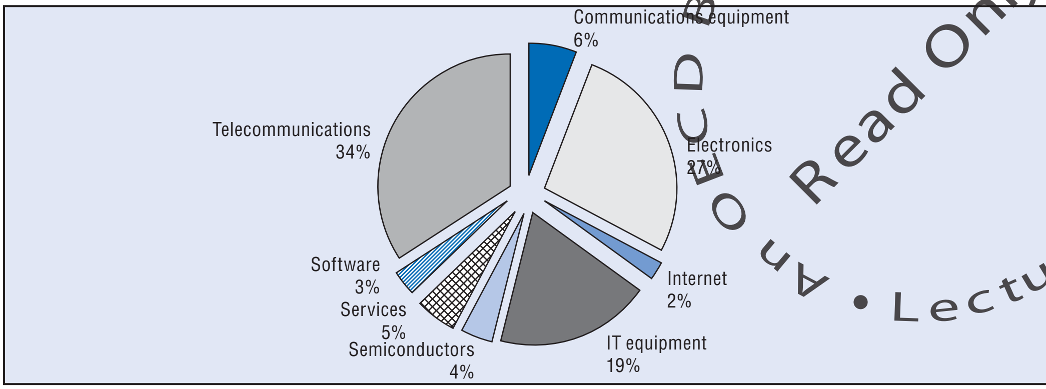
StatLink http://dx.doi.org/10.1787/476228688162

Note: Cohort data are necessarily incomplete for firms that did not exist and/or report in 2000.
Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

Nevertheless, revenue growth has been strongest for telecommunications services and software firms, both of which increased revenues by more than 9% a year between 2000 and 2006, and Internet firms have grown even more strongly, but from a low

Figure 1.9. **Top 250 ICT firms' revenue shares by sector, 2006**

Percentages



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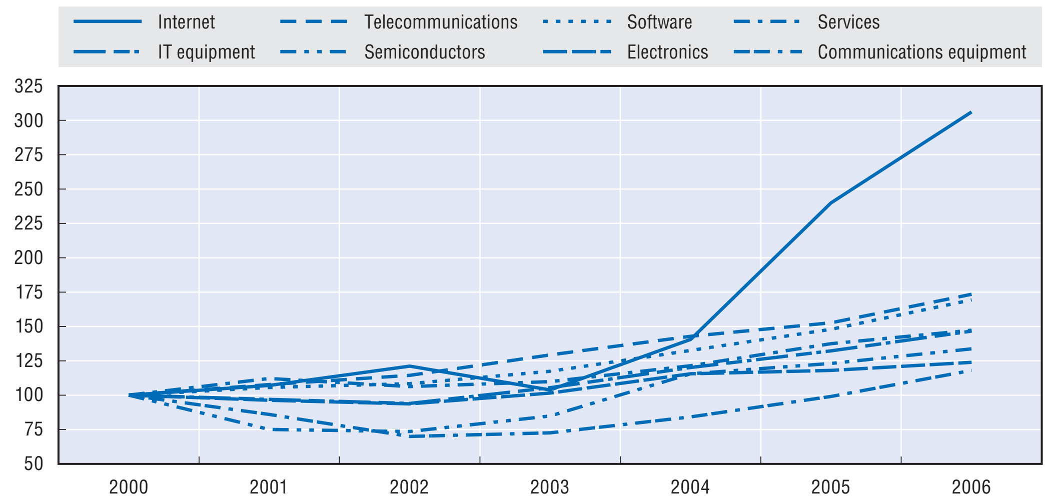
Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

base. IT services and IT equipment and systems firms increased revenues by around 6.6% a year, while electronics, semiconductors and communications equipment firms have seen increases of around 3 to 5% a year since 2000, owing to declining revenues in 2002-03. Employment in this group of firms has grown overall, particularly outside of the OECD area due to the rise of Asian ICT manufacturing and to a lesser extent ICT services firms. Employment grew most strongly in Internet, software and IT services firms, and only declined for communications equipment firms.

Figure 1.10. **Top 250 ICT firms' revenue trends by sector, 2000-06**

USD current prices, index 2000=100



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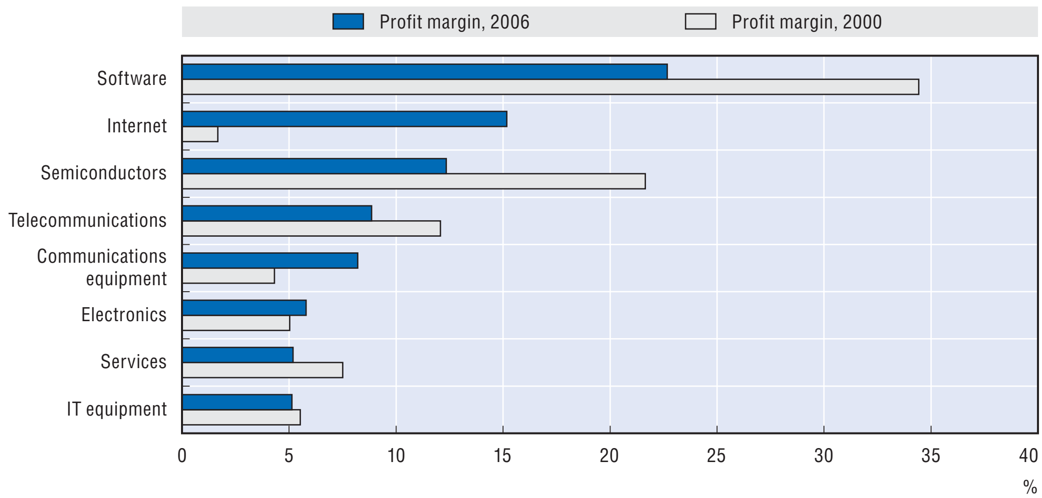
Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

During the 2001-02 downturn, top 250 cohort firms in the telecommunications services, communications equipment and electronics sectors experienced substantial losses, with software and IT services alone remaining profitable in the whole period from 2000 to 2006. All sectors were profitable from 2003, with strong income growth in the communications equipment, IT equipment and systems, and electronics sectors which tend to have more pronounced business cycle behaviour due to the investment accelerator effect of IT and IT-related investment. Similar patterns can be expected in the economic downturn that began in mid-2008.

The average profit margin of the top 250 ICT firms was 7.7% in 2006, compared with 8.5% in 2000 (*i.e.* average net income over average revenue, to account for missing data). Average margins in 2006 are highest among software, Internet and semiconductor firms, at 23, 15 and 12%, respectively, while telecommunications services and communications equipment firms realised average margins of 8.9 and 8.2%, respectively. The margin for telecommunications services was significantly lower in 2006 than in 2000, and the margin for communications equipment significantly higher. Average profit margins in the other sectors have been relatively steady throughout the period, at around 5 to 7%.

Figure 1.11. **Top 250 ICT firms' profitability by sector, 2000-06**

Average net income as a share of average revenue, percentages



StatLink http://dx.doi.org/10.1787/472731716217

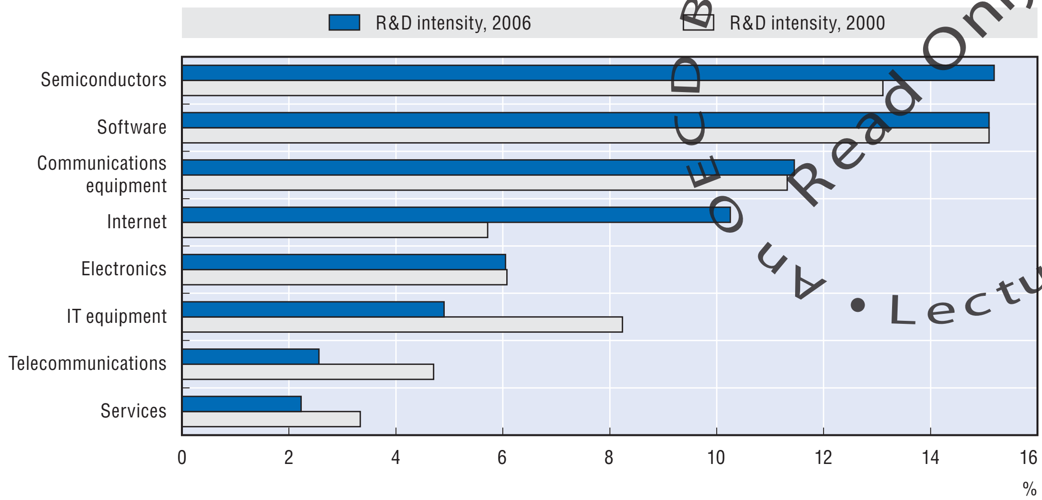
Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

R&D data are incomplete as not all firms report R&D expenditures; fewer services than manufacturing and systems firms do so. Reporting and accounting practices also vary. Nevertheless available data show that electronics and semiconductor firms have the largest share (47% of the top 250 total in 2006), followed by IT equipment and systems firms and communications equipment firms (36% between them). Reporting software and semiconductor firms were on average the most R&D-intensive. Communications equipment firms were also relatively R&D-intensive. However, R&D expenditures by Internet, telecommunications services and software firms reporting R&D expenditure increased more rapidly from 2000 to 2006. (The presentation here and in Annex 1.A1 is based on calculations for the whole cohort of top 250 firms, whether or not they report R&D. Chapter 3 contains a more detailed discussion based only on firms that report R&D.)

R&D spending reflects past firm performance and potential future performance, with past performance providing funding for current R&D spending and current R&D a platform for future growth, revenue and profits. It may also be seen as an element of cost, which directly affects current operating margins, although in the revised System of National

Figure 1.12. **Top 250 ICT firms' R&D intensity by sector, 2000-06**

Average R&D spending as a share of average revenue, percentages



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Note: R&D expenditure data are incomplete and the presentation is based on those firms reporting R&D compared with the whole database.

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

Accounts, output of R&D will be classified as assets and R&D expenditure as investments (Robbins, 2007). In 2006, average net income for the cohort of communications equipment, electronics and Internet firms was higher than it had been in 2000, suggesting that their R&D efforts were paying off. However, the opposite was true of semiconductor and software firms, showing that R&D does not automatically feed into profits and that firm-specific, sector-specific and market-specific factors intervene.

Individual firm performance

There have been numerous entries into and exits from the top 250 since it was first compiled in 2001 (See OECD *Information Technology Outlook 2002*). A number of those exiting have been taken over (*e.g.* Compaq by Hewlett Packard, C-MAC Industries by Solectron and now Flextronics, SCI Systems by Sanmina, Peoplesoft by Oracle, SBC, Bell South and MCI Worldcom by AT&T, Lucent by Alcatel, and Maxtor by Seagate). Others have simply dropped below the revenue cut-off line (*e.g.* ACT Manufacturing, ASM International, Ciena, Cirrus Logic, Iomega, Misys, Xilinx and Fairchild Semiconductor), although revenue differences between the firms rankings around 250 are very small. New entrants are the result of such forces as deregulation and privatisation in telecommunications, spin-offs and organic growth. Chief among new entrants are telecommunications and IT services firms (*e.g.* China Mobile, China Unicom, Singtel, Google, Yahoo!, Wipro, TCS and Infosys). Spin-offs include Benq, Palm, Infineon Technologies, Wistron, Freescale Semiconductor and NXP.

Of the top 250, 208 had increasing revenues between 2000 and 2006, and just 35 suffered declines (206 and 37 in 2007). Seven new arrivals that did not report in 2000 also increased revenues on trend. Thirteen of the top 250 had revenue growth in excess of 40% a year (*i.e.* Google, Research In Motion, High Tech Computer, Chi Mei Optoelectronics, VimpelCom, Infosys, Expedia, Hon Hai Precision, MTN, Bharti Airtel, AU Optronics, e-bay and ASUSTeK Computer, although the last two dropped a little below 40% CAGR by 2007). Of the 53 firms that increased revenues by more than 20% a year over the six years to 2006,

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16 were based in the United States and 11 were based in Chinese Taipei. Four were in the top 50 (Hon Hai Precision, ASUSTeK Computer, America Movil and Vodafone), and 14 in the top 100. Twenty-one of these fastest-growing firms were in telecommunication services, 12 in the IT equipment and systems sector, five were Internet firms. and five in communications equipment and electronics (including semiconductors), three in IT services, and one in software.

Box 1.3. **Fast-growing ICT firms in the top 250**

Thirteen of the top 250 ICT firms reported revenue growth of 40% a year or more between 2000 and 2006 (11 for the period between 2000 and 2007). By sector, they include three IT equipment, Internet and telecommunications firms, two electronics firms and a single IT services and communications equipment firm. No fewer than five are based in Chinese Taipei, two in India and the United States, and one in South Africa, the Russian Federation and Canada.

They are: Google (United States, Internet), Research in Motion (Canada, Communications equipment), High Tech Computer (Chinese Taipei, IT equipment), Chi Mei Optoelectronics Corp (Chinese Taipei, Electronics), VimpelCom (Russian Federation, Telecommunications), Infosys (India, IT services), Expedia (United States, Internet), Hon Hai Precision (Chinese Taipei, IT equipment), MTN (South Africa, Telecommunications), Bharti Airtel (India, Telecommunications), AU Optronics (Chinese Taipei, Electronics), e-bay (United States, Internet) and ASUSTeK Computer (Chinese Taipei, IT equipment). The last two dropped a little below 40% CAGR by 2007.

Employment increased in 134 of the top 250 ICT firms over the period 2000-06, and declined in 70 (data were not available for the rest). Job growth has clearly been strong in most IT services, software, Internet, IT equipment and systems firms, although in all sectors individual firms did well while others performed poorly. Deregulation and increasing competition has led to some significant declines in employment in telecommunications services.

Among the top 250 ICT firms that report R&D expenditures, nine spent more than 20% of revenue on R&D in 2006 (four in the semiconductors sector, two in communications equipment, two in the software sector, and one in the electronics sector). No fewer than 42 firms reported R&D spending in excess of 10% of revenues.

Top 50 ICT firms

Ranked by 2006 revenues, the largest ICT firms are: Siemens (USD 97 billion), Hewlett-Packard (USD 92 billion), IBM and NTT (USD 91 billion), Verizon (USD 88 billion), Hitachi (USD 81 billion), Deutsche Telekom (USD 77 billion), Matsushita (USD 76 billion) and Telefonica (USD 66 billion). In 2007, AT&T and Hewlett-Packard surpassed USD 100 billion in revenues (see last column in Table 1.3). At the other end of the top 50, just eight firms earned revenues of less than USD 20 billion (Apple, Korea Telecom, Accenture, Telstra, Sumitomo Electric, Schneider Electric, ASUSTeK Computer and Ricoh), and in 2007 only Ricoh, ASUSTeK, and Sanyo were below this threshold. Ten firms employed more than 200 000 in 2006 (Hitachi, Hon Hai Precision, Siemens, IBM, Matsushita, AT&T, Deutsche Telekom, China Telecom, Verizon Communications and Telefonica SA), and 23 employed

Table 1.3. **Top 50 ICT firms ranked by revenue in 2006**

USD millions in current prices and number employed

		Industry	Revenue 2000	Revenue 2006	Revenue 2007	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006	Market cap 2007
Siemens	Germany	Electronics	64 405	97 436	99 108	419 000	371 000	4 425	6 312	6 528	3 823	116 630
Hewlett-Packard	United States	IT equipment	48 870	91 658	104 286	88 500	156 000	2 627	3 591	3 697	6 198	129 370
IBM	United States	IT equipment	85 089	91 423	98 785	316 303	355 766	5 084	6 107	8 093	9 491	154 450
NTT	Japan	Telecommunications	92 679	91 410	91 191	224 000	199 113	3 178	2 651	–603	4 286	59 810
Verizon Communications	United States	Telecommunications	64 707	88 144	93 469	263 552	238 519	..	..	11 797	6 197	125 360
Hitachi	Japan	Electronics	72 725	81 345	86 059	323 827	390 725	3 930	3 546	154	321	23 920
Deutsche Telekom	Germany	Telecommunications	37 559	77 069	85 580	205 000	248 480	642	643	5 437	4 044	78 110
Matsushita (Panasonic)	Japan	Electronics	68 711	76 442	76 488	314 267	328 645	4 881	4 854	874	1 327	38 850
Telefonica SA	Spain	Telecommunications	27 306	66 459	77 264	145 730	232 996	..	739	1 693	7 966	118 160
France Telecom	France	Telecommunications	30 894	64 952	72 497	188 866	191 036	412	1 075	4 707	8 714	75 000
Sony	Japan	Electronics	62 046	64 550	69 665	189 700	163 000	3 660	4 675	1 131	1 062	49 560
Samsung Electronics	Korea	Electronics	34 573	63 480	67 970	173 000	85 813	1 332	6 004	4 768	8 532	..
AT&T	United States	Telecommunications	46 850	63 055	118 928	304 800	301 840	..	223	4 669	7 356	239 380
Dell Computer	United States	IT equipment	25 265	55 788	57 420	40 000	82 800	374	458	1 666	3 602	63 110
Toshiba	Japan	IT equipment	53 349	54 519	59 761	190 870	165 000	3 103	3 197	–305	672	..
Nokia	Finland	Communications equipment	27 868	51 660	69 895	58 708	109 871	2 371	4 896	3 613	2 992	121 100
Microsoft	United States	Software	22 956	44 282	51 122	47 600	79 000	3 772	6 584	9 421	12 599	281 260
Vodafone	United Kingdom	Telecommunications	11 929	43 750	51 199	29 465	66 000	109	408	838	–9 286	175 790
Motorola	United States	Communications equipment	32 107	42 879	36 622	147 000	66 000	3 426	4 106	1 318	3 661	39 220
NEC	Japan	IT equipment	48 343	41 762	39 072	154 787	154 000	2 924	167	97	104	9 620
Fujitsu	Japan	IT equipment	48 484	41 180	42 830	188 053	158 491	3 722	2 071	397	589	13 060
Sprint Nextel	United States	Telecommunications	17 220	41 028	40 146	64 900	64 600	..	..	1 964	1 329	54 690
Telecom Italia	Italy	Telecommunications	27 516	40 052	43 399	107 171	83 209	247	167	3 231	1 303	52 540
China Mobile	Hong Kong, China	Telecommunications	15 249	38 083	46 922	38 345	111 998	..	..	2 978	8 162	219 090
BT	United Kingdom	Telecommunications	28 356	35 937	40 830	132 000	106 204	552	1 349	2 111	1 958	52 700
Canon	Japan	Electronics	25 020	35 725	38 055	86 673	120 976	1 805	2 650	1 244	3 913	69 220
Intel	United States	Semiconductors	33 726	35 382	38 334	86 100	90 300	3 897	5 873	10 535	5 044	144 130
Philips Electronics	Netherlands	Electronics	34 736	33 889	36 678	219 429	125 834	2 553	2 095	8 786	6 763	43 620
Mitsubishi Electric	Japan	Electronics	35 021	30 976	32 379	116 588	99 444	1 615	1 117	230	822	..

Table 1.3. **Top 50 ICT firms ranked by revenue in 2006** *(cont.)*

USD millions in current prices and number employed

		Industry	Revenue 2000	Revenue 2006	Revenue 2007	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006	Market cap 2007
Cisco Systems	United States	Communications equipment	18 928	28 484	34 922	38 000	49 926	2 704	4 067	2 668	5 580	190 640
Hon Hai Precision	Chinese Taipei	IT equipment	2 900	28 440	51 828	9 000	382 000	..	327	..	892	..
KDDI	Japan	Telecommunications	14 159	26 306	28 009	7 361	14 358	73	130	–99	1 638	..
LG Electronics	Korea	Electronics	20 085	24 263	25 286	55 000	31 201	312	1 754	356	223	..
Ericsson	Sweden	Communications equipment	29 866	24 113	27 788	105 129	67 500	4 577	3 787	2 300	3 537	59 800
Sharp	Japan	Electronics	17 210	24 040	26 266	49 748	48 927	1 363	1 596	261	762	19 790
3M	United States	Electronics	16 699	22 923	24 462	75 026	75 333	1 101	1 522	1 782	3 851	62 180
China Telecom	China	Telecommunications	15 663	21 961	23 484	102 647	243 072	..	37	2 754	2 765	42 610
America Movil	Mexico	Telecommunications	3 181	21 482	28 511	13 450	47 526	..	..	96	3 615	102 750
Sanyo Electric	Japan	Electronics	18 005	21 351	19 387	83 519	94 906	928	1 070	201	–1 768	2 890
EDS	United States	Services	18 856	21 268	22 134	122 000	131 063	..	..	1 143	470	11 590
Tech Data	United States	Services	16 992	20 483	21 440	10 500	8 000	..	..	128	27	1 890
Emerson Electric	United States	Electronics	15 545	20 133	22 572	123 400	127 800	594	356	1 422	1 845	36 290
Apple Inc	United States	IT equipment	7 983	19 315	24 006	8 568	17 787	380	712	786	1 989	109 910
Korea Telecom	Korea	Telecommunications	10 686	18 655	20 076	52 533	37 514	..	228	789	1 397	..
Accenture	Bermuda	Services	11 331	18 228	21 453	71 300	140 000	252	298	2 464	973	30 360
Telstra	Australia	Telecommunications	11 246	17 379	20 544	50 761	44 452	91	110	2 138	2 399	38 010
Sumitomo Electric	Japan	Electronics	12 142	17 250	20 198	66 992	133 853	389	554	219	501	..
Schneider Electric	France	Electronics	8 894	17 249	23 695	72 144	100 078	450	411	573	1 692	21 210
ASUSTeK Computer	Chinese Taipei	IT equipment	2 146	16 485	17 931	..	9 587	..	237	475	661	9 310
Ricoh	Japan	Electronics	12 870	16 409	17 374	67 300	81 939	591	988	373	834	14 890
Total			1 508 944	2 130 531	2 387 318	6 048 612	6 833 482	74 445	93 742	121 896	147 426	3 301 870
Average			30 179	42 611	47 746	120 971	136 670	1 477	1 869	2 437	2 949	66 029

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Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

fewer than 100 000. At the end of 2007, the largest single employer was Hon Hai Precision, which reported more than 500 000 employees.

Nineteen of the top 50 ICT firms enjoyed double-digit revenue growth over the period 2000-07, most notably Hon Hai Precision, America Movil, ASUSTeK Computer, and Vodafone. Revenue declined in only four. Twelve firms showed double-digit employment growth between 2000 and 2006 (Hon Hai Precision, America Movil, China Mobile, China Telecom, Vodafone, Apple, Dell Computer, Sumitomo Electric, Accenture, KDDI, Nokia and Hewlett-Packard as a result of mergers and acquisitions); just two firms had double-digit declines.

Profitability was mixed. Thirty-four of the top 50 ICT firms made a net profit of USD 1 billion or more in 2006, with twelve firms making more than USD 5 billion (Microsoft, IBM, France Telecom, Samsung Electronics, China Mobile, Telefonica SA, AT&T, Philips Electronics, Hewlett-Packard, Verizon Communications, Cisco Systems and Intel). Just two reported a net loss for 2006 (Sanyo and Vodafone). Reported market capitalisation of the top 50 exceeded USD 3.3 trillion in late 2007, up from USD 2.3 trillion in 2001. Average market capitalisation (taking account of missing data) increased from USD 47 billion to USD 66 billion, or by 6% a year. The slowdown in the United States and capital market concerns that emerged in late 2007 have led to a reduction in the market capitalisation of some ICT firms in early 2008, but the value of the top 50 firms reporting was down by less than 2.5% as of mid-February.

While firms often cut R&D budgets to control costs during difficult times, some see the need to maintain and even increase them in order to innovate in the years ahead. Overall, ten of the top 50 ICT firms reduced R&D expenditure between 2000 and 2006, and eight significantly increased it (by 10% a year or more). R&D expenditure data are not available for nine of the top 50 ICT firms (primarily telecommunications services providers). Of the remainder, ten spent more than USD 4 billion on R&D in 2006 and Microsoft, Siemens, IBM, Samsung and Intel each spent more than USD 5 billion. Across the top 50, firms reporting R&D expenditure spent an average of 5% of 2006 revenues. However, R&D intensity varied considerably; some firms had very high levels of R&D expenditure as a share of sales and some rather low levels. Four of top 50 firms invested between 10 and 20% of revenue in R&D (Intel, Ericsson, Microsoft and Cisco Systems).

Ongoing globalisation of ICT production and a renewed surge of merger and acquisition activity over recent years have led to considerable changes in the top rankings. Telephonos de Mexico, Lenovo, China Netcom, Amazon, Google, Celestica, Saudi Telecommunications, AU Optronics, HuaWei Technologies and Hynix Semiconductor have joined the ranks of the top 100 ICT firms, while Fuji Electric, First Data, JVC and ADP have fallen out of the top 100. SBC Communications, Bell South and MCI Worldcom have been involved in mergers.

Compiled financial information for 2007 shows that the top ICT firms continued to grow to the end of 2007 and into 2008, with the top 100 reporting revenues of over USD 3 000 billion, USD 340 billion or 13% more than in 2006. USD 257 billion of that increase accrued to the top 50 firms, raising their revenues to over USD 2 380 billion in 2007 but with a sharp slowdown in many segments from mid-2008.

Semiconductors

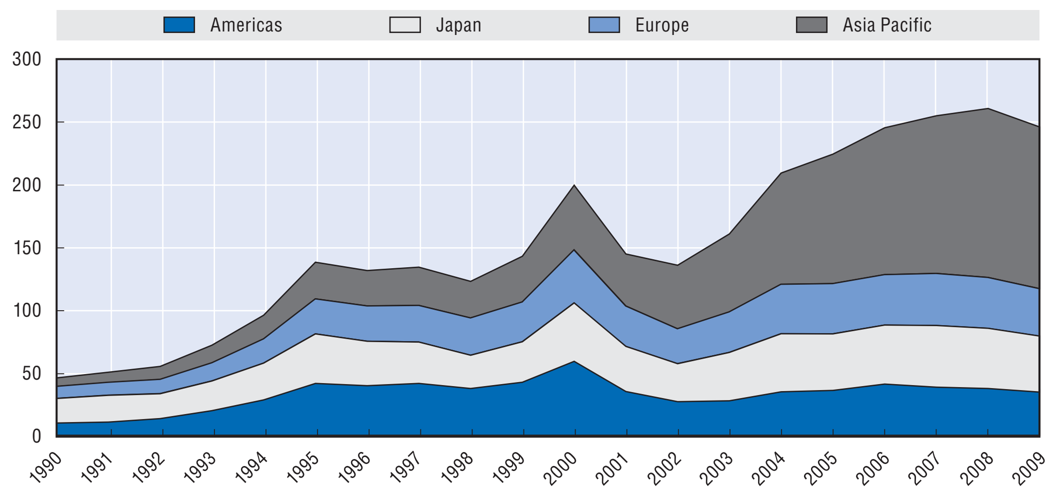
Semiconductors are a key intermediate input into ICT equipment and embedded systems and semiconductor production and shipments are leading indicators of ICT product market trends. Production is highly cyclical, dropping sharply during downturns and recovering quickly in upturns. Continuously growing demand for consumer PCs, digital appliances and mobile communications, enhanced by the increase in semiconductor content per installed system, is expected to drive longer-term growth in semiconductors.

The most recent data suggest 2008 growth of 2.2% to just over USD 260 billion in current prices, down from earlier projections of USD 280 billion, and 2009 sales declining by 5.9% (Figure 1.13).[14] On average, worldwide semiconductor sales have increased by 10% a year since 1990 (in current prices). In the growth cycle between 1990 and 2000 the world market for semiconductors rose from USD 50 billion to more than USD 200 billion, followed by a dramatic collapse of 32% in sales in 2001 to less than USD 140 billion. The upturn beginning in 2002 was strong, with sales increasing by 10% a year to USD 255 billion in 2007, but sales weakened markedly towards the end of 2008.

Asia is the leading semiconductor market with the global reorganisation of electronics production. By 2007, Asia-Pacific (including Japan) accounted for 68% of worldwide sales, while Europe and the Americas each accounted for around 16%. Between 2000 and 2007, the rest of Asia-Pacific grew by more than 13% a year while Japan's semiconductor market grew slightly and the Americas and Europe declined (Figure 1.13).

Figure 1.13. **Worldwide semiconductor market by region, 1990-2009**

USD billions, current prices



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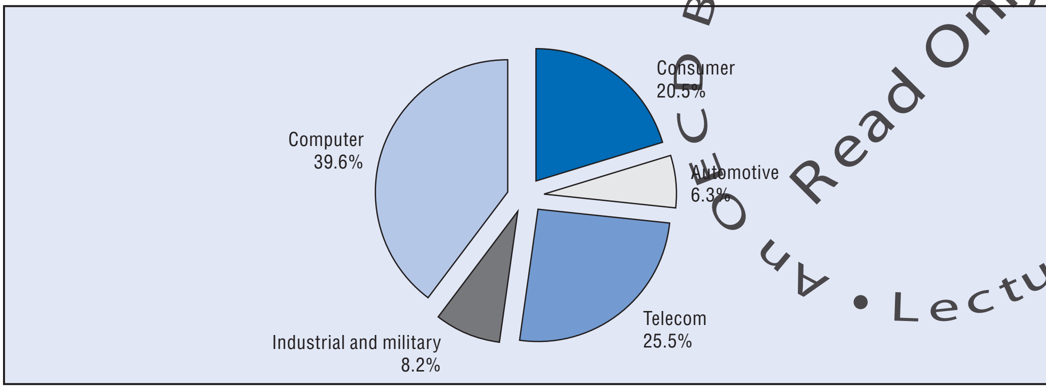
Note: 2008 data are preliminary and 2009 are forecast.

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

The final use of semiconductor products has changed due to shifts in final consumption and technological advances. Consumer electronics and other products, including telecommunications systems and industrial and automotive devices, have all increased, and combined they now take a larger share of final use than computers (Figure 1.14). In the period since 1990 there have been stronger sales of microprocessors and logic devices than of other categories. However since the sales peak in 2000, sales of

Figure 1.14. **Worldwide semiconductor sales by market segment, 2007**

Percentages



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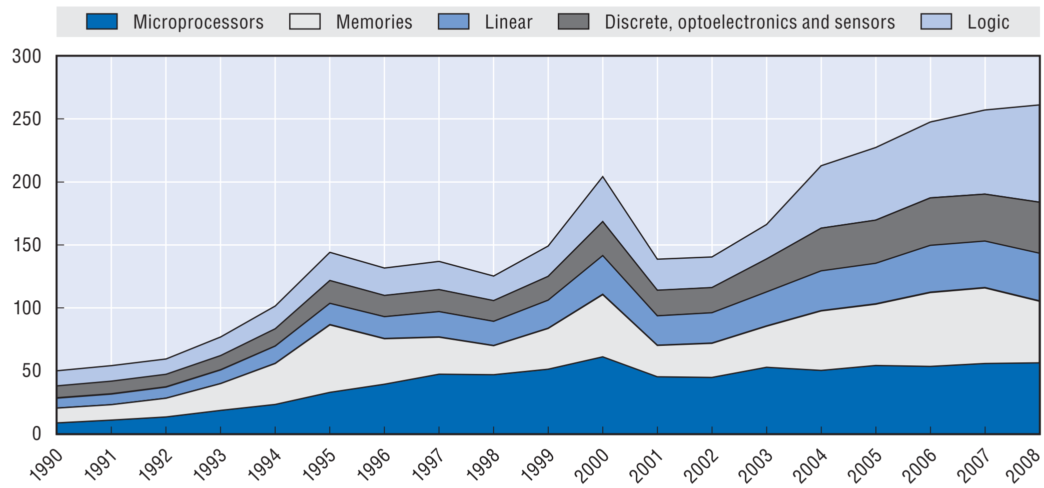
Source: Semiconductor Industry Association (SIA), various years.

logic devices have been strongest in value terms, increasing by 9.4% a year, compared with 4.7% for discrete devices (including optoelectronics and sensors), 2.6% for analogue and memory devices and a decline of 1.3% in microprocessor sales (Figure 1.15).

Figure 1.15. **Worldwide semiconductor market by segment, 1990-2008**

USD billions, current prices



StatLink http://dx.doi.org/10.1787/472805681204

Note: 2008 data are preliminary.

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

In the first half of 2008 semiconductor capacity utilisation was around 90%, with wafer starts increasing particularly for large wafers (300 mm) and very fine line-widths (< 0.08 µm), but with pronounced weaknesses in older, more standard products (SIA, 2008c). However capacity utilisation was starting to decline in mid-2008 and the most recent peak in capacity utilisation around the start of 2008 was lower than the previous peak in the second quarter of 2006 for both larger and smaller wafers.

Demand for semiconductor production equipment is a predictor of the performance of semiconductors and the whole ICT goods industry, as it is driven by projections of semiconductor markets, capacity utilisation and technological change. Delivery of, and demand for, production equipment both declined by at least 20% and up to 40% in 2008, with declines in all regions, and particularly in the biggest market of 2007, Chinese Taipei. Increases are expected in some regions from late 2009 as projected demand for semiconductors strengthens (Semiconductor International, 2008, Manufacturing.net, 2008, Fabtech, 2008).

Semiconductor capital spending had increased by more than 17% a year in current prices to USD 57 billion between 2003 and 2007,[15] with strong growth in 2004 and 2006 and slower growth in 2007. Much of the expansion was in memory manufacturing in Asia (Semiconductor International, 2008; IMF, 2007, p. 45). Spending on wafer fabrication equipment has been stronger, accounting in 2007-08 for around 80% of semiconductor capital equipment spending, packaging and assembly equipment for 12% and automated testing equipment for the remaining 8-9%.

Structural change in the ICT sector

Long-term prospects for sustained growth in the ICT sector[16] are good, as ICTs become a fundamental part of the economic and social infrastructure.[17] The development of new goods and services will drive demand from businesses, households and governments; replacement ICT investment will help boost demand; and the growth of IT services will be underpinned by the expanding use of software and by increasing recourse to outsourcing as ICT-related service activities become codified and rationalised to achieve the productivity gains that have eluded services in general. This section analyses value added and employment on the ICT supply side; it excludes the myriad of ICT and ICT-related activities in other manufacturing and services sectors and in the public sector (education, health care, public services). It is based on the most recent official data and OECD definitions of the ICT sector.

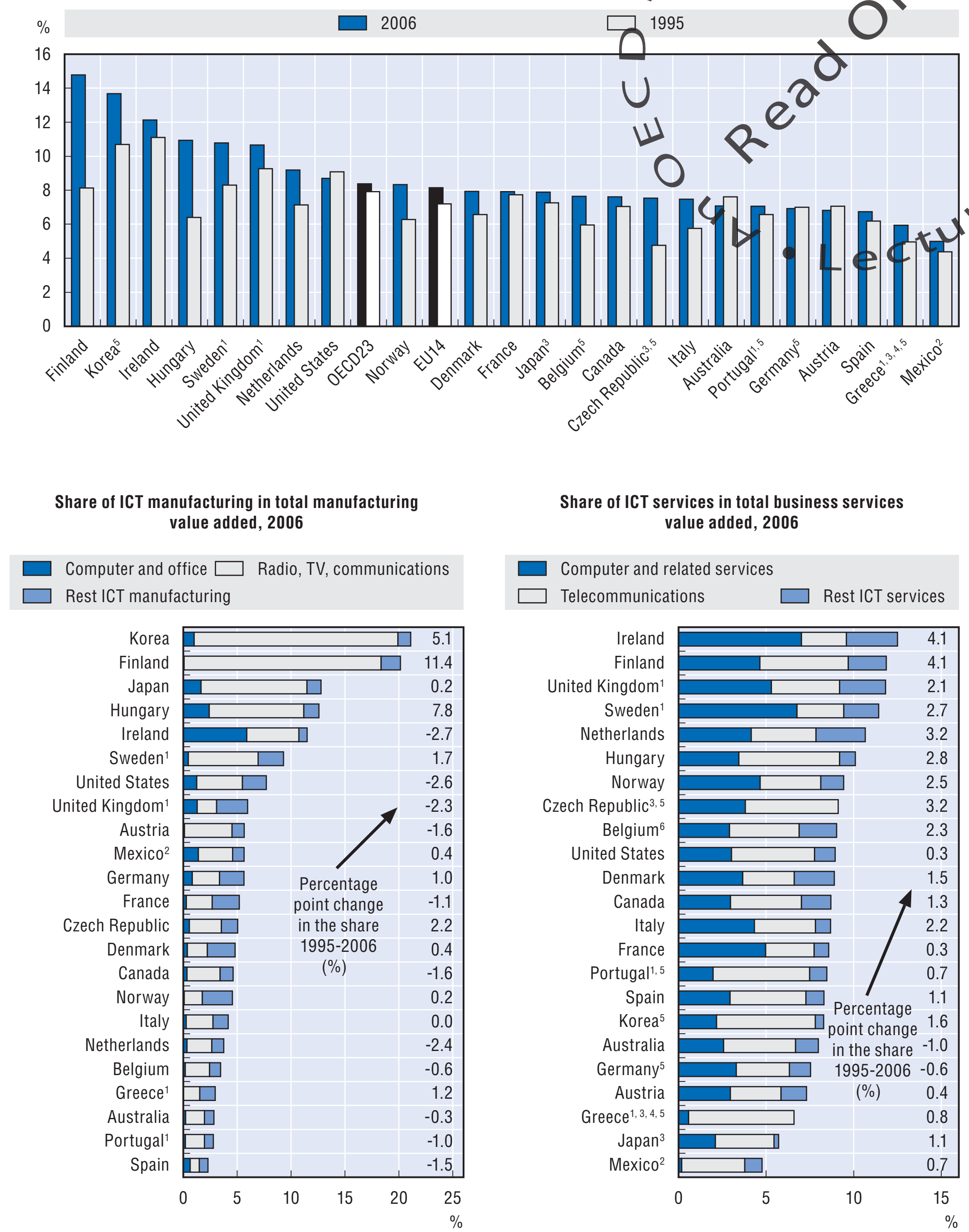
Value added

Value added in the ICT sector increased as a share of business sector value added in most OECD countries over the period 1996-2006, despite the downturn in the early 2000s. The share of the ICT sector was over 8% in 2006, after peaking in 2000 (Figure 1.16). The largest shares are in Finland, Korea and Ireland (all over 12%) and the smallest in Mexico and Greece (below 6%). Increasing shares were most notable in Finland, Hungary and the Czech Republic, as well as in Korea. The shares declined somewhat between 1995 and 2006 in three countries (Australia, Austria and the United States). By country the United States still has around 40% of OECD ICT value added, Europe has around 30%, Japan 12% and Korea 5% (shares in current USD PPPs).

ICT services account for more than two-thirds of total ICT sector value added in most countries and their share has grown. Overall, computer and related services and other ICT services have grown most rapidly, and more rapidly than total business services. They have led the expansion of the total ICT sector which grew more rapidly than the total business sector. ICT manufacturing grew less than manufacturing as a whole from 1995 to 2006, but grew very rapidly until 2000; this points to the structure and impact of the dot.com boom and bust, and the shift of ICT manufacturing to non-OECD economies and particularly to Asia (see above and Chapter 2).

Figure 1.16. **Share of ICT valued added in business sector value added, 1995 and 2006**

Percentages



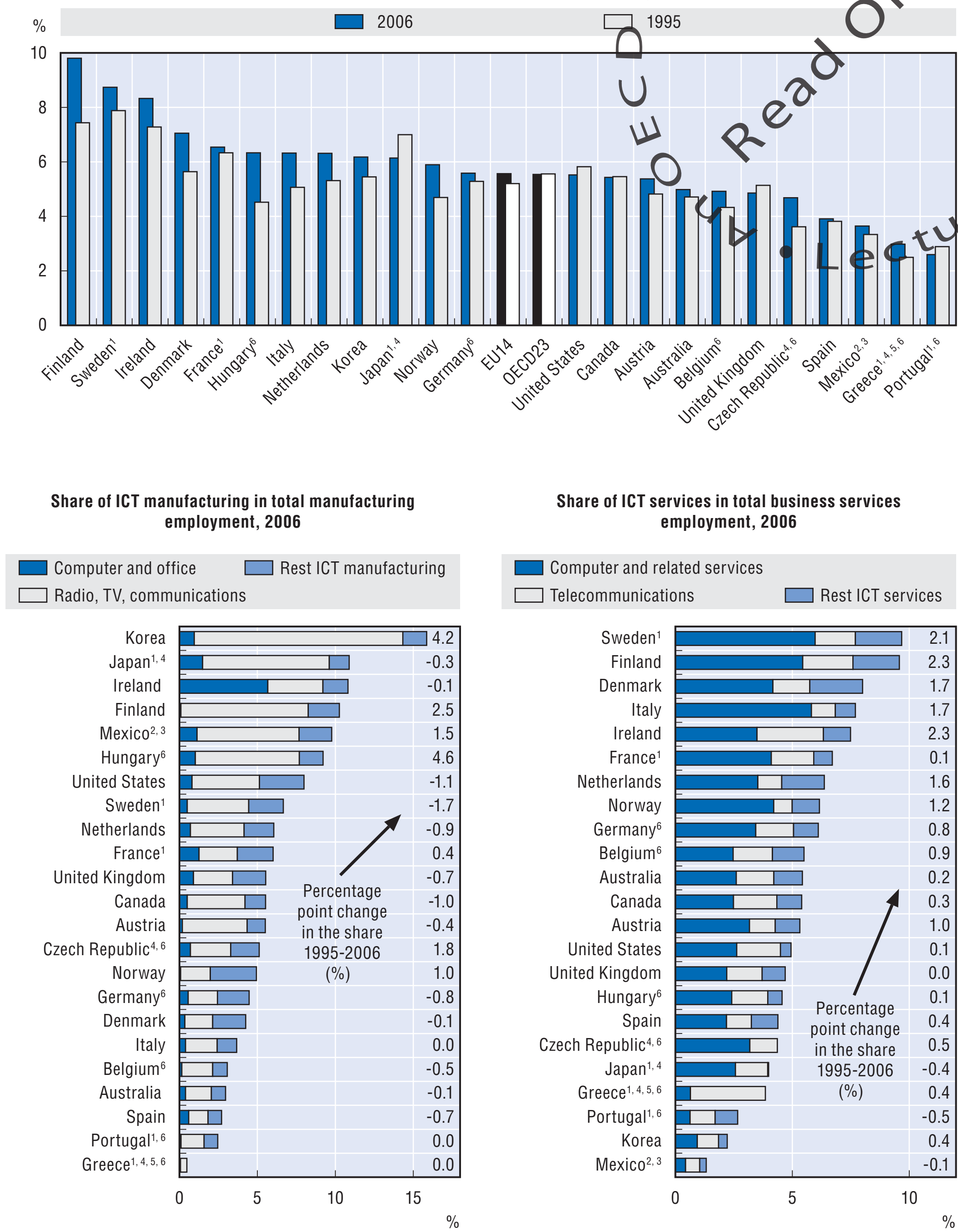
StatLink http://dx.doi.org/10.1787/472807663377

1. 2005 instead of 2006.
2. 2004 instead of 2006.
3. ICT wholesale (5150) is not available.
4. Telecommunication services (642) included Postal services.
5. Rental of ICT goods (7123) is not available.

Source: OECD estimates, based on national sources; *STAN* and *National Accounts databases*, March 2008.

Figure 1.17. **Share of ICT employment in business sector employment, 1995 and 2006**

Percentages



StatLink http://dx.doi.org/10.1787/473088268473

1. 2005 instead of 2006.
2. 2003 instead of 2006.
3. Based on employees figures.
4. ICT wholesale (5150) is not available.
5. Telecommunication services (642) included Postal services.
6. Rental of ICT goods (7123) is not available.

Source: OECD estimates, based on national sources; *STAN* and *National Accounts databases*, March 2008.

Some countries have well above average shares of ICT manufacturing value added despite its relative decline: Korea and Finland above 20% and Japan, Hungary and Ireland above 10%. Most OECD countries manufacture communications equipment and components. However Ireland focuses on computer equipment as an export platform mainly for United States firms, and Denmark, France, Norway and the United Kingdom focus on other ICT equipment, suggesting relative strength in measuring and controlling equipment, also shown in relatively good trade performance in these products (see Chapter 2, Annex).

Employment

More than 15 million people were employed in the ICT sector in OECD countries in 2006, 5.5% of total OECD business sector employment (Figure 1.17). Over the period 1995-2006 ICT sector employment increased at an annual average rate of 0.9%, almost the same as for the total business sector, adding 1.4 million people. Finland, Sweden and Ireland had the largest shares of employment in total business employment, over 8%, and these shares have increased markedly, as they also did in Hungary, the Czech Republic and Denmark. The share of employment in ICTs declined in a few countries (Japan, the United States, the United Kingdom, Portugal and Canada), an indication of the impact of increasing manufacturing and services trade with non-OECD economies; all had relative declines or very low growth in both manufacturing and services. The United States has about 30% of OECD ICT employment, Europe 35%, Japan 14% and Korea 6%.

Over 10 million people are employed in services compared with 5 million in manufacturing, although ICT manufacturing has a higher share of manufacturing employment at around 7.5%, than ICT services have of total services (around 5%). Employment in computer and related services and IT services has grown more rapidly than business services. However, increases in ICT services employment did not counteract declines in ICT manufacturing employment, so that the ICT sector did not increase its share of total business sector employment. As the value added share increased, this is an indication that the sector is becoming less employment-intensive. ICT employment is also more cyclical than value added; it reached a peak in 2000-2001 (2000 in manufacturing, 2001 in services) and only started growing again in 2005.

ICT specialisation and productivity

There are strong parallels between the shares of ICT in manufacturing and services value added and trade performance. Specialisation in the ICT sector reflects the relative strengths of national firms and national factor endowments (see Chapter 2). Korea, Finland, Japan, Hungary, Ireland and Sweden have high manufacturing value added shares, relatively strong export performance, consistent ICT trade surpluses and all except Sweden were in the top group of OECD countries in revealed comparative advantages in ICT goods exports. Ireland also has a high share and strong growth of value added in computer and related services, and is the leading exporter of computer and information services (see Chapter 2).

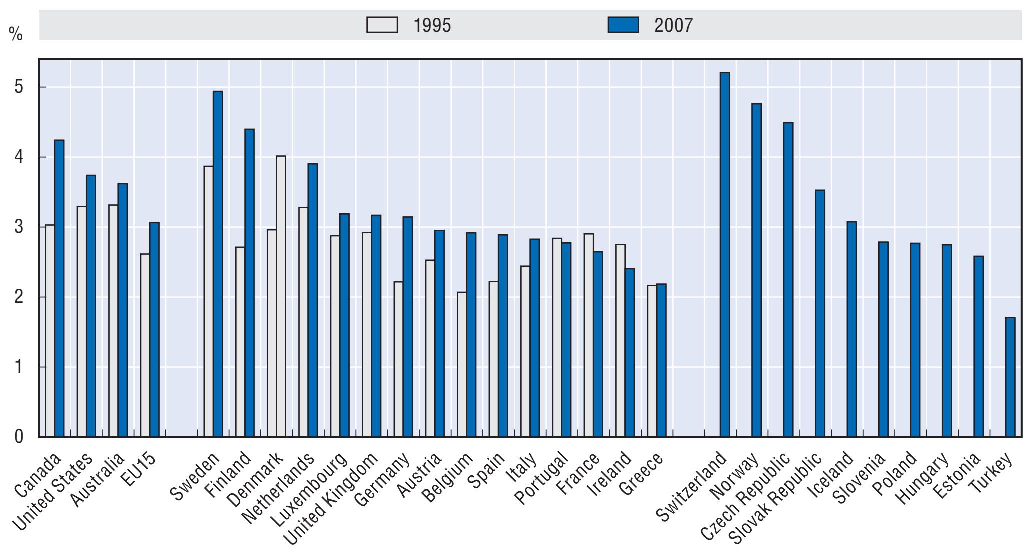
Countries with the highest revealed comparative advantages in ICT goods exports (Korea, Hungary, Ireland, Mexico, Japan, Finland and the Netherlands; see Chapter 2) have a range of production structures and strategies, illustrated by their manufacturing value added/employment productivity ratios (in constant prices and USD PPPs). These ratios are high for Finland, Japan and Korea pointing to innovative and capital-intensive manufacturing. That for the Netherlands is somewhat lower despite strong domestic firms, suggesting that factors other than simple relative productivity in ICT manufacturing drives the Netherland's export performance. Ireland's position contrasts strongly with those of Hungary and Mexico, although all three are assembly platforms for international ICT firms. Ireland has a very high and fluctuating value added/employment ratio due to the pricing behaviour of international firms operating there. Hungary and Mexico have relatively low ratios, suggesting that low-cost labour is a major factor driving their good export performance (see also Chapter 2 on Ireland's exceptional software and computer and IT services trade performance).

ICT employment across the economy

ICT-related employment is spread widely across all sectors of the economy. The analysis in the previous section focuses exclusively on total employment in the ICT sector only. However many ICT employees are elsewhere in the economy carrying out ICT tasks and some employees in the ICT sector are non-ICT. Two measures of ICT employment have been developed based on ICT occupations. One is a narrow measure of ICT occupations, comprising ICT specialists whose job is ICTs, *e.g.* software engineers. The other is a broader measure of ICT employment where ICTs are used regularly as part of the job, but where the job is not focused on ICTs, *e.g.* a researcher or an office worker (see OECD, 2004 and OECD, 2006 for the methodology).

Around 3-4% of total employment in most OECD countries was accounted for by ICT specialists in 2007 (Figure 1.18). This share has risen consistently in recent years in most countries, despite the relative stagnation in the share of ICT sector employment in

Figure 1.18. **Share of ICT specialist occupations in the total economy, narrow definition,[1] 1995[2] and 2007**



StatLink http://dx.doi.org/10.1787/473176738275

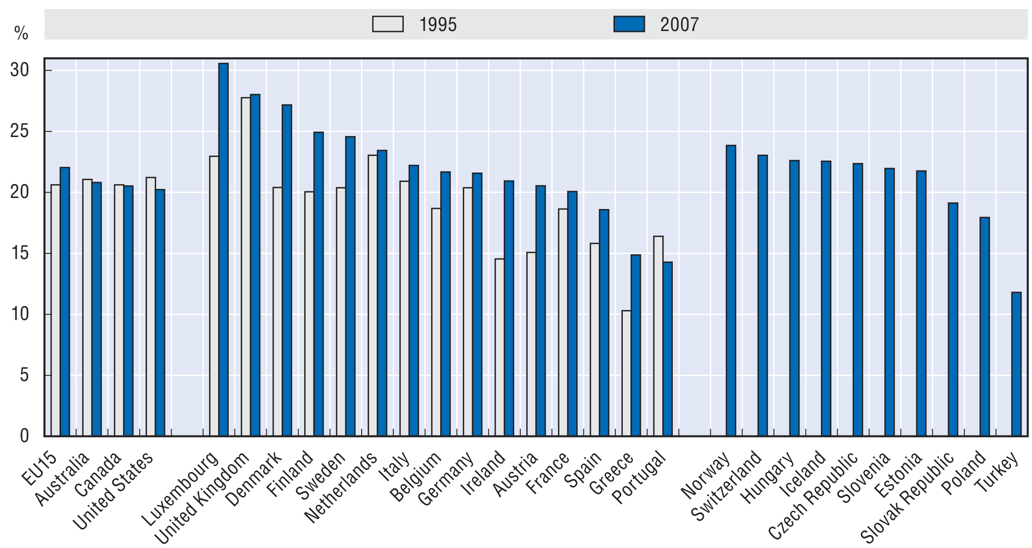
1. Narrow definition based on methodology described in OECD (2004, Chapter 6; 2006). The shares for non-European countries are not directly comparable with shares for European countries as the classifications were not harmonised. The EU15 aggregate has been estimated for missing years.
2. Except: Australia, Finland and Sweden 1997 instead of 1995.

Source: OECD calculations from EULFS, United States Current Population Survey, Statistics Canada, Australian Bureau of Statistics.

business sector employment (see preceding section). Although these data are not directly comparable, the divergences between the two suggest that there is ongoing occupational specialisation as higher level ICT skills are required. These skills are used partly in the ICT sector as it restructures around more advanced products and activities, and partly across the wider non-ICT economy as ICT specialist skills are needed to produce ICT products in non-ICT sectors (software in the banking industry for example) and non-ICT products with ICTs embedded in them (automobile braking systems for example) (see Chapter 3). The share of ICT specialists in total employment declined only in France, Ireland and Portugal.

ICT-using occupations (including specialists) make up over 20% of total employment in most countries (Figure 1.19). These occupations include *e.g.* scientists and engineers, as well as office workers, but exclude teachers and medical specialists for whom the use of ICTs is in general not essential for their tasks. There remains a contrasting picture in terms of trends, with the share of ICT-using occupations declining in English-language countries (Australia, Canada, the United States) or remaining flat (the United Kingdom) over the period 1995-2007, whereas the EU15 increased somewhat overall and with some countries increasing considerably (Denmark, Finland, Sweden, Ireland and Austria). In most countries, specialist and user occupations move in the same direction, except for Ireland where the rapid increase in Ireland's ICT-using population reflects the structural transformation of Ireland's work-force into a more high-skilled one with an increasing share of employment in service occupations. Overall, these estimates show the importance of ICT-related occupations across the economy and the necessity of analysing ICT-related activities and employment very broadly across the economy.

Figure 1.19. **Share of ICT-using occupations in the total economy, broad definition,[1] 1995[2] and 2007**



StatLink http://dx.doi.org/10.1787/473184647884

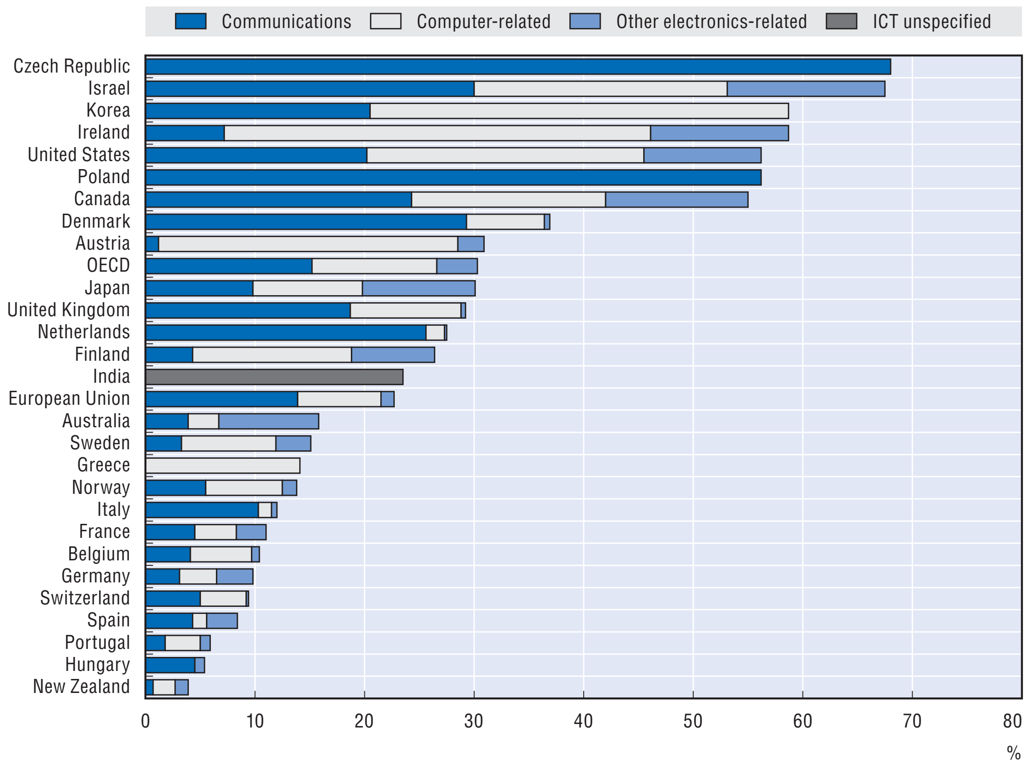
1. Broad definition based on methodology described in OECD (2004, Chapter 6; 2006). The shares for non-European countries are not directly comparable with shares for European countries as the classifications were not harmonised. The EU15 aggregate has been estimated for missing years.
2. Except: Australia, Finland and Sweden 1997 instead of 1995.

Source: OECD calculations from EULFS, United States Current Population Survey, Statistics Canada, Australian Bureau of Statistics.

Venture capital

A major share of all venture capital continues to go to the ICT sector, although the share has declined from its peaks around 2000-01. Venture capital has long been seen as a major factor converting commercial potential into reality and all OECD countries have made continued efforts to improve the supply of venture capital going into potentially productive activities. By country, well over 50% of total venture capital has gone into ICTs in Canada, Ireland, Korea and the United States, and also in rapidly developing sources of ICTs in the Czech Republic, Israel, and Poland (Figure 1.20). Although the share of ICT venture capital in GDP has declined, it still retains a significant share. However, the 2008 financial market crisis cut back the supply of venture capital and financing for promising new ventures.

Figure 1.20. **Venture capital investments in ICT as a percentage of all venture capital investment, 2006**



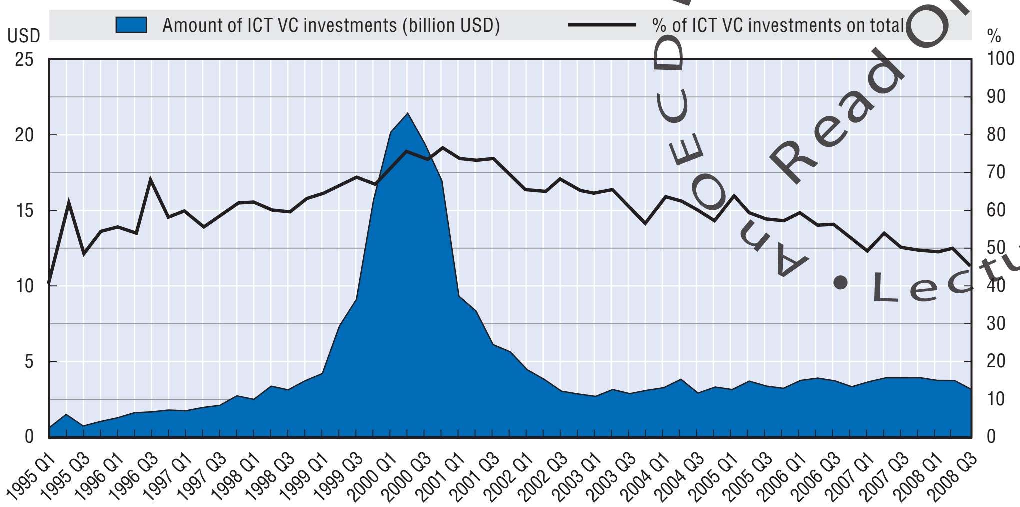
StatLink http://dx.doi.org/10.1787/473202205467

Source: *OECD Venture Capital Database*, 2008.

In the United States venture capital market – by far the world's largest – around 50% of total venture capital still goes to ICTs. This share has declined from its peak of 75% in 2000, but is still around the level of the mid-1990s (Figure 1.21). The amount flowing into ICT ventures remained over USD 15.6 billion in 2007 and was USD 7.4 billion in the first half of 2008 although there was a considerable slowdown in the third quarter of 2008. There have however been some changes in the composition of this investment, with a shift towards software, and increasing competition from *e.g.* energy and environmental innovations and technologies, many of which are ICT-intensive. The extent to which the

Figure 1.21. **Quarterly venture capital investments in the ICT sector in the United States, Q1 1995-Q3 2008**

In billion USD and percentages



StatLink http://dx.doi.org/10.1787/473220263452

Note: The ICT sector comprises the following: software, media and entertainment, IT services, telecommunications, semiconductors, computers and peripherals, networking equipment, electronics and instrumentation.

Source: OECD based on data from PricewaterhouseCoopers/National Venture Capital Association MoneyTree Report, October 2008.

composition and amounts flowing into this market will endure depends in part on the relative opportunities for growth in other technologies, as well as investor confidence in the returns on these kinds of investments and the potential for successful exit.

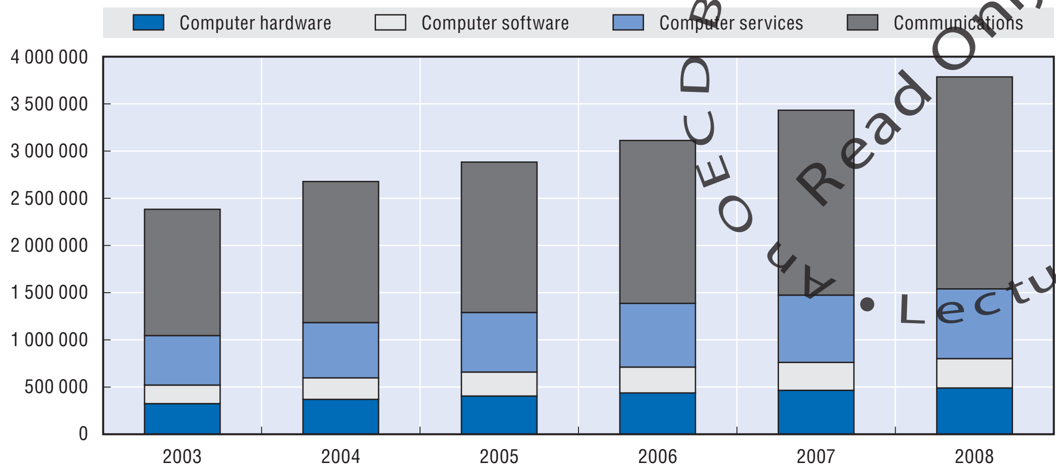
ICT markets and spending

Total worldwide ICT spending was estimated to reach USD 3 433 billion in 2007, of which 78% (USD 2 681 billion) by OECD member countries, down from 85% in 2003. The North American market (the United States, Canada and Mexico) is the largest, accounting for 34% of worldwide ICT spending (USD 1 157 billion). Western Europe accounted for 30% in 2007 (USD 1 030 billion) and the Asia-Pacific region for 26% (USD 878 billion). With the emergence of new growth economies as markets for ICT products and services, worldwide ICT spending has increased 9.6% a year since 2003 while OECD spending increased by an annual 7.3%. Worldwide, a slowing of growth in ICT spending is expected through to 2011, but there is unlikely to be as large a drop in current USD as there was in 2001-02, owing to growth in non-OECD economies and introduction of new products. However the shape of growth will also depend on the spillovers from turmoil in financial markets onto the global economy, the depth and length of the looming recession in OECD countries as well as currency movements and the impacts of food and commodity prices on developing economies, which are likely to slow ICT growth or lead to declines.

Worldwide, more than half of the estimated 2007 ICT spending (USD 1 960 billion) was on communications services and hardware, 21% (USD 712 billion) on computer services, 14% (USD 466 billion) on computer hardware and 9% (USD 296 billion) on software (but note that these totals are based on a narrower definition of ICT than elsewhere in this report[18]). As equipment prices have continued to fall, software spending has increased most rapidly since 2003 (by 10.6% a year), compared with computer hardware by 9.5% a year. Communications services and hardware spending have increased by 10% reflecting

Figure 1.22. **Worldwide ICT spending by market segment, 2003-08**

USD millions, current prices



StatLink http://dx.doi.org/10.1787/473236127104

Note: Data for 2008 are forecast.

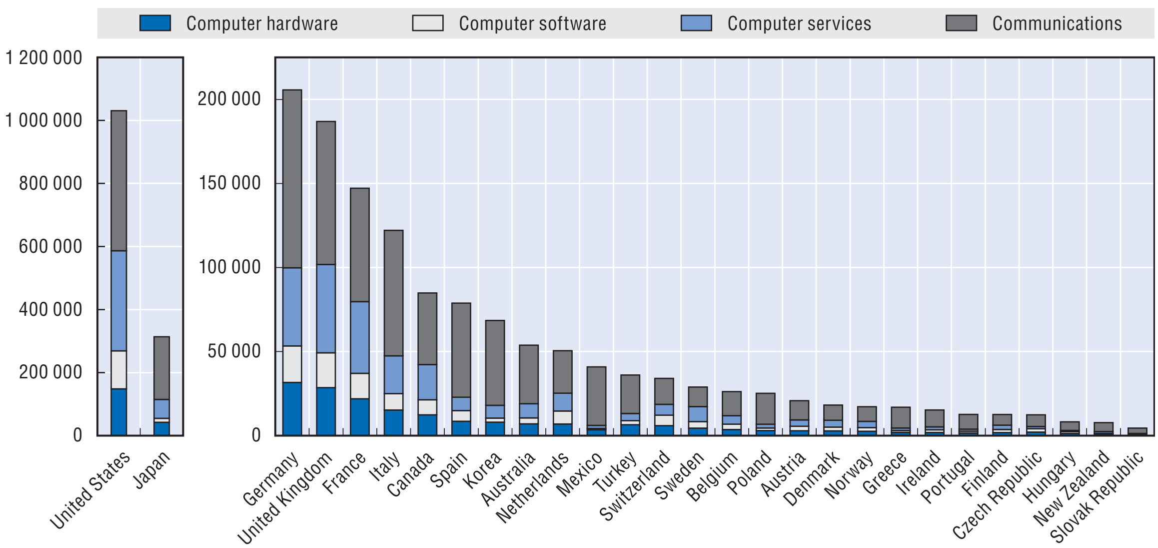
Source: OECD, from data published by World Information Technology and Services Alliance (WITSA), based on research by Global Insight, Inc.

the uptake of more advanced services in OECD countries and the rapid spread, particularly of mobile services, in developing countries.

The United States is by far the largest national market, spending some USD 1 031 billion during 2007 – USD 444 billion on communications services and hardware, USD 317 billion on computer services, USD 148 billion on computer hardware and USD 121 billion on software. Japan, the second largest spender on ICT in 2007 spent less than one-third as much as the United States at USD 314 billion. Other major markets

Figure 1.23. **OECD ICT spending by market segment, 2007**

USD millions, current prices



StatLink http://dx.doi.org/10.1787/473245056815

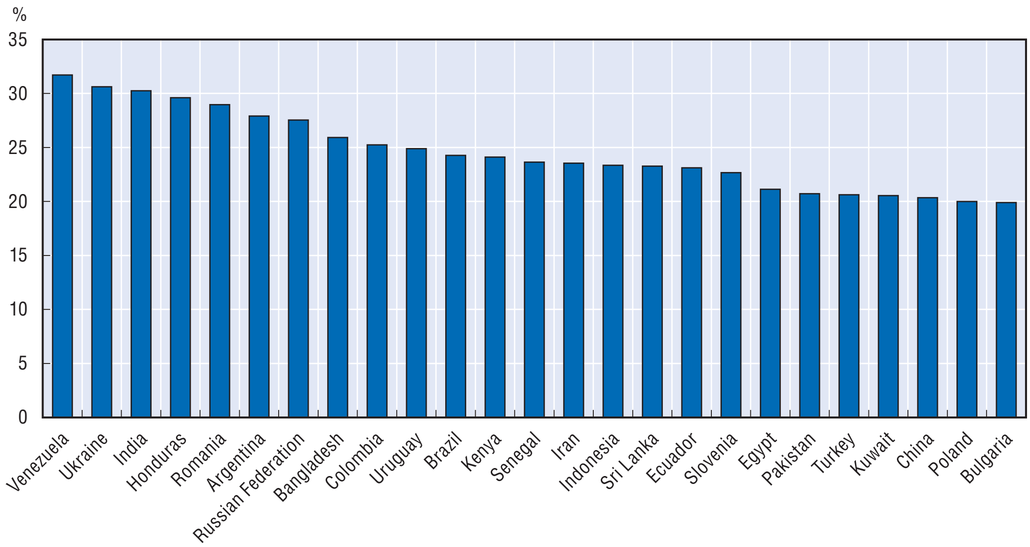
Source: OECD, from data published by World Information Technology and Services Alliance (WITSA), based on research by Global Insight, Inc.

include Germany (USD 206 billion), the United Kingdom (USD 187 billion), and France (USD 147 billion). Outside the OECD, China was the third largest market at USD 254 billion in 2007, Brazil ranked ninth at USD 76 billion, India tenth at USD 66 billion, the Russian Federation sixteenth at USD 53 billion and South Africa twenty-first at USD 27 billion.

ICT spending increased most rapidly between 2003 and 2007 in Latin America and eastern Europe (Figure 1.24). In North America, growth in spending was more subdued in the United States (6.2% a year), Canada (11%) and Mexico (14%). Japan was the OECD member country with the slowest growth, with a rise from USD 278 billion in 2003 to USD 314 billion in 2007 (in current prices).

Figure 1.24. **Fastest ICT spending growth, 2003-07**

Annual average growth, percentages



StatLink http://dx.doi.org/10.1787/473246468561

Note: Includes the 25 fastest-growing markets.

Source: OECD, from data published by World Information Technology and Services Alliance (WITSA), based on research by Global Insight, Inc.

There are significant differences in expenditure shares by market segment for historical structural, cyclical, and regulatory reasons. Among OECD member countries:

- Communications services and hardware account for more than 70% of total 2007 ICT spending in Mexico, Korea, Greece, Poland, Spain and the Slovak Republic, but less than 45% in Sweden and the United States.
- Computer services account for more than 25% of total ICT spending in the United States, France, United Kingdom and Canada, but less than 10% in Mexico, Greece, Poland, Hungary and Portugal.
- Computer hardware accounts for more than 17% of total ICT spending in Turkey, Switzerland and the Czech Republic, but less than 10% in Mexico.
- Computer software accounts for more than 15% of total spending in Switzerland, the Netherlands, the Czech Republic and Finland, but less than 5% in Mexico, Korea, Japan and New Zealand.

ICT spending is increasing rapidly in many emerging non-OECD economies, particularly the larger ones (Figure 1.24). China's ICT spending is estimated to have grown by more than 20% a year since 2003. ICT spending in India, the Russian Federation and Brazil increased even more rapidly, by 30, 28 and 24% a year, respectively. In terms of the BRIICS rankings of growth in ICT spending between 2003 and 2007, India ranks third worldwide, the Russian Federation seventh, Brazil eleventh, Indonesia fifteenth and China twenty-third. Of the accession countries Slovenia is eighteenth. Turkey is the first OECD country in the top group in terms of market growth at number 21 and Poland is number 24.

Spending on computer hardware was relatively high in some non-OECD economies: 16% of total ICT spending in the Russian Federation in 2007 and 15% in India, compared with an of OECD average of 14%. Conversely, spending on software and services was below the OECD average at between 3 and 10% of total ICT spending in India, Brazil and China, indicating structural differences in ICT markets due to national development, acquisition and use preferences.

By end-markets, the consumer market is the largest, accounting for 29% of total worldwide ICT spending in 2007 as defined in this section. Other segments are significantly smaller, with communications services accounting for 12%, the financial services sector for 10%, and the government, manufacturing and professional services sectors for around 8% each. On trend, the consumer market and transport and communication services have increasing market shares, while shares of other sectors are declining.

Conclusion

Prospects for the ICT sector are very much less favourable than in the 2006 *Information Technology Outlook*. The macroeconomic outlook has progressively worsened over the last year and both business and consumer confidence in OECD countries has fallen sharply as the financial markets crisis has unfolded and food and commodity prices soared. This has led to sharp downward revisions to macroeconomic projections and for the ICT sector. In the recent past, ICT expenditures and markets have closely tracked GDP growth and non-residential fixed investment. They are likely to continue to do so considering the relative importance of ICT investment in total investment, and will reflect the deep economic downturn starting in third-quarter 2008 in the OECD area.

Recent weaknesses in short-term ICT indicators parallel the weakening macroeconomy and aggregate investment. In the United States ICT production and markets have weakened considerably as recession loomed; this has been reflected in Europe and Japan although they have performed somewhat better than the United States, and ICT trade continued to perform somewhat better in the first half of 2008 than aggregate performance and ICT indicators would suggest. Macroeconomic forecasts combined with business and consumer sentiment suggest that ICT growth in OECD countries will at best be slow in 2008 and decline in 2009, but is unlikely to collapse as it did in 2001.

The outlook for semiconductors – the bellwether for ICT goods production – remains moderate with 2.2% growth in 2008 and a projected 5.6% decline in 2009. Additionally, investment in semiconductor production equipment has plunged but is forecast to pick up from late 2009. Major ICT firms reporting for the first three quarters of 2008 show positive, but mixed, results overall. New products were performing well, particularly in consumer goods, despite ebbing consumer confidence, IT services and software were generally growing, and established Internet businesses maintained very high growth rates. Most other segments were under pressure, including telecommunications services, which were looking to new 3G services and non-OECD economies for growth.

Overall growth for 2008 is constrained to a maximum of 4%, with very different performances across segments and markets, and may well be below zero in 2009 for OECD markets, but with potentially higher growth outside the OECD area. There is likely to be considerable pressure on OECD ICT employment, as there was in the last downturn, owing to increasing competition from non-OECD economies and global industrial restructuring in both goods and services, and production and value added will decline somewhat in the medium term.

Global ICT markets are also shifting to non-OECD economies. The share of OECD countries declined to 78% of the world total market in 2007 from 85% in 2003, as ICT markets grew at 9.6% globally but at a more subdued 7.3% in OECD countries. Furthermore there were only two OECD countries in the top 25 ICT markets, but six enhanced engagement and accession countries (Brazil, China, India, Indonesia; the Russian Federation and Slovenia). This shows that ICT markets in non-OECD economies are growing in parallel with the reorganisation of ICT manufacturing and services. This shift is captured in the top 250 ICT firms, which include increasing numbers of non-OECD firms, and they are growing more rapidly than OECD firms. Notable among them are manufacturing firms from Chinese Taipei which have benefited from and partly driven the rise of China as by far the major exporter of ICT goods. Also notable are IT service firms from India and telecommunications service providers from a range of non-OECD economies.

Over the long term the OECD ICT sector has grown and in 2006 represented more than 8% of OECD business value added and employed over 15 million people. With global restructuring of production, ICT manufacturing has tended to decline overall, but countries with high shares of ICT manufacturing value added have positive comparative advantages and consistent export surpluses in ICT goods. The ICT sector has also shifted towards computer and related services and other ICT services in OECD countries. In terms of ICT-related employment across the economy, around 3-4% of total employment in most OECD countries was accounted for by ICT specialists in 2007 and this share has risen consistently in most countries; and ICT-using occupations make up over 20% of total employment in most countries. Furthermore the ICT sector continues to attract a disproportionate share of venture capital; the flows remained around 50% of the total in the United States with little sign of slackening in the first half of 2008, but slowing in the third quarter with the financial crisis.

The longer-term global performance of the ICT sector will depend on whether new goods and services continue to prompt businesses and consumers to keep investing in and buying ICT output; whether non-OECD economies maintain their dynamic growth paths, although their aggregate markets are still considerably smaller than for the OECD area; and how large the contribution of ICTs will be to meeting major challenges such as climate change, the environment, ageing populations, skills shortages and continuing globalisation.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2008 – ISBN 978-92-64-05553-7 – © OECD 2008

Notes

1. See Methodology and Definitions Annex for the definition of ICT investment.
2. See Global Insights data later in this chapter. See also Forrester *www.forrester.com/ER/Press/Release/0,1769,1195,00.html*, "Global IT 2008 Market Outlook"; IDC *www.idc.com/getdoc.jsp?containerId=prSG21195508*, and OECD (2008c and 2008d).
3. See Computerworld (2008) for employment trends in the US IT industry.
4. Gartner (2008), "CIOs in Asia expect IT budget growth of 8.3 percent in 2008 compared to worldwide average of 3.3 per cent", 13 February, *www.gartner.com/it/page.jsp?id=604408*.
5. CIO survey 2008; *www.idc.com/getdoc.jsp?containerId=prUS21200908*.
6. Gartner projected worldwide semiconductor markets to grow by 4.6% in 2008, "Gartner Semiconductor Insight: Identifying the Growth Hot Spots", San Jose, 4 June, Stamford, Conn., 2 June; IDC, 3 June 2008; SIA 30 October 2008; *Financial Times* (2008a), Worldwide PC Processor Market Slowed in the First Quarter; section on semiconductors.
7. *IDC Worldwide Quarterly PC Tracker, 16 April* 2008 Gartner's PC Quarterly Statistics Worldwide by Region program; Gartner report "Market Trends: Worldwide PC Market Scenarios, 1Q08" *www.gartner.com/it/page.jsp?id=648619*; *www.gartner.com/it/page.jsp?id=631107*; IDC: PC shipments growth for EMEA and Asia-Pacific 17% in 2008 *www.idc.com/getdoc.jsp?containerId=prUS21190708*; Worldwide PC shipments were projected to grow by 12.8% in 2008 to reach 302 million units, IDC Worldwide Quarterly PC Tracker, *www.idc.com/getdoc.jsp?containerId=prUS21138308*.
8. *Financial Times* (2008b), Tech tock; OECD (2008c)
9. Gartner (2008), "Gartner Says Economic Slowdown in the US to Accelerate Offshoring of IT Services", 24 April, *www.gartner.com/it/page.jsp?id=654707*.
10. Market capitalisations change daily and data collected on a particular day are no more than indicative. The slowdown in the United States that emerged in late 2007 has affected industry growth expectations and a number of the leading ICT firms lost value during early 2008.
11. Greater effort was made to identify non-OECD-based firms for this year's list, with a few firms newly identified that would have qualified for the 2006 *Information Technology Outlook* top 250 list (prepared in 2005). Nevertheless, the majority of new identifications are due to rapid firm growth.
12. Where there are few firms, performance is firm-based rather than industry-based or country-based.
13. This section focuses on 2006 as the cut-off year for discussion as 2007 data are still incomplete.
14. See Semiconductor Industry Association (2008a), which gave 2007 worldwide sales of USD 255.6 billion. September 2008 data showed the sector still growing steadily with world-wide sales to July 2008 of USD 148.3 billion, an increase of 5% from the same period of 2007 when sales were USD 141.3 billion (SIA, 2008b). This is a slight slowdown from the 30 June release when sales to May 2008 were up by 5.3% from the first five months of 2007. Worldwide sales of semiconductors grew by 7.6% to USD 22.2 billion in July 2008 from July 2007. Semiconductor sales reflected continued strong sales of consumer electronic products, despite the general decline in consumer confidence. They also reflect the shift in sales of final products to non-US markets, and show that a slowdown in the US would not have the same impact as in the past. "Growing sales of consumer electronics, personal computers and cell phones – which account for about 80 per cent of chip demand – contributed to a healthy 7.6 per cent year-on-year increase in worldwide microchip sales … [with strong] … second quarter GDP growth in the US ,and continued strength in world markets … For the second quarter of this year we've seen a significant crossover – 300 mm for the first time accounts for the largest share of wafer manufacturing capacity and actual wafers processed, with 44 per cent of total capacity and 47 per cent of total silicon processed" (SIA, 2008b).
15. According to Semiconductor International (2008), semiconductor equipment sales were forecast to drop to USD 34 billion in 2008, down 20% from USD 43 billion in 2007, and the outlook has weakened sunsequently.
16. See Methodology and Definitions Annex for the ICT sector value added and employment definition. The data in this section are not directly comparable with data in the *Information Technology Outlook 2006*.
17. See in particular the outcomes of the 2008 Seoul Ministerial on the Future of the Internet Economy, and the document on future work "Shaping policies for the future of the Internet economy" and Annexes, available at *www.oecd.org/FutureInternet*
18. See Methodology and Definitions Annex for the ICT spending definition.

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ANNEX 1.A1

Top 10 firms in each ICT sector

The top 250 ICT firms are dominated by large telecommunication services and electronics firms. Analysis of, for example, the top 50 firms, does not show the performance of major firms in other industry sectors or indicate the performance of sectors in which smaller firms predominate. There is, for example, only one software firm in the top 50 (Microsoft). This section analyses the activities of the top 10 ICT firms in each sector: communications equipment and systems, electronics, semiconductors, IT equipment and systems, IT services, software, Internet, and telecommunication services.

Communications equipment and systems

Reflecting a recovery in activity, the top 10 communications equipment and systems firms generated combined revenues of USD 208 billion in 2006 and net income of USD 18.8 billion. They employed more than 500 000 and spent more than USD 23 billion or 11% of revenues on R&D. There are 15 communications equipment firms in the ICT top 250, ranked by 2006 revenue, with Nokia, Motorola, Cisco Systems and Ericsson in the top 50. The composition of the top 10 is much the same as it was in 2005, with the merger of Alcatel and Lucent Technologies making way for the addition of the rapidly growing China-

Table 1.A1.1. **Top 10 communications equipment and systems firms**

USD millions in current prices and number employed

		Revenue 2000	Revenue 2006	Revenue 2007	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006
Nokia	Finland	27 868	51 660	69 895	58 708	109 871	2 371	4 896	3 613	2 992
Motorola	United States	32 107	42 879	36 622	147 000	66 000	3 426	4 106	1 318	3 661
Cisco Systems	United States	18 928	28 484	34 922	38 000	49 926	2 704	4 067	2 668	5 580
Ericsson	Sweden	29 866	24 113	27 788	105 129	67 500	4 577	3 787	2 300	3 537
Alcatel-Lucent	France	28 815	15 430	24 356	131 598	89 370	2 610	1 842	–521	–741
L-3 Communications	United States	1 910	12 477	13 961	14 000	63 700	24	86	83	526
Nortel Networks	Canada	27 948	11 418	10 948	94 500	33 760	3 663	1 939	–2 995	28
Huawei Technologies	China	1 933	8 504	11 000	. .	. .	193	850	345	512
Qualcomm	United States	3 197	7 536	8 871	6 300	11 200	340	1 538	622	2 470
Avaya	United States	7 732	5 148	5 279	31 000	10 000	468	428	–375	201
Total		180 303	207 648	243 641	626 235	501 327	20 376	23 539	7 057	18 766

StatLink http://dx.doi.org/10.1787/476301335863

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

based Huawei Technologies. Since 2001, two firms have exited the top 10, Marconi and Tellabs, to be replaced by Qualcomm and L-3 Communications.

Communications equipment firms were severely affected by the downturn and sudden slowdown in telecommunications infrastructure investment from 2001. Nevertheless, some continued to perform well, and a broad recovery is now evident. Between 2000 and 2006, revenues increased by USD 27 billion, net income increased by USD 11.7 billion and R&D expenditures by more than USD 3 billion. Nevertheless, employment in the top 10 communications equipment firms has fallen by around 125 000, although data are incomplete with respect to Huawei Technologies and the merger of Alcatel and Lucent Technologies. Combined net income of almost USD 19 billion in 2006 is a marked improvement on the losses experienced in 2001 and 2002. The top 10 enjoyed an average margin (*i.e.* combined net income over revenue) of 9% in 2006, with strong returns from Qualcomm, Cisco Systems and Ericsson. Average reported market capitalisation of communications equipment firms increased from USD 39 billion in 2001 to more than USD 44 billion in late 2007, or by 2.2% a year.

R&D intensity (*i.e.* R&D spending as a percentage of revenue) averaged more than 11% across the top 10 in 2006, with Qualcomm, Nortel Networks, Ericsson and Cisco Systems all spending between 14 and 20% of revenues on R&D. L-3 Communications and Huawei Technologies were among the fastest growing communications equipment and systems firms, with revenues increasing by 37 and 28% a year, respectively. Other communications equipment and systems firms enjoying rapid growth include: Research in Motion, UTStarcom, Juniper Networks and ZTE. These increases reflect opportunities in security, defence-related and mobile communications markets and the success of the Blackberry, as well as the emergence of growth markets in China.

IT equipment and systems

Leading IT equipment and systems firms tend to be larger than specialist communications equipment firms, with nine of the top 10 in the ICT top 50. A number are also diversified, but tend to be diversified within ICT (*i.e.* producing IT equipment, software and services). For example, IBM derives a larger share of revenues from services and software than from hardware, while others depend much more upon hardware sales (*e.g.* Hewlett-Packard). New entrants into the IT equipment top 10 since 2001 include: Hon Hai Precision, Apple, ASUSTeK and Quanta Computer. Exits include Compaq Computer, which was taken over by Hewlett-Packard, Gateway, EMC and Sun Micro Systems. Seagate entered the 2003 top 10 and exited the 2005 list.

Total revenue of the IT equipment and systems top 10 amounted to USD 455 billion in 2006, they employed more than 1.5 million people and spent around USD 20 billion on R&D. Between 2000 and 2006, top 10 IT equipment firms' total revenue increased by USD 130 billion, total employment increased by around 520 000, and the R&D expenditure of those reporting also increased. Total net income increased, with the top 10 firms reporting a combined net income of almost USD 25 billion in 2006 and a margin (*i.e.* net income over revenue) of 5.4%. Average reported market capitalisation of IT equipment firms increased from USD 24 billion in 2001 to USD 33 billion in late 2007, or by 5.4% a year. In 2007 top 10 IT equipment firm revenues were USD 518 billion.

Among the top 10 IT equipment firms two had declining revenues over the 2000-06 period (NEC and Fujitsu). These firms shed jobs, while employment increased in most of

Table 1.A1.2. **Top 10 IT equipment and systems firms**

USD millions in current prices and number employed

		Revenue 2000	Revenue 2006	Revenue 2007	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006
Hewlett-Packard	United States	48 870	91 658	104 286	88 500	156 000	2 627	3 591	3 697	6 198
IBM	United States	85 089	91 423	98 785	316 303	355 766	5 084	6 107	8 093	9 491
Dell Computer	United States	25 265	55 788	57 420	40 000	82 800	374	458	1 666	3 602
Toshiba	Japan	53 349	54 519	59 761	190 870	165 000	3 103	3 197	–305	672
NEC	Japan	48 343	41 762	39 072	154 787	154 000	2 924	2 933	97	104
Fujitsu	Japan	48 484	41 180	42 830	188 053	158 491	3 722	2 071	397	589
Hon Hai Precision	Chinese Taipei	2 900	28 440	51 828	9 000	382 000	. .	327	. .	892
Apple Inc	United States	7 983	19 315	24 006	8 568	17 787	380	712	786	1 989
ASUSTeK Computer	Chinese Taipei	2 146	16 485	17 931	. .	9 587	. .	237	475	661
Quanta Computer	Chinese Taipei	2 661	14 041	22 262	. .	34 077	. .	153	253	390
Total		325 089	454 611	518 181	996 081	1 515 508	18 214	19 787	15 158	24 588

StatLink http://dx.doi.org/10.1787/476315780205

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

the others. Data reflect the ongoing globalisation of ICT manufacturing and the rapid emergence of manufacturing activities in China and elsewhere in Asia, with IT equipment firms enjoying annual revenue growth in excess of 25% including High Tech Computer, Hon Hai Precision, ASUSTeK Computer, Lite-on Technology, Lenovo, SanDisk, Quanta Computer, Compal Electronics, Inventec and Benq/Qisda, with all but SanDisk from Chinese Taipei or China, and emerging firms with rapid revenue growth over the last few years: TPV Technology (essentially a Chinese firm registered in Bermuda) and Wistron of Chinese Taipei.

Electronics

Leading electronics firms tend to be significantly larger than those in the communications equipment and systems sector. They also tend to be more diversified, and many have significant non-ICT business. There are no less than 61 electronics firms in the ICT top 250, ranked by 2006 revenue, with 16 in the top 50.

In 2006, the top 10 electronics firms generated combined revenues of USD 532 billion, employed almost 2 million people, and realised an aggregate net profit of more than USD 27 billion. Top 10 revenues increased by more than USD 98 billion between 2000 and 2006, but employment fell by 180 000. Total net income increased by USD 3.2 billion. The combined margin (*i.e.* net income over revenue) was 5.2%, with much higher margins enjoyed by Philips, Samsung and Canon. Average reported market capitalisation of electronics firms in the top 250 increased from USD 12 billion in 2001 to USD 22 billion in late 2007, or by 11% a year. The top 10 electronics firms spent an average of 6.5% of revenue on R&D during 2006.

Samsung and Siemens enjoyed strong revenue growth between 2000 and 2006. Other electronics firms enjoying rapid growth included the emerging Asian manufacturers Chi Mei Optoelectronics and AU Optronics, Nvidia, Jabil Circuit and Sanmina SCI. These results reflect some consolidation, especially in contract electronics manufacturing (Flextronics of Singapore has recently acquired United States-based Solectron), as well as the growth of emerging Asian economies as the preferred locations for electronics manufacturing. In 2007 top 10 revenues exceeded USD 550 billion.

Table 1.A1.3. **Top 10 electronics firms**

USD millions in current prices and number employed

		Revenue 2000	Revenue 2006	Revenue 2007	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006
Siemens	Germany	64 405	97 436	99 108	419 000	371 000	4 425	6 312	6 528	3 823
Hitachi	Japan	72 725	81 345	86 059	323 827	390 725	3 930	3 546	154	321
Matsushita (Panasonic)	Japan	68 711	76 442	76 488	314 267	328 645	4 881	4 854	874	1 327
Sony	Japan	62 046	64 550	69 665	189 700	163 000	3 660	4 675	1 131	1 062
Samsung Electronics	Korea	34 573	63 480	67 970	173 000	85 813	1 332	6 004	4 768	8 532
Canon	Japan	25 020	35 725	38 055	86 673	120 976	1 805	2 650	1 244	3 913
Philips Electronics	Netherlands	34 736	33 889	36 678	219 429	125 834	2 553	2 095	8 786	6 763
Mitsubishi Electric	Japan	35 021	30 976	32 379	116 588	99 444	1 615	1 117	230	822
LG Electronics	Korea	20 085	24 263	25 286	55 000	31 201	312	1 754	356	223
Sharp	Japan	17 210	24 040	26 266	49 748	48 927	1 363	1 596	261	762
Total		434 532	532 146	557 954	1 947 232	1 765 565	25 876	34 602	24 332	27 548

StatLink http://dx.doi.org/10.1787/476317727081

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

Semiconductors

A number of the larger electronics firms have spun off their semiconductor manufacturing activities to specialist firms (*e.g.* Infineon, Freescale Semiconductor and NXP), making it possible track the performance of specialist semiconductor firms, with market and investment challenges different from those of the diversified electronics manufacturers. Nevertheless, a number of the large electronics firms also have substantial semiconductor operations (*e.g.* Samsung), but are not specialist semiconductor firms.

Top 10 specialist semiconductor firms earned total revenues of almost USD 110 billion in 2006, up from around USD 90 billion in 2000. They employed 350 000 people and earned a combined net profit of USD 13 billion. The largest semiconductor firm, Intel, accounted for 32% of top 10 revenue and is the only semiconductor firm in the ICT top 50. In 2006, profit margins were relatively high for semiconductor firms, with a combined margin (*i.e.* net income over revenue) of 12%. Some firms enjoyed margins as high as 30% (*e.g.* Texas

Table 1.A1.4. **Top 10 specialist semiconductor firms**

USD millions in current prices and number employed

		Revenue 2000	Revenue 2006	Revenue 2007	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006
Intel	United States	33 726	35 382	38 334	86 100	90 300	3 897	5 873	10 535	5 044
Texas Instruments	United States	11 875	14 225	13 835	42 481	30 986	1 747	2 195	3 058	4 341
Infineon Technologies	Germany	8 791	9 961	10 549	29 166	42 500	1 238	1 561	1 359	–335
STMicroelectronics	Switzerland	7 813	9 854	10 001	43 650	51 770	1 026	1 667	1 452	782
Taiwan Semiconductor	Chinese Taipei	4 968	9 656	9 807	15 888	20 167	215	489	650	2 912
Qimonda	Germany	..	7 026[1]	4 939	..	12 974	..	797	..	136
Freescale Semiconductor	United States	7 986	6 363	6 365	24 800	22 700	1 352	1 180	–5	563
NXP	Netherlands	..	6 231	6 395	..	37 468	..	1 250	..	–768
Advanced Micro Devices	United States	4 644	5 649	6 013	14 435	16 500	642	1 621	983	–166
Micron Technology	United States	6 362	5 272	5 688	18 800	23 500	427	656	1 504	408
Total		86 165	109 619	111 927	275 320	348 865	10 544	17 289	19 536	12 918

StatLink http://dx.doi.org/10.1787/476318735154

1. Qimonda in 2007 restated past revenue figures. After restating, the company reported revenues for 2006 of EUR 3 815 million (USD 4 786 million).

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

Instruments and Taiwan Semiconductor), while Infineon, NXP and AMD reported losses. Average reported market capitalisation of semiconductor firms in the top 250 declined from USD 35 billion in 2001 to USD 24 billion in late 2007, or by 6% a year, with further falls in early 2008 as concerns about an economic slowdown lowered expectations. R&D intensity is high, with combined R&D expenditure of the top 10 semiconductor firms in 2006 equivalent to almost 16% of revenues. AMD and NXP were the most research-intensive.

Reported revenue growth since 2000 has been no more than 2% a year, with Taiwan Semiconductor the only firm in the top 10 to report double-digit growth. However, semiconductor firms just below the top 10 – ASM Lithography, Broadcom, Advanced Semiconductor Engineering and PCS (Powerchip Semiconductor) – have enjoyed strong growth.

IT services

Only three of the top 10 IT services firms rank in the ICT top 50 (at 41, 42 and 46). Nevertheless, a number of the larger IT equipment and systems firms earn a significant share of their revenue from services. In 2006, software and services accounted for 77% of IBM's total revenues, with services revenue of around USD 35 billion, which would put it at the top of the IT services list.

Revenues of the top 10 specialist IT services firms amounted to USD 118 billion in 2006, up from USD 88 billion in 2000. They employed some 630 000 people and earned a combined net profit of USD 5.8 billion. Their revenues increased by almost USD 31 billion between 2000 and 2006, and total employment grew by around 127 000. However, net income fell by USD 1.2 billion. Average reported market capitalisation of IT services firms in the top 250 declined from USD 11 billion in 2001 to USD 9 billion in late 2007, or by 3.4% a year.

Table 1.A1.5. **Top 10 IT services firms**

USD millions in current prices and number employed

		Revenue 2000	Revenue 2006	Revenue 2007	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006
EDS	United States	18 856	21 268	22 134	122 000	131 063	..	..	1 143	470
Tech Data	United States	16 992	20 483	21 440	10 500	8 000	..	..	128	27
Accenture	Bermuda	11 331	18 228	21 453	71 300	140 000	252	298	2 464	973
CSC	United States	9 345	14 639	14 857	68 000	79 000	..	..	403	528
CapGemini Ernst and Young	France	6 359	9 625	11 914	59 549	79 981	..	..	395	366
SAIC	United States	4 000	7 775	8 294	40 000	44 100	..	..	400	927
First Data (Concord EFS)	United States	5 922	7 076	8 051	25 380	29 000	..	..	930	1 513
ADP	United States	6 168	6 836	7 800	41 000	36 000	460	472	841	1 554
Atos Origin	France	1 756	6 780	7 388	26 916	49 847	..	..	65	–312
Unisys	United States	6 885	5 757	5 653	36 900	31 500	334	231	225	–279
Total		87 613	118 467	128 984	501 545	628 491	1 046	1 001	6 993	5 767

StatLink http://dx.doi.org/10.1787/476342277563

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

There has been relatively little change at the top of the IT services sector since 2000, with the takeover of PricewaterhouseCoopers and the reclassification of Ingram Micro and IAC/Interactive making space for First Data and Atos Origin. SAIC and Atos Origin are the fastest-growing firms in the top 10; only Unisys has experienced declining revenues since 2000. Top 10 IT services firms are predominantly from the United States, with two from France. However, developing country-based firms are rapidly catching up, with India's Infosys, Wipro and TCS now in the ICT top 250, along with South Africa's Datatec and Dimension Data.

Software

Software firms tend to be smaller than those in other ICT sectors. Only one software firm ranks in the ICT top 50 (*i.e.* Microsoft) and there are just nine in the top 250 ICT firms, so Autodesk is added to make up the software top 10. The top 10 earned a total of more than USD 90 billion in 2006, employed 268 000 people and spent almost USD 14 billion on R&D. Microsoft is the clear leader, accounting for almost 50% of total top 10 revenue in 2006.

Table 1.A1.6. **Top 10 software firms**

USD millions in current prices and number employed

		Revenue 2000	Revenue 2006	Revenue 2007	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006
Microsoft	United States	22 956	44 282	51 122	47 600	79 000	3 772	6 584	9 421	12 599
Oracle	United States	10 231	14 380	17 996	42 927	74 674	1 010	1 872	6 297	3 381
SAP	Germany	7 562	11 812	14 021	24 177	39 355	1 170	1 677	743	2 351
Symantec/Veritas	United States	746	4 143	5 199	3 800	17 100	108	682	170	157
Computer Associates	United States	6 094	3 772	3 943	18 200	14 500	1 110	697	696	159
Electronic Arts	United States	1 420	2 951	3 091	3 500	7 900	256	758	117	236
Adobe Systems	United States	1 226	2 575	3 158	2 947	6 082	240	540	288	506
Amdocs	United States	1 118	2 480	2 836	8 400	16 234	75	187	6	319
Intuit	United States	1 037	2 342	2 673	6 000	7 500	166	399	306	417
Autodesk	United States	947	1 840	2 172	..	5 169	185	406	90	290
Total		53 337	90 577	106 211	157 551	267 514	8 092	13 802	18 133	20 415

StatLink http://dx.doi.org/10.1787/476363002435

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

Between 2000 and 2006, total top 10 revenues increased by USD 37 billion or more than 9% a year, employment increased by almost 110 000, and R&D expenditure by USD 5.7 billion. Net income increased by USD 2.3 billion to more than USD 20 billion. Average reported market capitalisation of software firms in the top 250 increased from USD 51 billion in 2001 to USD 59 billion in late 2007, or by 2.5% a year. Software firms' profit margins are high, with the top 10 reporting a combined margin of 22.5% during 2006 (*i.e.* net income over revenue). Microsoft and Oracle enjoyed higher than average margins, while Symantec reported a margin of just 3.8% and Computer Associates 4.2%. Software firms are also relatively R&D-intensive, with combined top 10 R&D spending equivalent to 15% of revenues in 2006. Electronic Arts, Adobe Systems and Autodesk were the most R&D-intensive.

Growth performance has been varied, with some market segments performing well (*e.g.* security and virus protection) and others less so. Among the top 10, revenue grew for all but one between 2000 and 2006. Symantec, Amdocs, Intuit and Verisign showed rapid growth.

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Internet

There is no clear definition of an Internet firm, but there are a number of obvious examples of firms earning their revenue from Internet-based activities without being members of any of the other ICT firm categories. Some have enjoyed spectacular growth and are moving up the ICT 250 rankings. The largest by revenue is Amazon, closely followed by Google, ranking 77th and 78th in the ICT top 250, respectively.

Table 1.A1.7. **Top 10 Internet firms**

USD millions in current prices and number employed

		Revenue 2000	Revenue 2006	Revenue 2007	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006
Amazon	United States	3 122	10 711	14 835	7 500	14 400	269	662	–1 411	190
Google	United States	19	10 605	16 594	1 000	13 786	11	1 229	–15	3 077
AOL LLC	United States	7 605	7 866	5 181	15 000	. .	. .	. .	1 855	1 923
Yahoo	United States	1 110	6 426	6 969	3 259	11 400	111	688	71	751
IAC/Interactive	United States	2 918	6 278	6 373	20 780	26 000	. .	. .	–148	46
e-bay inc	United States	749	5 970	7 672	. .	13 200	75	495	90	1 126
E*Trade	United States	2 061	3 840	2 223	. .	4 027	. .	. .	. .	629
Expedia	United States	222	2 238	2 665	. .	6 600	. .	121	–78	245
TD AMERITRADE Holding	United States	516	2 139	2 632	. .	3 947	. .	. .	–91	527
Yahoo! Japan	Japan	53	1 493	2 225	196	2 534	. .	. .	1	49
Total		18 375	57 566	67 369	47 735	95 894	466	3 195	274	8 563

StatLink http://dx.doi.org/10.1787/476365242040

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

In 2006, the Internet top 10 earned a total of almost USD 58 billion, employed around 100 000 people and had a combined net income of almost USD 9 billion. Between 2000 and 2006, total top 10 revenues increased by more than USD 39 billion, or by 21% a year, and net income increased by USD 8.3 billion or 77% a year, with the top 10 firms reporting a combined margin of 15% during 2006 (*i.e.* net income over revenue). Google, TD Ameritrade and AOL enjoyed higher than average margins. Growth performance has been a feature of many of these Internet firms, with Google increasing its revenue from USD 19 million in 2000 to more than USD 10 600 million in 2006, or by 187% a year. Yahoo! Japan, Expedia (which is part of IAC/Interactive, but reports separately) and e-bay have also had strong growth.

Telecommunication services

The deregulation of telecommunications and increasing private investment is leading to the growth and internationalisation of telecommunications firms. What were once national monopolies are now increasingly globalised, competitive firms. These firms are often among the largest ICT firms, with no fewer than 74 telecommunications carriers in the ICT 250 and 15 in the top 50.

In 2006, the top 10 telecommunication services firms earned revenues totalling almost USD 614 billion, with revenues increasing by USD 240 billion between 2000 and 2006 (or by 8.7% a year). Employment increased by around 166 000 to more than 1.7 million. What, with hindsight, seem ambitious investments and subsequent restructuring adversely affected profitability in the early years of the decade, with a top 10 net profit of USD 36 billion in 2000 becoming a net loss in 2002, led by significant losses by Deutsche

Telekom, Vodafone and France Telecom. The subsequent recovery has seen a return to profitability, with net income in 2006 approaching USD 40 billion, more than USD 3 billion higher than in 2000. In 2007 top 10 revenues were USD 721 billion.

Table 1.A1.8. **Top 10 telecommunication services firms**

USD millions in current prices and number employed

		Revenue 2000	Revenue 2006	Revenue 2007	Employees 2000	Employees 2006	R&D 2000	R&D 2006	Net income 2000	Net income 2006
NTT	Japan	92 679	91 410	91 191	224 000	199 113	3 178	2 651	–603	4 286
Verizon Communications	United States	64 707	88 144	93 469	263 552	238 519	..	..	11 797	6 197
Deutsche Telekom	Germany	37 559	77 069	85 580	205 000	248 480	642	643	5 437	4 044
Telefonica SA	Spain	27 306	66 459	77 264	145 730	232 996	..	739	1 693	7 966
France Telecom	France	30 894	64 952	72 497	188 866	191 036	412	1 075	4 707	8 714
AT&T	United States	46 850	63 055	118 928	304 800	301 840	..	223	4 669	7 356
Vodafone	United Kingdom	11 929	43 750	51 199	29 465	66 000	109	408	838	–9 286
Sprint Nextel	United States	17 220	41 028	40 146	64 900	64 600	..	..	1 964	1 329
Telecom Italia	Italy	27 516	40 052	43 399	107 171	83 209	247	167	3 231	1 303
China Mobile	Hong Kong, China	15 249	38 083	46 922	38 345	111 998	..	..	2 978	8 162
Total		371 908	614 001	720 954	1 571 829	1 737 791	4 588	5 906	36 711	40 070

StatLink http://dx.doi.org/10.1787/476375583387

Source: OECD, *Information Technology database*, compiled from annual reports, SEC filings and market financials.

Changes among the top 10 telecommunications services firms reflect major mergers and acquisition, including SBC Communications and Bell South merging with AT&T, and MCI Worldcom's merger with Verizon, while the ranks of the ICT 250 increasingly feature telecommunications firms from emerging and developing economies, including China Mobile, China Telecom, America Movil, Telephonos de Mexico (Telmex), China Unicom, China Netcom, Saudi Telecommunications, Tele Norte Leste, South Africa's MTN and Telkom, Telecomunicacoes de Sao Paulo, the Russian Federation's Mobile Telesystems, Chunghwa Telecom, Telekomunikasi Indonesia, VimpelCom and Orascom. Most are reaping the benefits of serving rapidly growing markets.*

* Detailed analysis of the telecommunication services sector is available in the *OECD Communications Outlook 2007* (OECD, 2007a).

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ANNEX 1.A2

Table 1.A2.1. **Total ICT spending, 2003-08**

USD millions in current prices

	2003	2004	2005	2006	2007	2008
Australia	32 891	38 499	41 619	45 781	53 825	60 099
Austria	15 145	16 828	17 978	18 748	20 802	22 833
Belgium	18 440	21 303	22 117	23 355	26 201	28 891
Canada	56 410	63 547	70 848	77 657	84 863	92 136
Czech Republic	7 308	8 343	9 516	10 692	12 401	14 503
Denmark	12 502	14 269	14 989	16 345	18 203	19 972
Finland	9 256	10 661	10 562	11 285	12 604	13 777
France	107 073	122 630	127 851	135 526	147 174	159 188
Germany	148 624	169 313	176 329	185 550	205 648	222 860
Greece	11 155	13 573	13 716	14 859	16 917	19 077
Hungary	5 597	6 341	6 752	7 119	8 212	9 108
Iceland	. .	. .	. .	. .	. .	. .
Ireland	9 326	11 339	12 403	13 512	15 279	16 937
Italy	86 996	101 063	103 701	109 674	122 125	132 955
Japan	277 886	304 749	310 019	308 133	313 737	350 470
Korea	47 118	51 018	56 661	62 392	68 517	73 144
Luxembourg	. .	. .	. .	. .	. .	. .
Mexico	24 318	27 195	30 878	36 151	40 910	45 880
Netherlands	35 328	40 671	42 575	46 028	50 534	54 977
New Zealand	5 219	5 976	6 466	6 552	7 760	8 449
Norway	10 696	12 399	14 053	15 150	17 219	19 464
Poland	12 145	14 773	16 594	20 238	25 190	32 081
Portugal	9 405	10 883	10 963	11 532	12 649	13 990
Slovak Republic	2 327	2 746	3 167	3 552	4 515	5 476
Spain	53 292	56 971	62 599	69 457	78 838	88 258
Sweden	20 838	23 567	24 443	26 026	28 918	31 695
Switzerland	25 666	29 101	30 050	31 861	34 069	37 522
Turkey	17 032	21 266	25 849	29 354	36 067	43 907
United Kingdom	133 862	151 811	161 085	169 174	186 873	194 107
United States	829 042	884 063	936 894	988 859	1 030 754	1 061 394
OECD total	2 024 899	2 234 895	2 360 681	2 494 562	2 680 804	2 873 150
World	2 383 312	2 677 348	2 884 260	3 112 670	3 433 397	3 786 380
OECD share	85%	83%	82%	80%	78%	76%
North America	909 770	974 805	1 038 621	1 102 667	1 156 527	1 199 410
Latin America	55 420	70 138	88 320	107 259	129 730	153 122
Western Europe	724 637	827 646	871 265	927 436	1 030 121	1 120 410
Eastern Europe	56 523	71 959	84 820	102 903	127 514	152 398
Asia-Pacific	577 246	661 739	716 174	775 377	877 776	1 032 376
Rest of world	59 717	71 060	85 060	97 028	111 729	128 665
Computer hardware	323 967	369 112	405 586	436 999	465 706	489 886
Computer software	197 959	228 525	252 827	275 174	295 812	311 083
Computer services	522 820	585 452	631 032	674 446	711 678	739 252
Communications	1 338 566	1 494 259	1 594 816	1 726 051	1 960 201	2 246 159

StatLink http://dx.doi.org/10.1787/476428121276

. .: no data. Data for 2008 are forecast.

Source: OECD, based on data provided by WITSA (2008).

Table 1.A2.2. **Emerging economy ICT spending by segment, 2003-08**

USD millions in current prices

	2003	2004	2005	2006	2007	2008
IT HARDWARE						
China	15 365	18 605	22 023	25 027	29 355	33 014
Hong Kong, China	1 538	1 669	1 749	1 947	2 005	2 099
Chinese Taipei	2 351	2 612	2 770	2 911	3 032	3 160
India	3 955	5 189	6 334	7 760	9 273	10 460
Russian Federation	3 354	4 467	5 552	6 497	7 317	8 092
Brazil	4 393	5 319	6 629	7 770	8 531	9 231
South Africa	1 453	1 920	2 268	2 566	2 754	2 999
SOFTWARE						
China	3 339	5 542	7 878	9 937	12 315	14 376
Hong Kong, China	321	355	380	430	444	463
Chinese Taipei	733	839	912	981	1 029	1 072
India	797	1 066	1 351	1 664	1 988	2 239
Russian Federation	1 122	1 520	1 905	2 306	2 701	3 063
Brazil	1 186	1 436	1 776	2 089	2 300	2 510
South Africa	814	1 124	1 368	1 643	1 843	2 084
IT SERVICES						
China	5 481	9 814	13 657	17 266	21 347	24 783
Hong Kong, China	690	757	790	891	912	945
Chinese Taipei	1 350	1 527	1 605	1 706	1 777	1 833
India	3 160	3 777	4 328	5 065	5 855	6 391
Russian Federation	1 419	2 102	2 725	3 387	4 034	4 634
Brazil	3 151	3 988	5 111	6 120	6 826	7 554
South Africa	1 498	2 135	2 626	3 210	3 601	4 105
COMMUNICATIONS						
China	97 058	116 149	128 901	153 606	191 337	255 022
Hong Kong, China	5 751	5 869	5 830	6 249	6 435	7 009
Chinese Taipei	13 221	14 582	14 886	14 860	15 542	17 063
India	14 882	21 976	30 301	32 648	48 531	65 514
Russian Federation	14 189	19 648	23 568	29 934	39 094	47 690
Brazil	23 117	29 689	38 846	46 001	58 289	73 695
South Africa	9 862	12 309	16 650	17 666	19 252	21 457
TOTAL ICT						
China	121 243	150 110	172 459	205 836	254 353	327 194
Hong Kong, China	8 300	8 650	8 750	9 516	9 796	10 516
Chinese Taipei	17 655	19 560	20 174	20 457	21 380	23 128
India	22 795	32 008	42 314	47 138	65 648	84 604
Russian Federation	20 083	27 736	33 749	42 124	53 146	63 478
Brazil	31 847	40 432	52 362	61 980	75 946	92 990
South Africa	13 628	17 487	22 911	25 085	27 450	30 644

StatLink http://dx.doi.org/10.1787/476441412053

Notes: Data for 2008 are forecast.
Source: OECD, based on data provided by WITSA (2008).

ISBN 978-92-64-05553-7
OECD Information Technology Outlook 2008

Chapter 2

Globalisation of the ICT Sector

Global restructuring of ICT production continued in 2007 and 2008, with Asia, Eastern Europe, Mexico and some new locations becoming increasingly important as producers and growth markets. Global ICT trade has expanded strongly and was almost USD 1.5 trillion higher in 2007 than the peak of 2000. ICT trade slowed in 2007 and the first half of 2008 as world economic conditions weakened. Nevertheless, ICT trade continued to increase, due to the resilience of some OECD ICT imports and strong demand from some emerging markets. An important question is whether the demand for new ICT products, coupled with growth in emerging economies (in Asia but also in other countries) will compensate for the very sharp downturn in OECD countries. ICT-related FDI increased to historically high levels in 2007 with non-OECD economies increasingly active, notably in ICT mergers and acquisitions, but with a marked slowdown in global merger and acquisition activity and FDI flows in 2008 as the OECD area went into recession.

Introduction

This chapter examines recent trends in ICT trade and the globalisation of the ICT sector to analyse characteristics of the current round of globalisation. It discusses the continuing global restructuring of ICT production activities. This is apparent in the continuing emergence of Eastern European and non-member developing economies as both producers and new growth markets. It is also apparent in the worldwide reorganisation of both ICT manufacturing and IT and IT-enabled services production as global firms seek new low-cost production centres, particularly for labour-intensive assembly and service activities. Intra-regional production networks outside of the OECD area are emerging, particularly in Asia, sometimes with increasing trade linkages to new markets in Latin America, India and other non-OECD countries.

Global trade in information technology products[1]

Global ICT trade (the sum of exports and imports) expanded strongly in recent years to more than USD 3.5 trillion in 2006 and USD 3.7 trillion in 2007 (up from about USD 1 trillion in 1996 and an intermediate peak of USD 2.2 trillion in 2000) (Figure 2.1 and Annex Table 2.A1.1; 2007 ICT data are not directly comparable with earlier years). Recent strong commodity prices and falling ICT hardware prices tend to disguise the extent and significance of the recovery in ICT trade, which has been stronger in volume than value terms. However, currency fluctuations and the weakening of the USD against all key currencies affect all international trade data as these are expressed in USD (see Box 2.1).

The share of OECD ICT trade in total world ICT trade decreased steadily from 88% in 1996 to 56% in 2006 and 52% in 2007. The share of OECD ICT goods trade in total OECD merchandise trade went from 13% in 1996 to 16.5% in 2000 to 12.4% in 2006 and the share ICT goods trade in total OECD manufactured goods trade was 15.7% in 2006, down from a high of 20.1% in 2000, due in part to the relative slow-down in ICT goods exports compared with imports (see Annex Table 2.A1.1 for details). From 2002 OECD ICT goods trade grew by an average of 11.5% a year to close to USD 2 trillion in 2006 (a rise of more than 10% from a year earlier), far above the level in 2000 (USD 1.5 trillion). The share of communication equipment in total OECD ICT trade increased steadily to 19% in 2006. While the shares of audio and video equipment (14% in 2006) and of other ICT-related goods (11% in 2006) have increased, the shares of computer and related equipment (30%) and electronic components (14%) have decreased.

OECD exports of ICT goods reached a new peak of USD 932 billion in 2006 (including intra-OECD exports) (see Annex Table 2.A1.2).[2] OECD ICT goods imports exhibit similar trends and reached a new peak of USD 1 050 billion in 2006, driven by growth in audio, video and other ICT-related equipment. The OECD trade deficit in ICT goods jumped from USD 11 billion in 1996 to USD 116 billion in 2006 (see Annex Table 2.A1.3).

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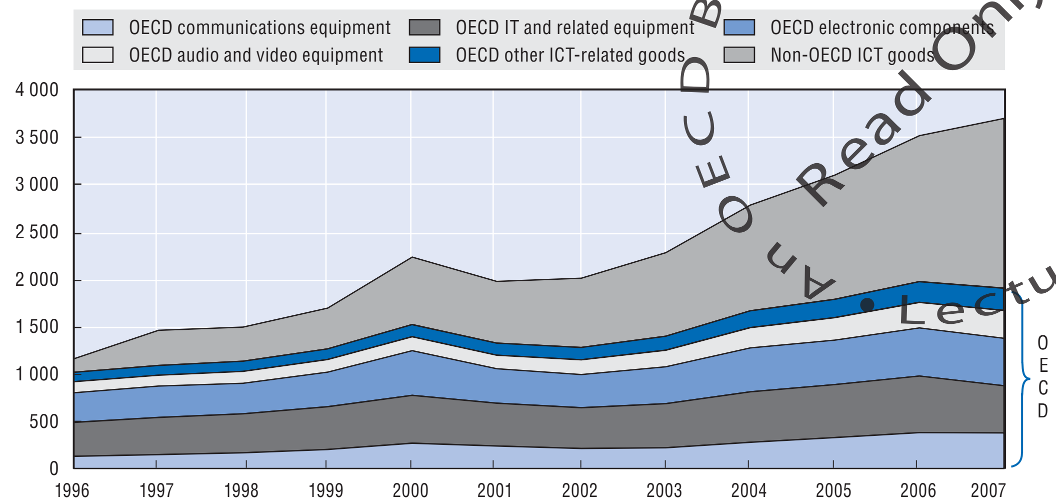
Figure 2.1. **World trade in ICT goods, 1996-2007**

USD billions in current prices



StatLink http://dx.doi.org/10.1787/473254016535

Note: No data for the Slovak Republic prior to 1997. Partly estimated for non-OECD 2007. ICT data for 2007 are not directly comparable with previous years.

Source: OECD-UNSD ITCS and the *UN COMTRADE database*, November 2008.

ICT trade in 2007 and 2008 outlook

Total world goods and services trade volumes slowed to 7.1% in 2007, close to the average rate of trade expansion over the last decade, but down from 9.5% in 2006, as weaker demand in developed countries outweighed higher growth in imports in some developing countries (OECD, 2008a; WTO, 2008a, b). In parallel, growth in ICT trade slowed in 2007 and the first half of 2008, after four years of strong expansion. Rapidly weakening economic conditions in leading OECD countries, falling demand in key markets, such as the United States and Europe, and tightening monetary policies in Asia are affecting ICT trade; and November 2008 reports suggest declines. However, the effects are not uniform and the exports of some countries continued to grow, mainly boosted by the resilience of some OECD ICT trade and strong demand from emerging markets. Unfortunately, the magnitude of the slowdown since the end of 2006 is hard to quantify owing to a lack of detailed international data. Values of OECD ICT goods trade in 2007 cannot be directly compared with earlier years owing to: the new Harmonized System (HS) classification adopted in 2007,[3] currency fluctuations due to the rapid decline in the USD (see Box 2.1), and downward corrections in 2007 due to VAT fraud (see Box 2.2).

Taking these factors into account, aggregate OECD ICT goods trade grew less rapidly in 2007 than in 2006. A country-by-country analysis based on these data shows strong USD growth in 2007 for total ICT goods trade for Eastern Europe (*e.g.* Slovak Republic, 68% year-on-year growth; Czech Republic, 32%); Norway, 16%; Austria, 10%; Australia, New Zealand and Korea, around 9%; Finland, 8%, and Switzerland, 7%, although all of these USD data are heavily influenced by exchange rate movements and particularly the drop in the USD *vis-à-vis* most currencies in 2007, which detailed analysis of data in national currencies would help clarify. In Turkey, Canada and Sweden growth was more moderate at 2-3%. Most OECD countries with stagnating or falling ICT trade are EU countries, but this may be due in part to VAT corrections (the United Kingdom, but also Germany and France). However, the

Box 2.1. Depreciation of the US dollar against leading currencies: Impacts on ICT trade data

In recent years the USD depreciated against most currencies (Table 2.1), and by over 25% against key currencies since 2001: 26% against the Korea won and around 15% against the Indian, Chinese and Japanese currencies. From July 2008 the USD started to appreciate again against key currencies. Given that all international trade data are expressed in USD, these fluctuations affect the analysis of trade flows, as exchange rate (price) effects are hard to dissociate from volume (quantity) effects.

Table 2.1. Currency exchange rates, national units per USD, percentage changes compared to 2001

%

	2002	2003	2004	2005	2006	2007	1st Q 2008
Australia	–4.86	–20.35	–29.77	–32.17	–31.39	–38.24	–42.91
Euro area	–4.98	–20.73	–27.92	–27.94	–28.65	–34.58	–40.22
Canada	1.40	–9.56	–15.97	–21.74	–26.74	–30.62	–35.10
United Kingdom	–4.00	–11.81	–21.39	–20.77	–21.73	–28.02	–27.18
Brazil	24.29	30.98	24.49	3.61	–7.42	–17.13	–26.13
Korea	–3.05	–7.71	–11.25	–20.63	–26.24	–27.97	–25.88
Russian Federation	7.47	5.22	–1.22	–3.03	–6.78	–12.30	–16.81
India	3.02	–1.28	–3.96	–6.54	–3.98	–12.37	–15.61
China	0.00	0.00	0.00	–1.00	–3.67	–8.09	–13.46
Japan	3.10	–4.57	–10.98	–9.37	–4.22	–3.07	–13.37
South Africa	22.44	–12.13	–24.97	–26.13	–21.35	–18.16	–12.31

Source: OECD calculations based on *OECD Main Economic Indicators*.

In terms of ICT trade analysis, appreciation against the USD inflates the total reported export and import value and growth of non-USD countries to the extent that their products are initially priced in their national currencies and their trade values are subsequently converted into USD. This leads USD trade values to exaggerate actual exports and imports in the short term for strong currency exporters and imports from countries with strong currencies. In terms of impacts over time, ICT exporters in the United States and countries which have appreciated less against the USD will find their ICT export products more competitive and may increase sales abroad. In turn, when their currency appreciates, non-US ICT exporters will find it harder to export to the United States than countries which have appreciated less, etc. However ICT exports are often priced in USD and do not change greatly with changes in the exchange rate; in this case USD fluctuations have a less immediate impact and will partly reflect export volumes rather than currency movements.

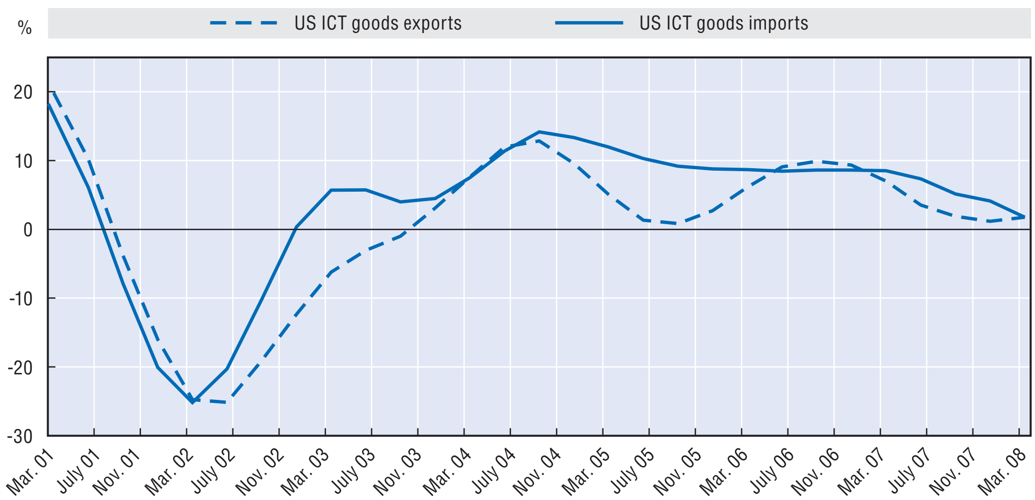
United States, Japan and Mexico also displayed slowdowns. The most prominent non-OECD traders have increasing ICT trade, although growth is slower than in previous years: China (16%), Hong Kong, China (10%), Thailand (7%) and Malaysia (2%); Singapore is an exception. However, as noted, direct detailed comparisons between 2006 and 2007 are not possible owing to classification issues.

National quarterly trade data on ICT goods such as office machinery, electronic components or semiconductors shed light on recent ICT trade performance. These data (current value) show that ICT trade continued to grow in most countries throughout 2007, albeit on a sometimes rapidly slowing path. During the first two quarters of 2008, ICT trade seems to have held up reasonably well, with ICT exports increasing more slowly than in 2007 in most countries, in line with slowing demand. US ICT imports were mostly falling, probably because of the weakening USD, but given the rise of other markets the overall effect was not pronounced. In Asia growth in ICT exports was slowing or negative owing to faltering global demand for ICT goods and strengthening currencies, as these affect the production of multinational ICT firms and purchases of components. In particular, semiconductor trade – a lead indicator for production and trade in ICT goods – has grown less strongly in most countries.

Turning to national data, in the United States from 2006 to 2007, growth of ICT trade[4] slowed from 8.9 to 2.9%, with import growth falling faster (from 7.9 to 3.8%) than ICT export growth (from 5.6 to 2.8%), following a trend since 2004. Export growth peaked in 2006 before slowing again in 2007 (Figure 2.2). In the first quarter of 2008, ICT exports recovered slightly (4.5% year-on-year growth), with telecommunications equipment (15% year-to-date growth) and computers (12%) growing strongly.[5] US semiconductor exports slowed to 4% year-on-year growth from the previous year; the United States also saw a fall in exports of stereo equipment and computer accessories. At the same time, US ICT imports have dropped, improving the US ICT trade balance. Declines in US imports have been strongest in business machines and equipment, computer accessories, and stereo equipment. In early 2008, US imports of TVs, VCRs and telecommunications equipment increased.

Figure 2.2. **United States ICT goods trade growth, March 2001-March 2008**

Year-on-year percentage change, trade values, seasonally adjusted, 4-month moving average



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Source: OECD, based on US Department of Commerce, July 2008.

In 2007, Germany experienced a fall in the value of IT hardware exports (–2.2%) and imports (–7.8%), a very pronounced fall in telecommunication equipment exports (–31%) and imports (–34%) but an increase in exports of consumer electronics (TVs, video, digital cameras, etc.) (12%) and imports (6%).[6] In the first quarter of 2008, there were also declines in IT hardware exports (–2%) and imports (–7%), and in telecommunications equipment exports (–31%) and imports (–34%). However, in consumer electronics growth continues, albeit more slowly, for both exports (+1%) and imports (+3.3%). A large share of German exports is for the European market.

In Japan office machinery exports grew from 2006 to 2007, mostly owing to strong Asian demand (by 6.7% in 2007 compared to 6% in 2006) despite strongly slowing ICT exports to the United States (down from growth of 7.4% in 2006 to 1% in 2007). However, Japanese ICT and electronics exports in the first five months of 2008 fell by 6.7% from 2007, possibly due to currency appreciation, and office machinery exports have fallen by 9% from 2007).[7] Whereas exports of consumer electronics and telecommunications equipment increased, exports of computer and related equipment, electronic components and integrated circuits fell. Overall Japanese exports have fallen for the first time in four years in 2008, with exports to the United States falling most strongly.

Between 2006 and 2007 Korean ICT exports continued to rise at double-digit rates. In order of absolute volume, electronic components were up by 12% (compared to 37% from 2005 to 2006, mainly owing to slower growth in semiconductors); mobile phones up by 13% (compared to stagnant growth from 2005 to 2006); screens and data displays up by 36% (compared to –10% from 2005 to 2006); and computer exports increased (by 10%).[8] Exports of household electronic articles fell by 8% (mainly owing to falling exports of colour TVs) and computer parts by 7%. Korean ICT goods exports are reported to have climbed by about 15% year on year in the first half of 2008, fuelled by greater overseas demand for mobile phones and display panels, although semiconductor exports seem to have contracted by 7%, while ICT imports have grown by 17%. Exports to China, other Asian economies, the EU and the United States have gained compared to the first half of 2007 while exports to Japan fell.

Australia's exports of office machines and data processing machines grew by 11% from 2006 to 2007, on a faster path than in 2006 (–0.5%). However, in the first five months of 2008, exports of office machines and data processing machines stagnated. For the same period, telecommunications equipment exports have grown by 8% (after a 14% fall in 2007).

Although growth of Chinese ICT exports and imports is slowing rapidly, both continue at very high levels (Figure 2.3). Quarterly data for Chinese exports of office equipment,

Figure 2.3. **China ICT goods export trade growth, April 2000-April 2008**

Year-on-year percentage change, trade values, 4-month moving average

StatLink http://dx.doi.org/10.1787/473284550361

Source: Chinese customs data, SITC codes: Chinese Office machinery and Telecom and Sound Recording equipment, July 2008.

computers and telecommunication equipment show a rapid increase. However, the quarterly growth of ICT exports peaked in early 2004 at a very high year-on-year rate but it has since slowed markedly. Up until the first quarter of 2007, Chinese ICT exports grew more rapidly than total Chinese manufacturing exports, but total Chinese manufacturing exports were growing faster in mid-2008.

In June 2008 Chinese Taipei's year-on-year growth in ICT exports (IT and communication products) stood at 12%, mainly owing to rising sales of computer components and flat-panel screens.[9] However, growth slowed and was falling most strongly for ICT exports to the United States. Shipments to China and Hong Kong, China (usually parts which are then re-exported as finished products) but also to Europe have so far served as a buffer.

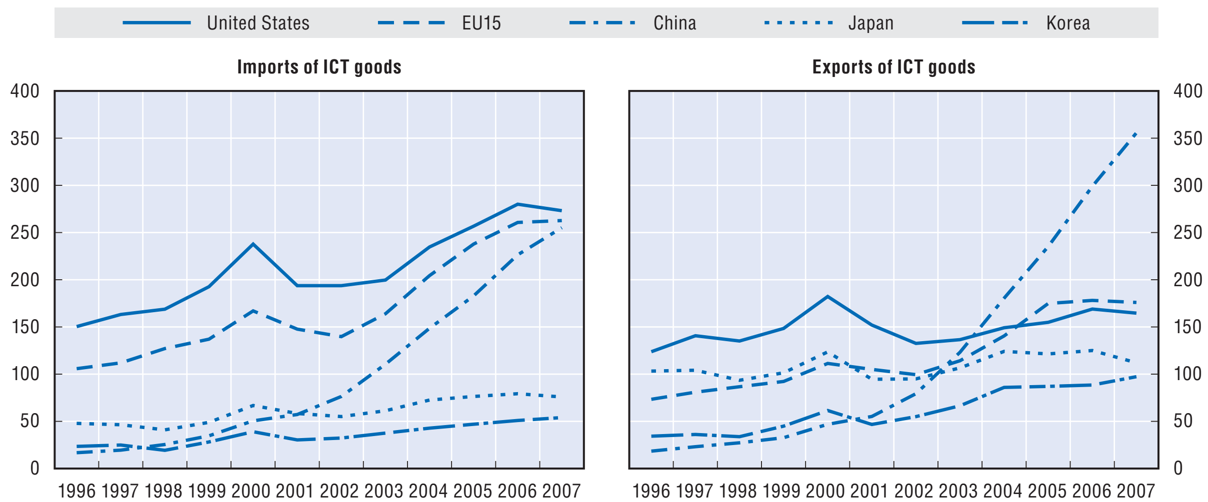
In the first half of 2008, Malaysia also reported decelerating growth in exports of electrical and electronics products (mainly due to falls in integrated circuit exports and in exports to the United States, its largest market).[10] Singapore's electronic shipments have declined each month since February 2007, mainly due to weaker exports of integrated circuits, computer parts and telecommunications equipment (a drop in exports of 15% in June 2008, as compared to the previous year).[11] Exports have decreased most to the United States and Europe and less to Japan, but exports to China and Hong Kong, China have also started to slow (12% decline year on year in June 2008, although still growing). ICT goods exports to Malaysia and Korea continue to grow.

Leading ICT goods exporters and importers

Since 2004, China has been the world's largest exporter of ICT goods. Exports increased by 30% a year since 1996 to almost USD 360 billion in 2007 and in 2007 eclipsed the combined exports of the EU15 and the United States (USD 341 billion) (Figure 2.4).

Figure 2.4. **Top importers and exporters of ICT goods, 1996-2007**

USD billions in current prices



StatLink http://dx.doi.org/10.1787/473308446681
StatLink http://dx.doi.org/10.1787/473322306525

Note: Data for the EU15 exclude intra-EU trade.

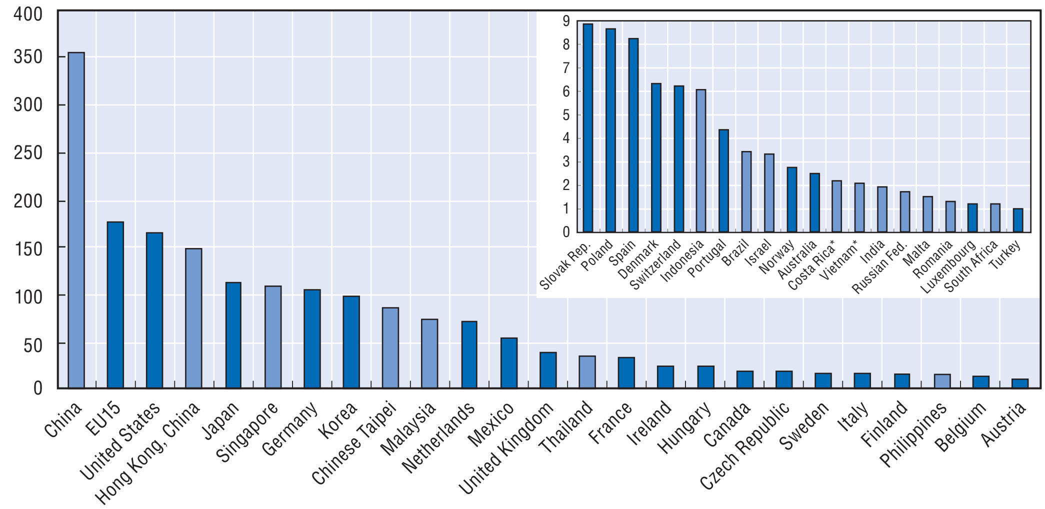
Source: Joint OECD-UNSD ITCS and the *UN COMTRADE database*, June 2008.

China's trade surplus exceeds USD 100 billion (see Chapter 3, *OECD Information Technology Outlook 2006*). China's ICT trade continues to be geared towards ICT product assembly: computers and related equipment, worth almost USD 126 billion, accounted for 42% of China's total ICT goods exports in 2006, and is the fastest-growing export category. Because of China's assembly operations, electronic components is the largest category of ICT goods imports (USD 158 billion in 2006, up from less than USD 7.4 billion in 1996, or by 36% a year. Electronic components accounted for no less than 70% of all ICT goods imported into China in 2006, resulting in a trade deficit in components of USD 92 billion as compared to trade surpluses in all categories of assembled ICT equipment. A shift in production from Chinese Taipei and Hong Kong, China, to mainland China has further inflated Chinese export figures.

After China, the largest exporters of ICT goods in 2007 were the EU15 (USD 176 billion), the United States (USD 165 billion), Hong Kong, China (USD 148 billion), Japan (USD 112 billion), Singapore (USD 108 billion), and Germany (USD 105 billion) (Figure 2.5a and Annex Table 2.A1.4). The role of Hong Kong, China and Singapore can mainly be attributed to re-exports, particularly of electronic parts and components from other Asian countries.

Figure 2.5a. **ICT goods exports, 2007**

USD billions



StatLink http://dx.doi.org/10.1787/473336776138

Note: Data for the EU15 exclude intra-EU trade. Countries for which only 2006 data are available are marked by *.

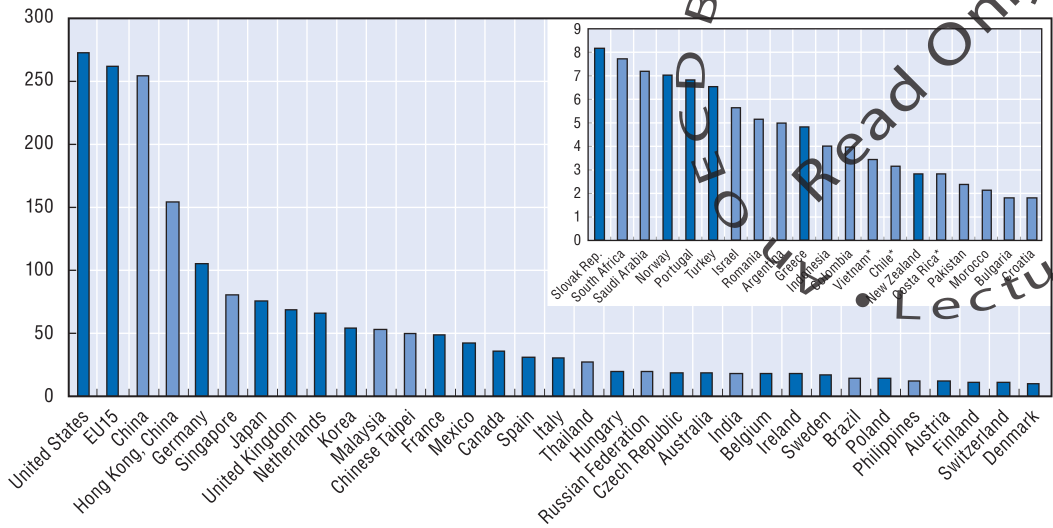
Source: Joint *OECD-UNSD ITCS database*, October 2008.

The fastest export growth among OECD countries over the decade to 2006 was in Hungary (40% a year), the Slovak Republic (38%), the Czech Republic (31%), and Poland (25%). ICT exports from Korea grew at an average of 10% from 1996 to USD 88 billion in 2006. Available data for 2007 show that many OECD countries had strong growth of ICT exports in 2006: mainly in the Asian region (New Zealand. 12%; Australia, 10%; Korea, 10%) but also in Europe (Norway, 24%; Austria, 13%; Switzerland, 12%).[12]

In 2007, the largest importers of ICT goods were the United States (USD 273 billion), EU15 (USD 263 billion), China (USD 255 billion), Hong Kong, China (USD 154 billion), Germany (USD 106 billion), Singapore (USD 81 billion), and Japan (USD 76 billion)

Figure 2.5b. **ICT goods imports, 2007**

USD billions



StatLink http://dx.doi.org/10.1787/473350057612

Note: Data for the EU15 exclude intra-EU trade. Countries for which only 2006 data are available are marked by *.

Source: Joint *OECD-UNSD ITCS database*, October 2008.

(Figure 2.5b and Annex Table 2.A1.4). In part, OECD imports of ICT goods are the result of OECD exports of high-value added electronic components (semiconductors) to Asia, which are then assembled in notebooks, PCs, communication products and imported as final products.

The EU15 and the United States have a steadily growing ICT trade deficit (from USD –50 billion in 2003 to USD –87 billion in 2007 for the EU15, and from USD –63 billion in 2003 to USD –109 billion in 2007 for the United States). Australia (USD –15 billion) and Canada (USD –17 billion) also had very large deficits. Spain, Canada, Italy, Australia and France all had deficits in excess of USD 10 billion, as did India, the Russian Federation, Brazil, and South Africa. However, Korea, Japan, China, Hong Kong (China) and Singapore have growing surpluses and nine OECD countries had a surplus in ICT goods in 2006, most notably Japan (USD 46 billion) and Korea (USD 38 billion).

ICT exports of OECD accession countries and the BRICS economies

The five OECD accession countries (Chile, Estonia, Israel, the Russian Federation and Slovenia) are not particularly prominent in world ICT goods trade, with combined trade (the sum of imports and exports) of less than USD 34 billion in 2006, a level similar to Ireland's and less than 6% of OECD ICT goods trade (see Annex Table 2.A1.5). Taken together, these countries have a deficit in all categories of ICT goods. At USD 25 billion in 2006 their imports were almost three times their exports (USD 8.6 billion), and exports have declined by almost 3% a year since 2000. Communication equipment accounted for 45% of combined exports in 2006, and components for 20%; communication equipment is also the largest category of ICT goods imports, accounting for 35% in 2006.

Israel is the largest exporter of ICT goods among accession countries at USD 5 billion in 2006, accounting for almost 60% of combined exports, more than half of which in communication equipment. However, Israel's exports of communication equipment have declined by 7% a year since 2000, as have its total ICT goods exports. The Russian Federation is the largest and fastest-growing importer of ICT equipment among these countries, owing to significant imports of communication equipment and rapidly increasing imports of audio and video equipment. Its ICT goods imports have increased by around 40% a year since 2000 to almost USD 14 billion in 2006.

The major emerging economies, or BRICS (*i.e.* Brazil, the Russian Federation, India, China and South Africa), are increasingly important as both producers and new growth markets for ICT goods and services. ICT goods exports from the BRICS economies have increased by almost 35% a year from USD 51 billion in 2000 to almost USD 307 billion in 2006 (equivalent to 33% of OECD exports), while imports have increased by 26% a year from USD 69 billion to USD 276 billion (equivalent to 25% of OECD imports) (see Annex Table 2.A1.6).

Since 1997, Brazil has increased its exports of ICT goods by 16% a year, faster than imports (5% a year) owing to strong growth in exports of communication equipment. In spite of a substantial trade surplus in communication equipment, Brazil had a trade deficit in ICT goods of almost USD 9 billion in 2006. Conversely, imports of ICT goods into the Russian Federation and India are growing more than three times faster than exports in both. Over the decade to 2006, communication equipment imports into India increased by 43% a year from USD 171 million to more than USD 6.2 billion. South Africa's ICT goods exports and imports have both risen by around 10% a year over the period, with slightly stronger growth in exports. With deficits on trade in all categories of ICT equipment in 2006, the Russian Federation's ICT goods deficit was more than USD 12.3 billion, India's more than USD 13 billion and South Africa's USD 6.8 billion.

Indonesia (an OECD enhanced engagement country) has a substantial and growing trade surplus in ICT equipment. It exported almost USD 7 billion of ICT equipment in 2006, an increase of more than 9% a year from USD 3.3 billion in 1996 (see Annex Table 2.A1.6). Computers and audio and video equipment are the main contributors, with exports of each worth around USD 2.3 billion in 2006. Electronic components were the other major category of exports at USD 1.6 billion. Communication equipment accounted for almost half of ICT equipment imports worth a total of USD 2.4 billion in 2006.

Direction of ICT trade

The direction and composition of trade in ICT goods shows a good deal about the changing patterns of global production, with rapid growth of non-member and, to a lesser extent, Eastern European countries as both markets and producers. Import trends in particular reveal a shift of manufacturing activity towards non-member economies, especially in Asia.

ICT goods imports into OECD countries increased by 7.4% a year between 1996 and 2006, with growth of imports much stronger from non-member economies (12% a year) than from OECD countries (4.7% a year) (Figure 2.6 and Annex Tables 2.A1.7 and 2.A1.8).

There is also a shift in manufacturing and related export activities within the OECD, which is apparent if Mexico and Eastern European members (the Czech Republic, Hungary, Poland, the Slovak Republic and Turkey) are separated out. Between 1998 and 2006, overall OECD ICT goods trade increased by 7.2% a year, while that of Mexico and the Eastern European members increased by 13.7% (Figure 2.6). In 2006, components accounted for 12% of ICT goods exports and 44% of imports for Mexico and the Eastern European members, compared with 31% of exports and 21% of imports of the other OECD countries. Conversely,

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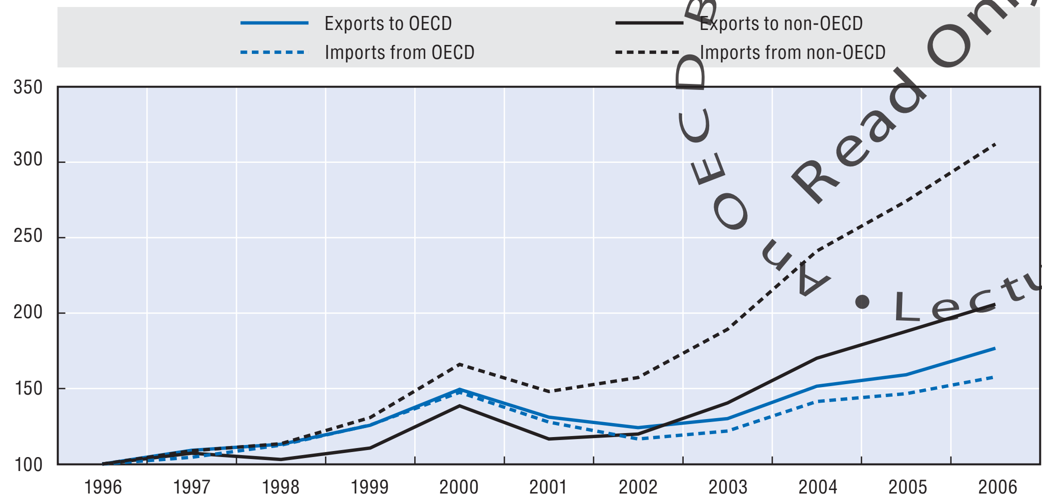
Figure 2.6. **Direction of OECD ICT goods trade, 1996-2006**

USD current prices, indexed 1996 = 100



StatLink http://dx.doi.org/10.1787/473362213212

Notes: No data for the Slovak Republic prior to 1997.

Source: Joint OECD-UNSD ITCS and the *UN COMTRADE database.*

audio and video equipment accounted for 36% of ICT goods exports and 10% of imports for Mexico and the Eastern European members, compared with just 9% of exports and 16% of imports for the other member countries.

Mexico and the Eastern European members had a trade surplus in most categories of assembled ICT equipment in 2006, but a combined trade deficit in components in excess of USD 32 billion. In contrast, the other OECD countries recorded a combined trade deficit in assembled audio and video and computer equipment, with a trade surplus in components in excess of USD 60 billion. These figures reflect a shift of ICT equipment assembly activities to Mexico and Eastern Europe which, while less pronounced, is similar in nature to what is occurring in China and elsewhere in Asia.

OECD trade in ICT subsectors

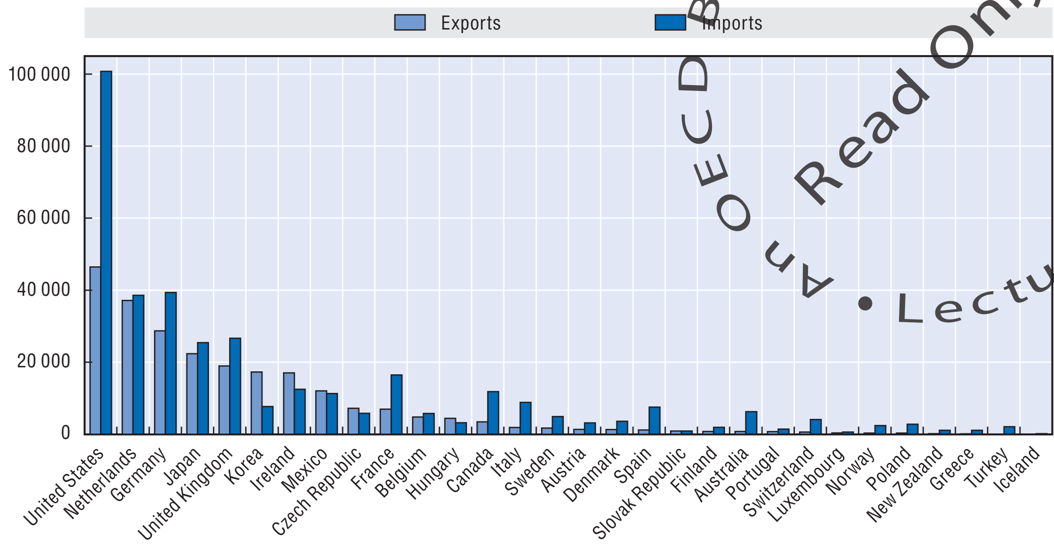
OECD trade flows are dominated by computer and related equipment, electronic components and communication equipment (in that order). Yet, apart from OECD trade in ICT services, which is discussed later, it is audio and video equipment and software trade which have grown fastest.

Computer and related equipment

Computer equipment is the largest segment of OECD ICT goods trade, accounting for around 30% of the total. In addition to the traditional producers, Korea and Ireland have become major producers, and Mexico and Eastern Europe have also emerged as significant producers in recent years (Figure 2.7). In 2006, OECD exports reached USD 239 billion, exceeding the previous peak in 2000 (Annex Table 2.A1.9). The largest exporters were the United States (USD 46 billion), the Netherlands (USD 37 billion), Germany (USD 29 billion), Japan (USD 22 billion), and the United Kingdom (USD 19 billion). However, at almost USD 126 billion, China's exports of computer equipment were almost three times those of

Figure 2.7. **OECD computer equipment trade, 2006**

USD millions



StatLink http://dx.doi.org/10.1787/473368034141

Source: Joint OECD-UNSD ITCS and the *UN COMTRADE database.*

the United States. Over the last decade, exports from Hungary, the Slovak Republic, the Czech Republic and Portugal have increased by 30% a year or more.

OECD imports of computer equipment also reached a new peak of USD 357 billion in 2006, with the United States (USD 101 billion), Germany (USD 39 billion), the Netherlands (USD 39 billion), the United Kingdom (USD 27 billion) and Japan (USD 25 billion) among the largest importers (Figure 2.7). Where both imports and exports of a particular category of equipment are relatively large (*e.g.* the Netherlands) a substantial element of that trade may be transhipment (*i.e.* re-exports).

Korea enjoyed the OECD's largest trade surplus in computer equipment in 2006, at USD 9.6 billion. Other countries with significant surpluses included Ireland (USD 4.5 billion), the Czech Republic (USD 1.4 billion), Hungary (USD 1.2 billion) and Mexico (USD 787 million). The Slovak Republic was the only other OECD country with a surplus. None approached the USD 87.5 billion surplus enjoyed by China. The United States had a trade deficit in computer equipment of more than USD 54 billion, while Germany (USD 10.6 billion) and France (USD 9.5 billion) also had substantial deficits.

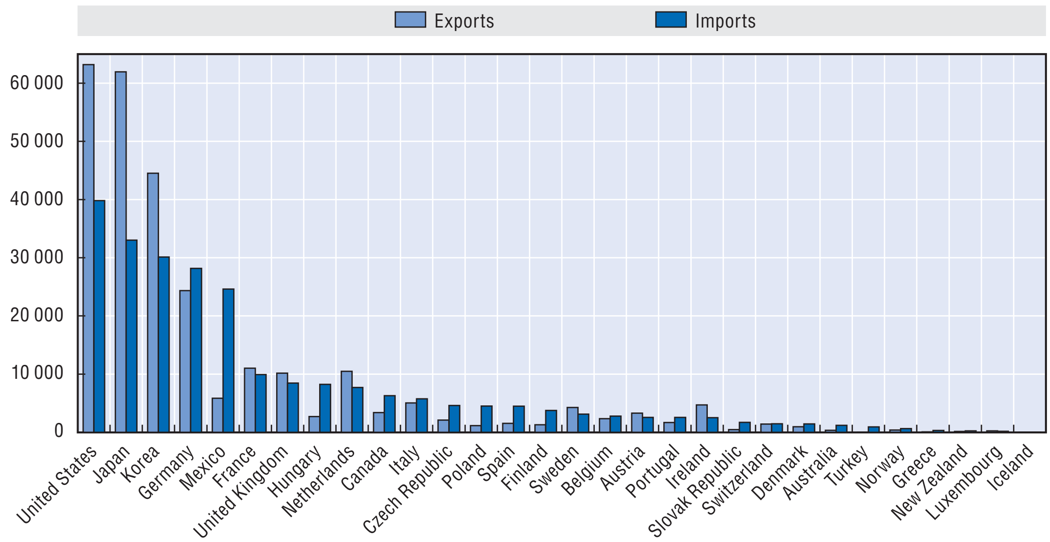
Electronic components trade

Electronic components account for almost 26% of OECD ICT goods trade, but has been one of the slowest-growing market segments in value terms owing, in part, to falling prices. Recovering in recent years, OECD exports of electronic components reached a new peak of USD 269 billion in 2006 (Annex Table 2.A1.10). The largest exporters were the United States (USD 63 billion), Japan (USD 62 billion), Korea (USD 45 billion) and Germany (USD 24 billion). OECD imports of components reached USD 241 billion in 2006, with the largest importers being the United States (USD 40 billion), Japan (USD 33 billion), Korea (USD 30 billion), and Germany (USD 28 billion). Reflecting their increasing role in ICT equipment assembly, imports into Hungary, the Slovak Republic, the Czech Republic and Poland have increased by 20% a year or more since 1996 (Figure 2.8).

Japan enjoyed the largest trade surplus in components in 2006, at almost USD 29 billion. The United States was the only other country with a large surplus (USD 23 billion), although Korea, the Netherlands and Ireland also had substantial surpluses, owing to their continuing role in high value electronics manufacturing. Reflecting their roles in assembly activities, Mexico (USD 18.8 billion) and Hungary (USD 5.5 billion) had the largest trade deficits in electronic components.

Figure 2.8. **OECD electronic components trade, 2006**

USD millions



StatLink http://dx.doi.org/10.1787/473423564664

Source: Joint OECD-UNSD ITCS and the *UN COMTRADE database.*

Communication equipment trade

Communication equipment is the fastest-growing segment of ICT trade, but it is affected by increasing VAT fraud, called missing trader inter-community (MTIC) fraud, which inflates in particular exports from certain EU countries such as the United Kingdom (see Box 2.2). OECD exports of communication equipment increased from USD 72 billion in 1996 to around USD 190 billion in 2006 (see Annex Table 2.A1.11). The largest exporters were the United Kingdom (USD 49 billion),[13] the United States (USD 22 billion), Germany (USD 21 billion) and Korea (USD 19 billion), with exports from Hungary, the Czech Republic, Poland and Korea (and the United Kingdom) growing by 20% a year or more between 1996 and 2006 (Figure 2.9). OECD imports of communication equipment also reached a new peak of USD 186 billion in 2006, with the United States, United Kingdom, Germany and France the largest importers.

The United Kingdom and Korea enjoyed the largest trade surpluses in communication equipment in 2006 at USD 21 billion and USD 16 billion, respectively. Other countries with a significant surplus were a mix of established high-value manufacturing locations (*e.g.* Finland USD 8 billion and Sweden USD 4.7 billion) and more recent manufacturing locations (*e.g.* Mexico USD 4.6 billion and Hungary USD 4.5 billion). The United States had a

Box 2.2. **Communication equipment trade and missing trader inter-community fraud**

Trade data show very volatile exports of communication equipment from the United Kingdom, increasing by 134% from USD 9.6 billion to USD 22.6 billion in 2005, by a further 116% to USD 48.7 billion in 2006 followed by a very substantial fall in total ICT exports of 39% in 2007 (however, the data are not directly comparable because of changes in the Harmonised System). This spike to 2006 and fall in 2007 is also apparent for some other EU member states and some other ICT trade sub-components and affects the overall aggregate trade figures. There are many reasons for volatility in communications equipment trade.[1] However, the main explanation for this spike in export activity is value-added tax (VAT) missing trader inter-community (MTIC) fraud, which has tended to concern small, high-value items of electronics, such as cellular mobile handsets.[2]

VAT intra-community missing trader fraud is a systematic criminal attack on the VAT system, which has been detected in many EU member states (Ruffles *et al.*, 2003). In essence, fraudsters obtain VAT registration to acquire goods VAT-free from other member states. They then sell on the goods at VAT-inclusive prices and disappear without paying the VAT paid by their customers to the tax authorities by the time the tax authorities follow up the registration with their regular assurance activities. The "carousel" version of the fraud occurs when goods that have been imported are sold through a series of transactions before being re-exported to another EU member state and subsequently re-imported. In 2006, communication equipment exports from the United Kingdom increased most rapidly in both volume and percentage terms to France (increasing by USD 12 billion or 408% during the year), Germany (USD 3.3 billion or 350%) and the Netherlands (USD 3.4 billion or 303%). However, UK import data do not show such rapid growth – increasing by 20% from USD 14 billion to USD 17 billion in 2004 and by a further 65% to USD 28 billion in 2006.

Taxation authorities and national statistical offices have been working hard to prevent the fraud and to minimise its impact on official national statistics. However, international convention dictates that the treatment of the impact is to adjust imports upwards to include the fraudulent transactions, rather than adjusting exports downwards to exclude them, even though the trade may not be genuine. This can have a significant impact on EU member trade statistics. The UK National Statistics Office (2007) estimated MTIC fraud trade adjustments at GBP 11.2 billion in 2005 and GBP 22.9 billion in 2006 (more than GBP 20 billion of which in the first two quarters). This means that when MTIC fraud declines exports decline markedly.

To estimate the impact on communication equipment trade data, growth in communication equipment production for 2004-06 was applied to UK export data. This is rather crude because re-exports can increase rapidly, but it may be taken as an approximate guide to export growth. On that basis, reported UK exports of communication equipment may have been as much as GBP 7 billion too high in 2005, and GBP 20 billion too high in 2006 – close to the official estimates of the total impact of MTIC fraud on UK trade data.

Official estimates of the impact of MTIC fraud on trade declined markedly in mid-2006 as a result of a number of initiatives aimed at detecting and preventing such fraud, including the introduction of a computer database containing the unique identification number of mobile phones being exported, tightening up the refund process and gaining a European Commission ruling to allow reverse charging for certain products. As a result, 2007 data, which is often substantially lower than 2006 data, more accurately reflects underlying trends in communication equipment trade. Total ICT exports for the United Kingdom, for

Box 2.2. **Communication equipment trade and missing trader inter-community fraud** *(cont.)*

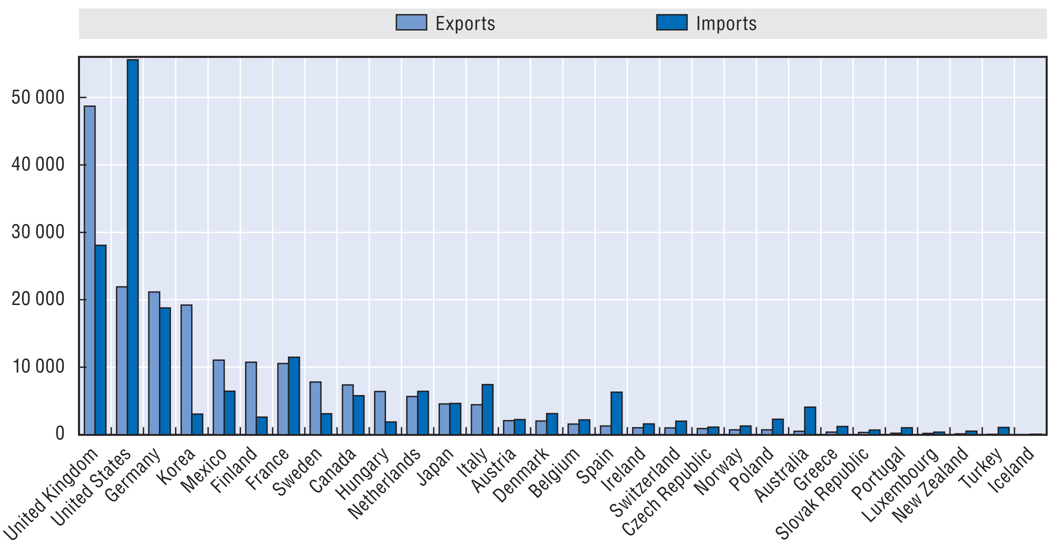
example, fell by 60% from USD 91 billion to USD 37.6 billion in 2007, in part due to reduced MTIC fraud and better measurement of actual trade. However, this downward correction of ICT export figures complicates the analysis of growth between 2006 and 2007 as it is hard to separate real slowdowns in ICT trade growth from downward corrections due to less MTIC fraud.

1. Other reasons include major communications network investments, technology life cycles driving investment cycles, and deregulation, increasing competition and cross-border mergers and acquisitions in telecommunications leading to sudden changes in supply contracts and relationships.
2. It was reported that in 2005 mobile phones worth more than EUR 2 billion were imported into Germany from Switzerland alone, although there is no manufacture of mobile phones in Switzerland and no other obvious commercial reason for such trade (HM Revenue and Customs, 2006).

Sources: House of Lords (2007), Pollack (2006), Recipero (2007),

Figure 2.9. **OECD communication equipment trade, 2006**

USD millions



StatLink http://dx.doi.org/10.1787/473431030025

Source: Joint OECD-UNSD ITCS and the *UN COMTRADE database.*

trade deficit in communication equipment of almost USD 34 billion, while Spain, Australia and Italy each had a deficit of USD 3 billion or more.

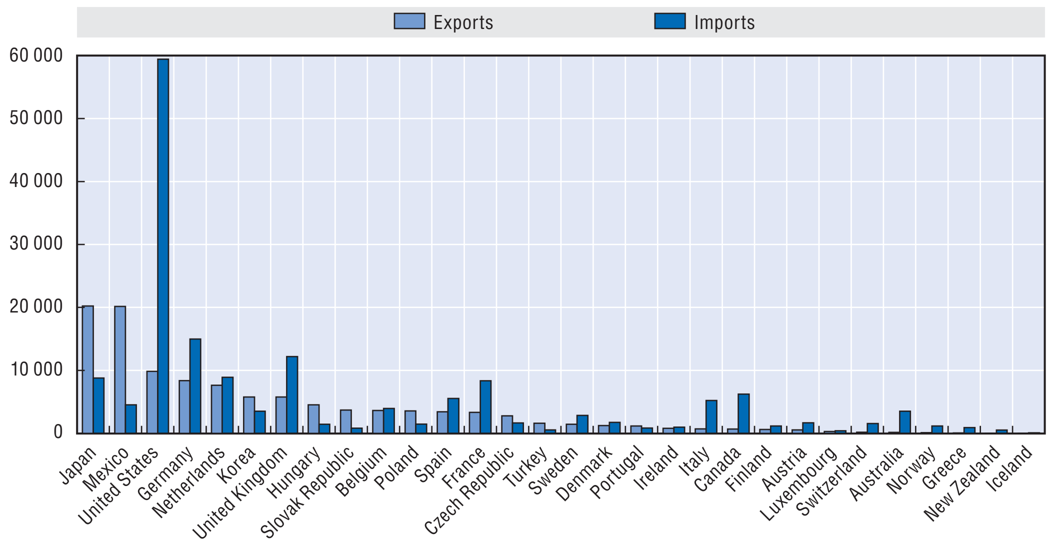
Audio and video equipment trade

Audio and video equipment accounts for less than 15% of ICT equipment trade, but sales of digital cameras, flat screen TVs and MP3 players have made this one of the faster-growing market segments. OECD exports of audio and video equipment reached USD 112 billion in 2006 (Annex Table 2.A1.12). The largest exporters were Japan and Mexico (USD 20 billion), the United States (USD 9.8 billion) and Germany (USD 8.4 billion), with exports from the Czech Republic, the Slovak Republic, Hungary and Poland increasing most rapidly as assembly activities have moved to Eastern Europe. China's exports of audio and video equipment reached more than USD 50 billion in 2006, equivalent to the combined exports of the United States, Japan and Mexico (Figure 2.10).

OECD imports of audio and video equipment reached almost USD 164 billion in 2006; the largest importers were the United States (USD 59 billion), Germany (USD 15 billion), the United Kingdom (USD 12 billion) and the Netherlands (USD 9 billion). Mexico enjoyed the largest trade surplus in audio and video equipment in 2006 at almost USD 16 billion, while Japan (USD 11.5 billion), Hungary (USD 3 billion), the Slovak Republic (USD 2.9 billion) and Korea (USD 2.3 billion) also had significant surpluses. China's surplus reached USD 40 billion. The US trade deficit in audio and video equipment was by far the largest at almost USD 50 billion in 2006.

Figure 2.10. **OECD audio and video equipment trade, 2006**

USD millions



StatLink http://dx.doi.org/10.1787/473505518578

Source: Joint OECD-UNSD ITCS and the *UN COMTRADE database.*

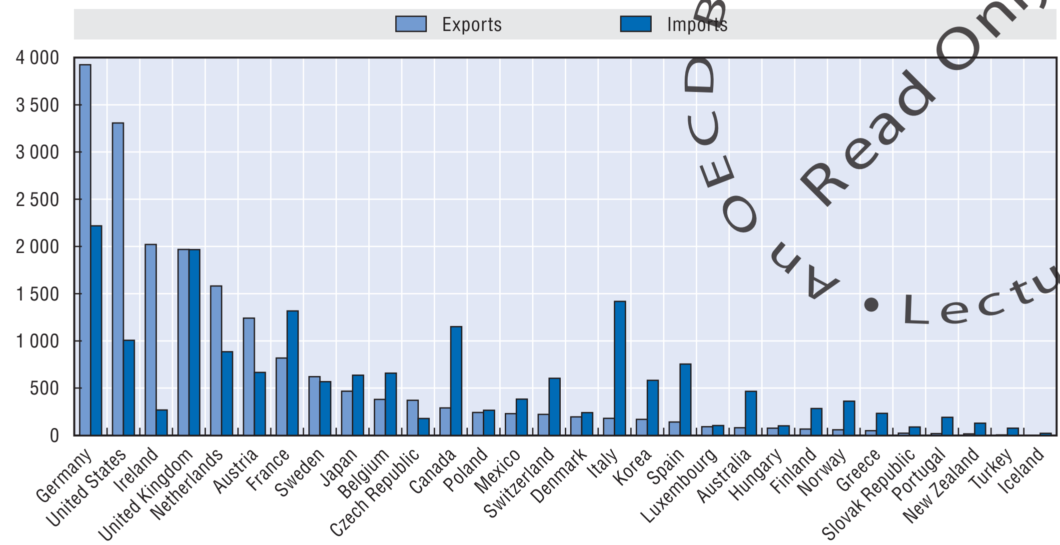
Software goods trade

Total OECD exports of software goods (*i.e.* the media that contain software, see Box 2.3, not included in ICT trade totals above) reached almost USD 19 billion in 2006, and imports USD 18 billion (Annex Table 2.A1.14). Between 1996 and 2006, exports increased by 5.2% a year, while imports increased by 5.6% a year (Figure 2.11).

In 2006, the leading exporters of software goods were Germany (USD 3.9 billion), the United States (USD 3.3 billion) and Ireland (USD 2 billion), although exports from Ireland have declined since 1996. Sweden, Poland, Mexico and Korea have also recorded strong growth in exports. Germany, the United Kingdom, Italy, France, Canada and the United States were the OECD's leading importers of software goods, each importing between USD 1 billion and USD 2 billion in 2006. Italy, Canada, Spain, France and Korea had the largest trade deficits in software goods in 2006, while the United States, Ireland and Germany had the largest surpluses (Figure 2.11).

Figure 2.11. **OECD software goods trade, 2006**

USD millions



StatLink http://dx.doi.org/10.1787/473514062576

Source: Joint OECD-UNSD ITCS and the *UN COMTRADE database.*

Box 2.3. **Measuring software trade**

There are a range of problems for measuring international trade in software. First, as border valuations are based on physical media, the value of the software traded is likely to be significantly understated. Second, the bundling of software with hardware leads to significant mis-measurement (with an overstating of equipment trade and understating of software trade). Third, trade statistics do not measure the value of copyright works sold in foreign markets when only the original software product is transferred internationally and copied multiple times for sale in the importing country (*i.e.* the "gold master" problem). Fourth, trade statistics do not measure the value of software transmitted electronically across borders, which accounts for a rapidly increasing share of sales, or the rise of application service providers of software (ASPs) and software as a service (SAAS). The approach used here is to track trade in the physical supports (*e.g.* magnetic and optical discs and other recorded media). When seen alongside trade in computer and information services (discussed below) these data give some indication of the relative size and geographical distribution of cross-border sales of software.

Source: *OECD Information Technology Outlook 2002* and OECD (2007a).

Trade in ICT services

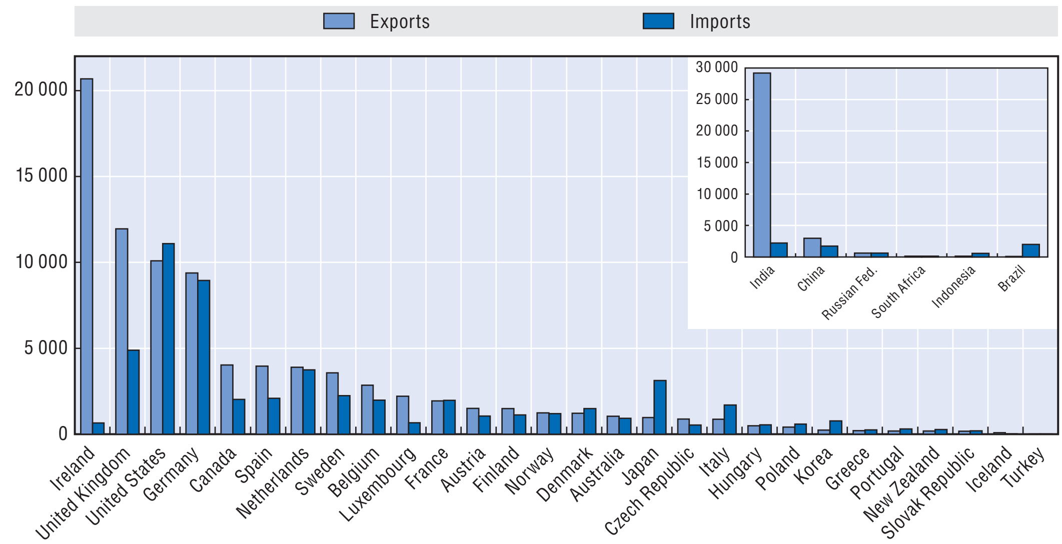
OECD ICT-related services trade – by far the most dynamic OECD ICT export component – increased from around USD 70 billion in 1996 to more than USD 235 billion in 2006, or by 13% a year. Over the period, OECD exports of ICT services increased by 16% a year to USD 134 billion and imports by 11% a year to USD 102 billion, and a trade deficit in ICT services has turned into a surplus of around USD 32 billion. The share of ICT services in total OECD services trade increased from 3.4% in 1996 to 6% by 2006, or by 5.8% a year (Annex Table 2.A1.15).

Computer and information services

Reported OECD exports of computer and information services increased by 20% a year from around USD 14 billion in 1996 to USD 86 billion in 2006, and imports increased by more than 15% a year from USD 13 billion to USD 54 billion (Figure 2.12 and Annex Table 2.A1.15).[14] In 2006, Ireland was the leading exporter (USD 20.7 billion), followed by the United Kingdom (USD 11.9 billion), the United States (USD 10.1 billion) and Germany (USD 9.4 billion). The United States (USD 11 billion) and Germany (USD 9 billion) were the largest importers, followed by the United Kingdom (USD 4.9 billion) and the Netherlands (USD 3.7 billion).

Figure 2.12. **OECD and major emerging economies' computer and information services trade, 2006**

USD millions



StatLink http://dx.doi.org/10.1787/473577474371

Source: *OECD Statistics on International Trade in Services*, Volume I, detailed tables by Service Category, Sept. 2008.

Ireland had by far the largest trade surplus in computer and information services in 2006. The United Kingdom also had a large surplus, followed by Canada, Spain, Luxembourg and Sweden. However, Ireland includes software licence fees in computer and information services, while other countries record them separately under "royalties and licence fees". Nevertheless, taking into account computer and information services, software goods (discussed above) and software-related royalties and licence fees, Ireland is a major producer and exporter of software and IT services due very largely to multinational enterprise activity.

Among the major emerging economies, reported data show that India is clearly the leading exporter of computer and information services, at USD 29 billion in 2006, more than any OECD country and almost three times more than the United States (for a more detailed analysis of outsourcing, see OECD, 2006, Chapter 4). China is also a significant exporter of computer and information services with USD 3 billion in 2006 (more than all but eight OECD countries). Brazil (USD 2 billion) and China (USD 1.7 billion) are also major importers. The globalisation of ICT services is particularly pronounced in countries which are not known for them. A few South African ICT services firms with very strong international linkages appear in the OECD Top 250 ICT firms (see Box 2.4).

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Box 2.4. **Out of South Africa: Globalisation of ICT services**

Some of the larger South African ICT service firms are globalising rapidly and are listed among the top 250 ICT firms (see Chapter 1).

Datatec Group

Datatec is registered in South Africa, its shares are listed in Johannesburg and London and its subsidiaries have headquarters and operations in multiple countries beyond Africa. Its revenues increased from USD 1.9 billion in 2000 to almost USD 4 billion in 2007 and the company employs just over 3 500 people. It ranked 220th in the OECD top 250 ICT firms, based on 2006 revenue. Westcom is its global distributor of networking and communications convergence products from Cisco, Nortel, Avaya, Checkpoint and Nokia; it is headquartered in the United States with operations in 16 countries. Since 1997, Datatec has undertaken more than 35 international acquisitions (M&As), including 14 in the United Kingdom and seven in the United States, and has made acquisitions in Argentina, Australia, Brazil, France, Germany, the Netherlands, Singapore, Switzerland and Turkey. Among the larger acquisitions reported are those of the Westcom Group, Bloomfield Computer Network Solutions, Avent Inc. (Hewlett-Packard Enterprise End-User Business), and Puget Sound Systems Group in the United States; and RBR Networks Ltd., Satelcom UK Ltd., Crane Telecommunications Group Ltd., Logical Networks plc., Mason Group Ltd., Bluepoint Plc. and Analysys Ltd. in the United Kingdom.

Dimension Data

Founded in 1983 and headquartered in South Africa, Dimension Data is a specialist IT services and solution provider which helps to build IT infrastructures. Dimension Data's revenues increased from less than USD 2 billion in 2000 to almost USD 3.8 billion in 2007, and the company employs 10 060 people worldwide. It ranked 205th in the ICT top 250, based on 2006 revenue. During the first half of 2007, Dimension Data reported that 27% of its total revenue was earned in Europe, 22% in Africa, 20% in Australia, 16% in the United States and 15% in Asia. Since 1997, Dimension Data has made close to 20 international acquisitions, including five in the United Kingdom, three in Australia, and two in Singapore and Belgium, as well as in Korea, the Netherlands, Switzerland, India and Nigeria. Major deals include the acquisitions of Comparex Holdings European Networking Operations, Chernikeeff Networks and Merchants Group in the United Kingdom, and Datacraft and Com Tech Communications in Australia. In November 2005, Dimension Data acquired the remaining 51% stake in Plessey, and in 2006 it acquired the remaining 20% in Internet Solutions (Pty) Limited.

Source: OECD, based on top ICT firms database, annual reports, market financials and data provided by Dealogic.

Communication services

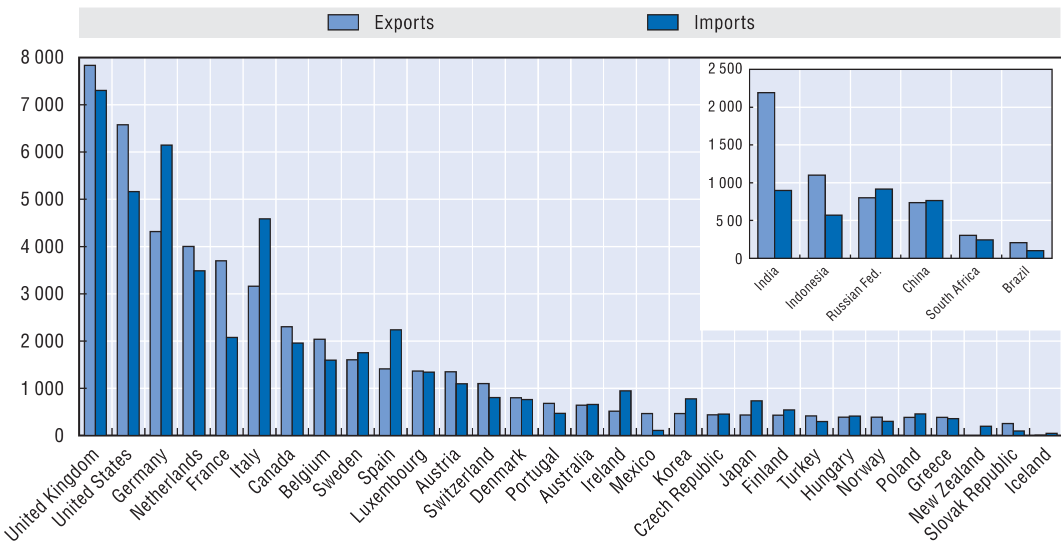
Communication services trade trends are difficult to interpret (see OECD *Communications Outlook* 2007 and the forthcoming 2009 edition). Values are often tied to progress in the deregulation of communications in various countries and trade is often a contrary indicator to overall services trade (*i.e.* communication services imports tend to increase when other services exports increase, and *vice versa*, as domestic service providers communicate with overseas clients more when they export more and provide services to them than when they import more and receive services from them).

Reported OECD trade in communication services increased by around 9% a year from 1996 to 2006, with exports increasing by 11% a year and imports by 7% (Annex Table 2.A1.12). The leading exporters were the United Kingdom (USD 7.8 billion), the United States (USD 6.6 billion), Germany (USD 4.3 billion), the Netherlands (USD 4 billion) and France (USD 3.7 billion). The main importers were the United Kingdom (USD 7.3 billion), Germany (USD 6.1 billion) and the United States (USD 5.2 billion). France had the largest surplus, at almost USD 1.6 billion (Figure 2.13).

The Russian Federation and China are significant exporters of communication services, with exports in 2006 of USD 738 million and USD 803 million, respectively (see Box 2.5). Both are also substantial importers and had trade deficits in communication services in 2006. However, India was the largest exporter among the BRICS economies at USD 2.2 billion.

Figure 2.13. **OECD and major emerging economies' communication services trade, 2006**

USD millions



StatLink http://dx.doi.org/10.1787/473588767036

Source: *OECD Statistics on International Trade in Services*, Volume I, detailed tables by Service Category, September 2008.

Globalisation of the ICT sector

Over the past quarter of a century, the overall pattern of world investment, production and trade has changed with the development of international sourcing (*i.e.* international purchasing of intermediate product and service inputs) both within firms and between firms in the same industry (*i.e.* intra-firm and intra-industry trade). The ICT sector plays a major role in this, as it is highly globalised and enables the globalisation of other sectors. This section explores these features of globalisation, and examines the level of specialisation and the nature and extent of globalisation of the ICT-producing sector.

Global ICT production

In recent years globalisation of ICT and electronics has featured the rapid development of new production locations and markets in emerging economies. Reed Electronics Research provides data on electronics production, one of the best available

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Box 2.5. **Russian communication service providers**

Two of the top 250 ICT firms are Russian communication service providers (see Chapter 1). Their development sheds light on the growing service markets in the Russian Federation and the Commonwealth of Independent States (CIS).

Mobile Telesystems (MTS)

MTS is the largest mobile phone operator in the Russian Federation and the CIS (it is listed on the New York Stock Exchange and is traded in Europe) servicing about 84 million subscribers. The Russian Federation and the CIS have a total population of over 240 million, and future subscriber growth is expected to be high. The company is majority-owned by Sistema, the largest private-sector consumer services company in the Russian Federation and the CIS. Its revenues grew from USD 893 million in 2001 to over USD 8 billion in 2007, with annual growth of about 40% between 2000 and 2006, and it had 24 700 employees in 2007.

VimpelCom

VimpelCom covers the same territories as MTS, with a focus on almost all Russian regions and the territories of Kazakhstan, Ukraine, Uzbekistan, Tajikistan, Georgia and Armenia (including 3G licences in some territories). Its active subscriber base in 2007 was close to 52 million. Its revenues have grown from USD 423 million in 2001 to more than USD 7 billion in 2007, with annual growth exceeding 50% between 2000 and 2006. VimpelCom had 23 200 employees by the end of 2007.

Source: OECD, based on top ICT firms database, annual reports and market financials.

proxies for ICT production (Annex Table 2.A1.16). Higher-cost locations accounted for 75% of electronics output in 1995. However, in 2007 this share was reduced to less than 50% of the total. Whereas the Asia-Pacific region (and China in particular) has been the main beneficiary, Central and Eastern Europe, Mexico and Brazil have also seen very significant increases in electronics production.

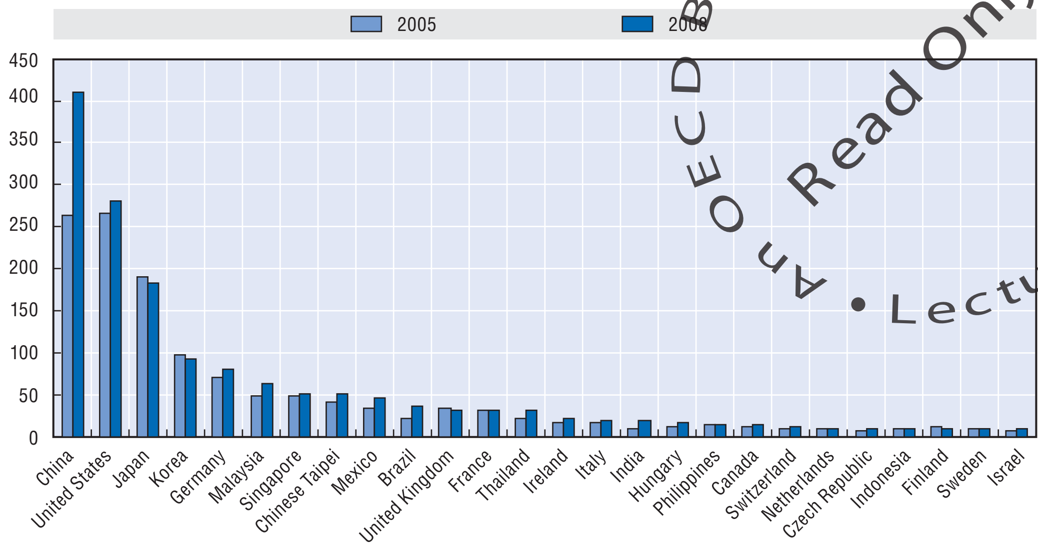
In line with earlier trade figures, China is the leading producer of electronics products in 2008 (USD 413 billion), followed by the United States (USD 282 billion), Japan (USD 184 billion), Korea (USD 94 billion), Germany (USD 81 billion), and some leading Asian producers (Malaysia, Singapore, Chinese Taipei) (Figure 2.14, Reed Electronics Research). ICT production locations such as Mexico, Brazil and Thailand and other countries in Eastern Europe (including established locations such as Hungary and the Czech Republic, but also newer ones such as Bulgaria, Romania and the Slovak Republic) are also gaining in importance.

From 2005 to 2008, electronics production increased by 10% a year or more in the Slovak Republic, Brazil, India, Vietnam, China, Poland, Thailand, the Czech Republic, Bulgaria, Greece, Hungary and Mexico (Figure 2.15 and Annex Table 2.A1.16), while it contracted in Hong Kong, China as well as in Belgium, Finland, France, Japan, Korea and the United Kingdom. However, ICT manufacturing value added rose substantially in Finland, Japan and Korea through 2006 (see Chapter 1).

Trade, production and sales

One indicator of increasing globalisation is that worldwide ICT trade is growing faster than production and sales (Table 2.2). Between 1995 and 2005, western European

Figure 2.14. **Electronics production, 2005 and 2008**
USD billions



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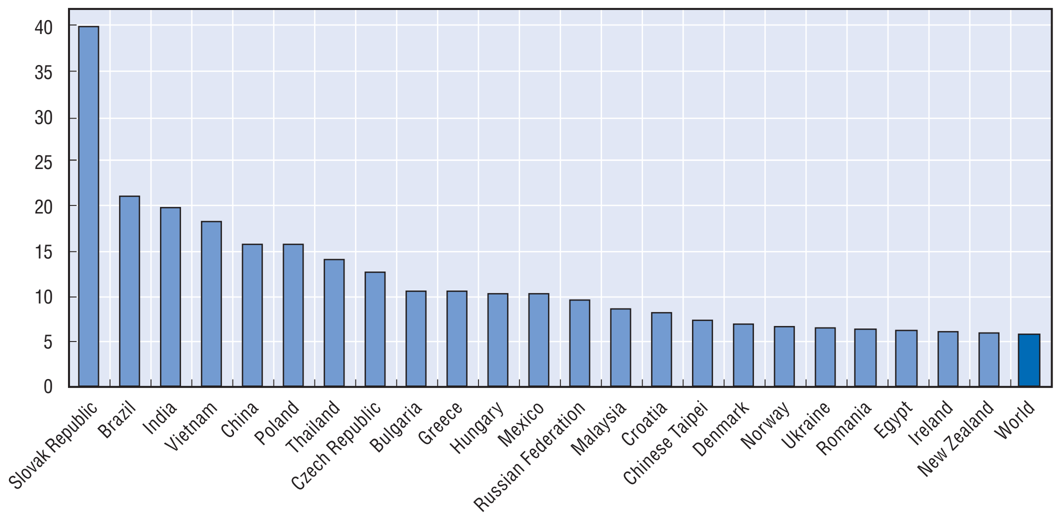
Notes: 2005 are current figures at current exchange rates. 2008 are forecasts at 2007 constant values and exchange rates.
Source: OECD, based on data provided by Reed Electronics Research.

Figure 2.15. **Growth in the value of electronics production, 2005-2008**
Percentage annual growth in current prices, top 25 economies



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Notes: 2008 are forecasts at 2007 constant values and exchange rates.
Source: OECD, based on data provided by Reed Electronics Research.

production of electronics goods increased by 0.4% a year, sales by 1.9%, and trade by 6.7% a year. Similarly, the production of electronics goods in the Americas and Asia-Pacific region increased by 1.7% a year, sales by 2.1% and trade by 6.7%. In Eastern European and emerging countries, production growth rates are very high, although lower than those of electronics exports.

Table 2.2. **Growth in electronics goods production, trade and sales, 1995-2006**

Annual percentage

	Electronic data processing equipment	Radio communications	Telecommunications	Other	Total
Western Europe					
Imports	6.6	17.5	6.0	5.2	6.8
Exports	5.5	15.5	3.3	5.5	6.5
Trade	6.2	16.4	4.6	5.3	6.7
Production	–2.0	5.0	–3.7	0.9	0.4
Market	2.7	4.7	–2.2	1.4	1.9
Americas and Asia-Pacific					
Imports	7.2	14.0	7.4	6.6	7.3
Exports	5.1	14.3	3.3	5.9	6.1
Trade	6.1	14.2	5.2	6.2	6.7
Production	0.2	7.0	–3.6	1.8	1.7
Market	1.3	6.5	–1.7	1.8	2.1
Eastern Europe					
Imports	14.1	26.9	7.0	16.3	15.9
Exports	42.9	36.7	13.2	24.6	28.5
Trade	19.3	30.3	8.4	18.8	19.4
Production	23.9	25.9	8.4	13.9	16.8
Market	11.4	21.9	6.4	11.8	12.2
Emerging economies					
Imports	21.7	16.1	5.9	18.9	18.4
Exports	28.2	30.0	20.1	17.9	22.2
Trade	25.9	24.4	12.8	18.4	20.5
Production	26.8	27.4	17.4	14.8	20.2
Market	21.2	18.1	7.4	16.0	16.7

StatLink http://dx.doi.org/10.1787/476441650312

Note: Annual growth for Eastern Europe is given for 1995-2005.

Source: OECD, based on data provided by Reed Electronics Research.

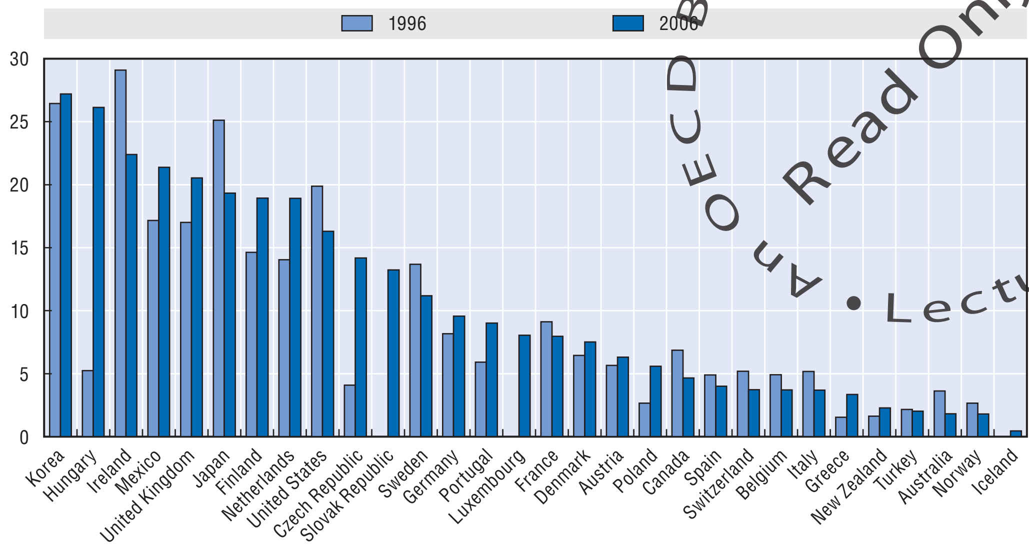
Specialisation in ICT production

Globalisation and the international rationalisation of production will also be expected to lead to increasing specialisation. One indicator is the share of ICT goods in total merchandise exports, which varies significantly from country to country (see Annex Table 2.A1.17). In 2006, ICT goods accounted for 27% of Korea's merchandise exports, and between 20 and 26% of merchandise exports from Hungary, Ireland, Mexico and the United Kingdom (Figure 2.16). Among OECD countries, Iceland, Norway, Australia and Turkey are the least specialised in the production of ICT goods for export. Some countries, such as the Netherlands, act as transport and distribution hubs and exhibit relatively high levels of trade in ICT equipment and a larger share of ICT equipment in merchandise trade than domestic production would suggest, with re-exports making a substantial contribution to exports.

Trends since 1996 reveal a number of aspects of globalisation, with rapid increases in the share of ICTs in merchandise exports from Hungary, the Slovak Republic and the Czech Republic owing to the establishment of manufacturing facilities in Eastern Europe. There has also been increasing specialisation among already relatively specialised countries (*e.g.* Korea, Finland and Mexico). The impact of the previous boom and bust cycle on particular sectors (*e.g.* communication equipment), firms (*e.g.* Ericsson and Nortel) and countries (*e.g.* Sweden, Canada, Ireland and Mexico) are also evident. While 16 OECD countries increased

Figure 2.16. **Share of ICT goods in total merchandise exports, 1996-2006**

Percentages



StatLink http://dx.doi.org/10.1787/473651121571

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.

Source: Joint OECD-UNSD ITCS and the *UN COMTRADE database.*

their specialisation in ICT production between 1996 and 2006, 14 reduced theirs. In general, those specialising in ICT production do so increasingly, while those not specialising are becoming even less specialised (Figure 2.16).

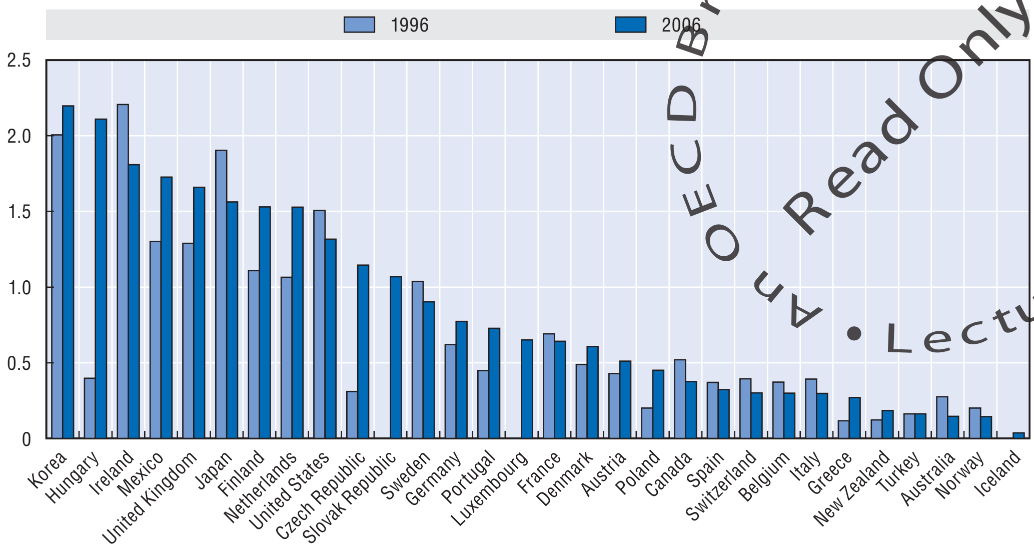
Another way to look at specialisation in manufacture of ICT goods for trade is to calculate an index of "revealed comparative advantage" (RCA) to see whether, as exporter, the ICT manufacturing industry performs better or worse in a given country than the average of its performance throughout the OECD area.[15] In 2006, 11 OECD countries had a comparative advantage in ICT manufacturing – Korea, Hungary, Ireland, Mexico, the United Kingdom, Japan, Finland, Netherlands, the United States, the Czech Republic and the Slovak Republic (Figure 2.17 and Annex Table 2.A1.18). Recent trends suggest increasing specialisation; those with an increasing advantage include a mix of countries that already had a high level of specialisation (*e.g.* Finland and Mexico) and countries with relatively recent investment in ICT manufacturing (*e.g.* Hungary, the Slovak Republic, Czech Republic and to a lesser extent Poland). Again, the focus of ICT production in Korea (and elsewhere in Asia), Ireland, Mexico and Eastern Europe is evident, as is the continuing global rationalisation of production.

Particular specialisations are also apparent, with the Slovak Republic, Mexico and Hungary the leading producer-exporters of audio and video equipment. Finland and Hungary lead in communications equipment (see Box 2.2 on MTIC fraud in the United Kingdom), Ireland leads in computer equipment, and Korea, Japan and the United States are the only OECD countries with a revealed comparative advantage in electronic components.

Intra-industry trade

As a result of specialisation, developed countries increasingly trade products of the same industries. This "intra-industry" trade tends to enhance gains from trade by increasingly focusing specialisation on a more limited number of products in particular

Figure 2.17. **Revealed comparative advantage in ICT goods, 1996-2006**



StatLink http://dx.doi.org/10.1787/473728384322

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.

Source: OECD based on Joint OECD-UNSD ITCS and the *UN COMTRADE database*.

industries. It reflects an increasingly fine-grained specialisation and global fragmentation of production activities.[16]

Among OECD countries, the Czech Republic, Germany, Mexico, Sweden, Netherlands and the United Kingdom have relatively high levels of intra-industry trade in ICT goods (Annex Table 2.A1.19). Fifteen OECD countries recorded higher levels of intra-industry trade in 2006 than in 1996, with the Eastern European countries experiencing some of the most rapid increases in their intra-industry trade index (*e.g.* the Slovak Republic, the Czech Republic, Poland, Greece, Turkey and Hungary) because of imports of electronic components for assembly into computer, communications, audio and video equipment.

Intra-firm trade

As multinational enterprises (MNEs) expand into new markets and production locations, a large and growing share of international trade takes place between related enterprises (*i.e.* within firms). Because of high levels of globalisation in the sector, ICT goods and services are among those with the highest shares of this related-party trade in total trade.

However, only a few countries, such as the United States, have the data to analyse intra-firm trends at sector level (Table 2.3). In 2006, intra-firm trade accounted for 41% of total US merchandise trade – 47% of imports and 30% of exports.[17] Intra-firm trade in ICT manufacturing industries accounts for more than 64% of US ICT goods imports and 37% of exports. Moreover, ICT goods accounted for 14% of total US goods imports and 11% of exports, but for more than 19% of related-party imports and 13% of related-party exports.

Intra-firm trade is also increasingly important in services. In 2006, affiliated trade accounted for 26% of US cross-border exports of services and 23% of cross-border imports, compared with 16 and 22%, respectively, in 1997. Again, the ICT sector appears relatively highly globalised, with affiliated trade accounting for 25% of US cross-border exports of computer and information services and 72% of cross-border imports, compared with

Table 2.3. **US intra-firm trade in ICT goods and services, 2006**

USD millions and percentage shares

	US imports			US exports		
	Total imports	Related party trade	Share	Total exports	Related party trade	Share
All NAICS	**1 845 053**	**862 657**	**47%**	**929 486**	**279 832**	**30%**
Computer equipment	83 928	55 347	66%	29 780	10 220	34%
Communication equipment	50 754	30 026	59%	14 995	3 303	22%
Audio and video equipment	46 778	29 169	62%	4 232	1 102	26%
Electronic components	75 042	49 743	66%	49 826	22 187	45%
Magnetic and optical media	4 758	3 043	64%	1 298	539	42%
ICT products	261 260	167 328	64%	100 131	37 351	37%
ICT share of total	14%	19%		11%	13%	
All services	**307 770**	**71 164**	**23%**	**404 327**	**103 315**	**26%**
Computer and information services	11 092	8 000	72%	10 096	2 500	25%
ICT share of total	3.60%	11.20%		2.50%	2.40%	

StatLink http://dx.doi.org/10.1787/476447383303

Note: ICT sector based on four-digit NAICS. ICT goods includes imports for domestic consumption and domestic exports. ICT services include affiliated and total cross-border trade in computer and information services.
Source: OECD, based on data from US Bureau of Economic Analysis, Survey of Current Business.

31 and 50%, respectively, in 1997. The emergence of IT services offshoring may be one factor in the relatively high and growing share of affiliated imports of computer and information services into the United States, reflecting, in part, the extent of captive (*i.e.* in-house) offshoring of such services by US parent firms (OECD, 2004, 2006).

Foreign direct investment

Foreign direct investment (FDI) increased to historically high levels in 2007, with an increasing focus on services, and greater participation by developing countries, both as destinations and sources of investment. Worldwide FDI inflows reached USD 1 538 billion in 2007, 18% higher than 2006, and recovering strongly from the depressed levels of 2002 and 2003, with about one-third of 2007 flows going to developing economies (USD 538 billion, up from less than 20% of total inflows in the 1980s) (OECD, 2008b, UNCTAD, 2006, 2008a; EIU, 2007). The share of developing countries' worldwide outflows increased from 7% to more than 12%.

FDI outflows from OECD countries in 2007 were USD 1.82 trillion (of which USD 471 billion to developing countries), considerably higher than the record outflows in 2000. FDI inflows to OECD countries were USD 1.37 trillion, only slightly higher than the previous record inflows to OECD countries in 2000 as an increasing share of OECD outflows goes to non-OECD economies (OECD, 2007b, 2008b). The United States continued as the top OECD investor and recipient of foreign investment (USD 333 billion in outflows, USD 238 billion in inflows) but EU countries combined – notably the UK and France – are well in advance of the US totals. The BRICS – Brazil, the Russian Federation, India, China and South Africa – account for around 55% of developing country inflows.

However, the performance in 2008 is less positive, with FDI flows projected to fall sharply and with negative implications for developing country inflows (OECD, 2008b). Based on the historical relationship between OECD outflows and developing country inflows, the projected 37% drop in OECD outflows in 2008 could mean a decline of around

40% for developing country inflows to around USD 276 billion. A recovery was projected for 2009 (OECD, 2008b).

FDI in the ICT sector

In spite of the recent resurgence of international investment in energy and resources, the ICT sector continued to be a major source and target of FDI (also reflected in M&A activity, see below). During 2006, ICT industries accounted for more than 20% of the number of FDI projects worldwide (EIU, 2007). Software and IT services led with 1 264 FDI projects, there were 548 in communications, 344 in electronic components, 222 in semiconductors and 146 in business machines and equipment.

ICT investments in Asia have increased rapidly, with cross-border M&A investments in electrical and electronic equipment manufacturing in south, east and south-east Asia worth USD 2.4 billion in 2005 (up from USD 1.7 billion in 2004), and M&As in transport, storage and communications worth USD 6.6 billion (up from USD 840 million) (UNCTAD, 2006). Aside from China, Chinese Taipei, Malaysia and other Asian countries, new investment locations are emerging (see Box 2.6). In 2004, developing economies accounted for 25% of inward FDI stock in electrical and electronic equipment manufacturing (up from 20% in 1990), and 24% of inward stock in transport, storage and communication services (up from just 3%) (UNCTAD, 2006). Developing economies accounted for no less than 82% of worldwide FDI inflows into electrical and electronic equipment manufacturing in 2002-04, and 26% of flows to transport, storage and communications.

The services sector has increased its share of worldwide M&As from around 30% in the late 1980s to around 60%, with a growing emphasis on telecommunications and a range of IT and IT-enabled business services. It is estimated that around 20 000 of the 78 000 MNEs operating worldwide originate from developing countries and that more than 80% of the total outward FDI stock from developing countries is in the services sector (UNCTAD, 2006).

Box 2.6. **Vietnam: A new centre for offshore assembly?**

The Vietnamese ICT sector, while still small, is growing rapidly and attracting increasing foreign investment. Vietnam's ICT production increased by around 12% annually from 2004 to 2007 to USD 2.5 billion. While still far behind China, Vietnam is ahead of for example Norway or South Africa. Vietnam's ICT goods exports are still modest (around USD 2 billion), but larger than ICT goods exports from for example India. Vietnam recently joined the World Trade Organization as part of a process of further liberalisation and to attract FDI.

Since 2000, FDI in Vietnam has been oriented towards export sectors, including assembly activities in the electronics and ICT industries, and is expected to continue to produce computer hardware, telecommunications equipment and related services. After initially opening marketing offices, global ICT firms have invested in Vietnam. As part of "China plus-one" strategies, firms from Korea, Japan and Chinese Taipei, including Samsung, LG Electronics, Fujitsu, Renesas and Hon Hai Precision, have invested or plan to invest in mobile phone production plants, electronics manufacturing and semiconductor production. Intel for example has started building a semiconductor assembly and test facility and has announced investments of up to USD 1 billion by 2009. The country's software and IT services sector is small, but has specialised in sourcing software development, IT services and telecommunications-related services. Diversified service

Box 2.6. **Vietnam: A new centre for offshore assembly?** *(cont.)*

providers such as FPT Corporation (2007 revenues USD 860 million), in which Intel has a stake, are developing rapidly.

Since the second half of 2007 macroeconomic conditions have deteriorated as the global economy has slowed, and GDP growth was at a seven-year low in 2008 at around 6.5% according to the Asian Development Bank. Rapidly rising inflation, increases in oil and food prices, rising interest rates and a contraction of credit have all had impacts on investment and trade and are hampering growth. In 2008 these challenges combined with skills shortages led some ICT firms to slow or stop investment. However, the economy remains strong overall, and Vietnam with its 87 million population is expected to play an increasing role as the global ICT industry looks to diversify investments in Asia.

Source: OECD from official Vietnamese data, US Department of Commerce (2008), World Bank (2008), annual reports and company information.

Mergers and acquisitions

Cross-border M&As have become the most common form of FDI. Recent years have seen a renewed upswing in M&A activity, with strong growth from 2003 through 2007, and particularly in 2007. The value and volume of cross-border M&As have grown faster than domestic M&As. Earlier there was an unprecedented spike in M&A activity in the ICT-producing sector during the boom years of the late 1990s followed b108y a collapse from 2001 to 2003 (OECD, 2006).[18] The outlook for 2008 was for a very marked slowdown in international merger and acquisition activity and an equally sharp downturn in total FDI activity with total OECD FDI inflows projected in mid-2008 to fall by around 24% and outflows by around 37% based on the sharp slowdown in M&A activity (OECD, 2008b). Declines will be much sharper.

Over the decade since 1997, the value of all cross-border M&As has increased annually by 17% and the number of deals by almost 10%. The ICT sector has played a leading role, with the value of M&A deals targeting ICT industries increasing by 14% a year (Figure 2.18).[19] During the boom of 2000, the ICT sector accounted for more than 30% of all cross-border M&A deal value, and it has accounted for around 17% since although flattening in 2007.

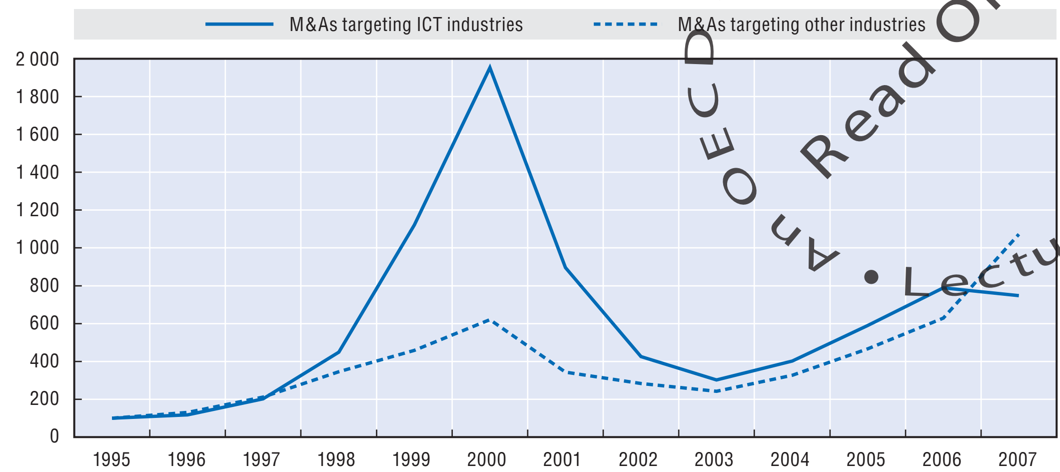
From 1997 through 2007, there were 55 M&A deals in the ICT sector with a reported value in excess of USD 5 billion, 18 with a value of more than USD 10 billion and two worth more than USD 50 billion, both of which were acquisitions by Vodafone (Mannesmann in 2000 and Airtouch Communications in 1999). Of the 18 deals worth more than USD 10 billion all but two were in telecommunications, the exceptions being Alcatel's 2006 acquisition of Lucent Technologies, and Seagram's 1998 acquisition of Polygram NV.

Cross-border M&As in the ICT sector

Over the last decade, there have been 16 710 completed cross-border M&A deals targeting the ICT sector and 12 883 in which the ICT sector was the acquirer. With the shift to services, most deals have been in IT services, followed by telecommunications and electronics, and the fastest growth has been in telecommunications and IT services (Figure 2.19 and Annex Table 2.A1.20).

Figure 2.18. **Value of cross-border M&A deals in ICT and non-ICT sectors, 1995-2007**

Deal value in current prices, index 1995 = 100



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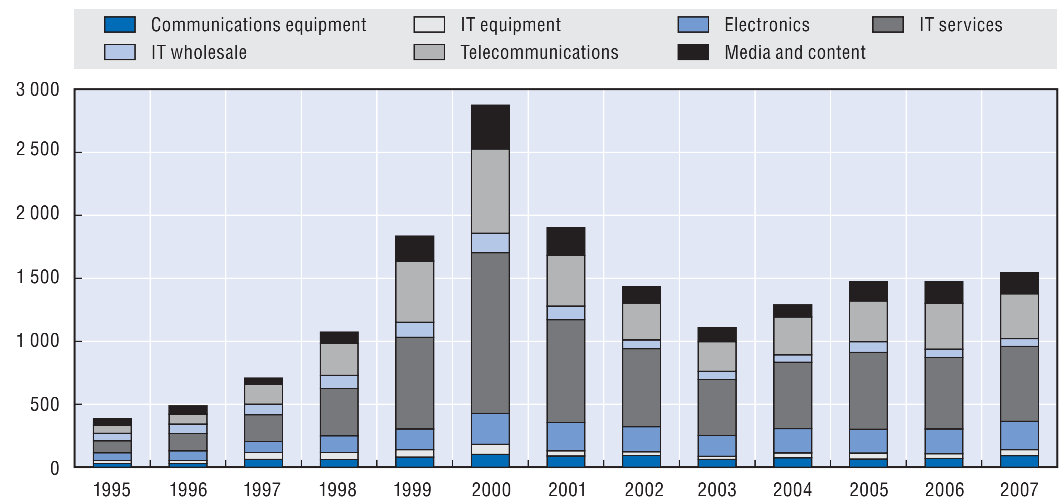
Source: OECD, based on data provided by Dealogic.

The recorded value of cross-border M&A deals targeting the ICT sector reached USD 170 billion in 2007, up by 14% a year from USD 46 billion in 1997 (in current prices); and the recorded value of deals in which the ICT sector was the acquirer reached USD 130 billion, up by 11% a year (Annex Table 2.A1.21). Some of the largest deals have occurred in telecommunication services, which as a target has accounted for more than 60% of total cross-border ICT industry M&A deal value over the last decade. As targets, the telecommunications, electronics and IT services industries have experienced the most rapid increases in cross-border M&A deal values over the decade; as acquirers, growth has been fastest in telecommunications and communications equipment.

Figure 2.19. **Cross-border M&As deals in the ICT sector, 1995-2007**

Number of deals targeting the ICT sector



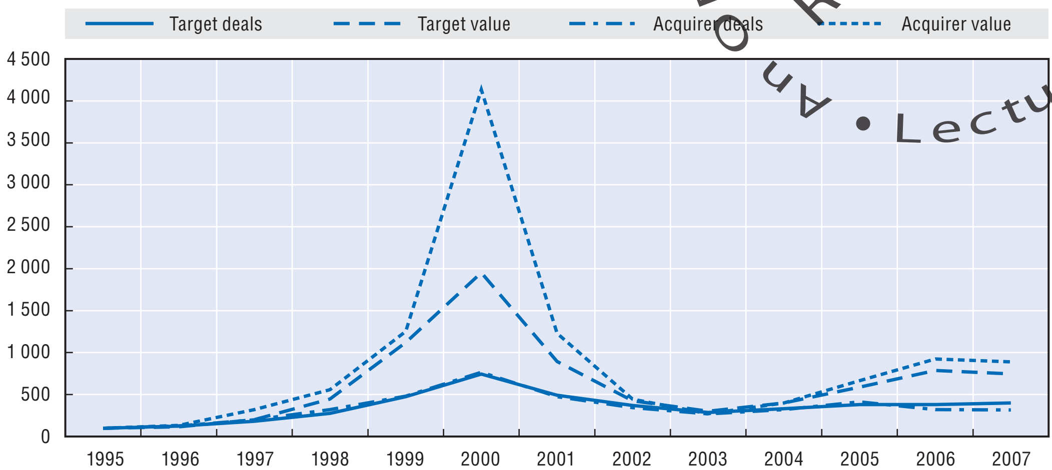
StatLink http://dx.doi.org/10.1787/473744514852

Source: OECD, based on data provided by Dealogic.

Whether one looks at the number or values of M&A deals, the extraordinary peak of cross-border M&A activity around 2000 is evident (Figure 2.20). What is also evident is the recent recovery in both, with increased stock market valuations again lifting deal values into the first part of 2007, when activity began to slow (EIU, 2007 and press reports).

Figure 2.20. **Cross-border M&As deals in the ICT sector, 1995-2007**

Number of deals and deal value in current prices, index 1995 = 100



StatLink http://dx.doi.org/10.1787/473748730457

Source: OECD, based on data provided by Dealogic.

The recovery in cross-border M&A deals focused on equipment manufacturing, semiconductors, telecommunications, IT and Internet services. Notable deals targeting the ICT sector during the last three years include Vodafone's acquisition of Hutchison Essar, Siemens' acquisitions of Dade Behring Holdings, Bayer HealthCare (Diagnostics Division) and UGS Corp, Swisscom's acquisition of FastWeb, and Weather Investments' acquisition of TIM Hellas Telecommunications in 2007, Telefonica's acquisition of O2, Alcatel's acquisition of Lucent, AMD's acquisition of ATI Technologies and South African MTN's acquisition of Investcom in 2006. In the preceding years major deals included France Telecom's acquisition of Retevision Movil SA of Spain, Vodafone's acquisition of the Dutch ClearWave, E-bay's acquisition of Skype, IAC/InterActive's acquisition of Ask Jeeves, Yahoo!'s purchase of a stake in Alibaba.com, Sun Microsystem's acquisition of StorageTek, Intelsat's purchase of PanAmSat, Oracle's acquisition of Siebel Systems, the buyout of SunGard Data Systems, the equity firm purchase of Agilent's semiconductor operations, and Lenovo's purchase of IBM's PC manufacturing operations.

Some of the larger ICT firms make many acquisitions. Over the decade to 2007, ten ICT firms made 50 or more – Telefonica SA (96 individual acquisitions and a further seven consortium deals), Vodafone Group (77 individual, plus 14 as Vodafone Airtouch), Siemens AG (77), Telenor ASA (75 individual and one consortium deal), Intel Corporation (74), France Telecom (67 individual and six consortium deals), Flextronics International Ltd (67), Tietoenator Oyj (68), Deutsche Telekom (65) and PSINet Inc. (59). A further 26 ICT firms made between 25 and 50 acquisitions.

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Box 2.7. ICT M&A targets and acquirers

A notable trend in ICT-sector M&As has software firms as common acquisition targets and capital funds and investment vehicles as increasingly common acquirers.

Software publishers: During the decade from 1997 (inclusive) there were 1 818 deals in which software publisher firms were the target. Of these, 618 (34%) were acquired by other software publishers (*i.e.* horizontal deals) and a further 340 (19%) by computer systems design and related services firms. The rest were acquired by a wide range of firms from many industries. Indeed, at the six-digit NAICS level, there were no fewer than 159 different industries listed as acquirers (and seven cases in which the acquiring industry was unrecorded).

Finance and investment vehicles: Of the 16 676 M&A deals targeting the ICT sector during the decade from 1997, more than 2 600 (15%) involved acquirers that were in the finance industries. Such deals are increasing, particulary since 2000.

ICT sector M&As by country

Globalisation of the ICT sector can be illustrated by the expansion of indigenous ICT industries through cross-border M&As and the expansion of MNEs into domestic industry.[20] Over the decade to 2007, the value of cross-border M&A deals targeting the ICT sector amounted to USD 1 792 billion worldwide, USD 1 411 billion (79%) of which were for deals in which OECD member countries were the target (Annex Table 2.A1.23); while the value of cross-border M&A deals in which the ICT sector was the acquirer amounted to USD 1 623 billion worldwide, USD 1 378 billion (85%) of which were for deals in which OECD member countries were the acquirer (Annex Table 2.A1.25 and 2.A1.26).

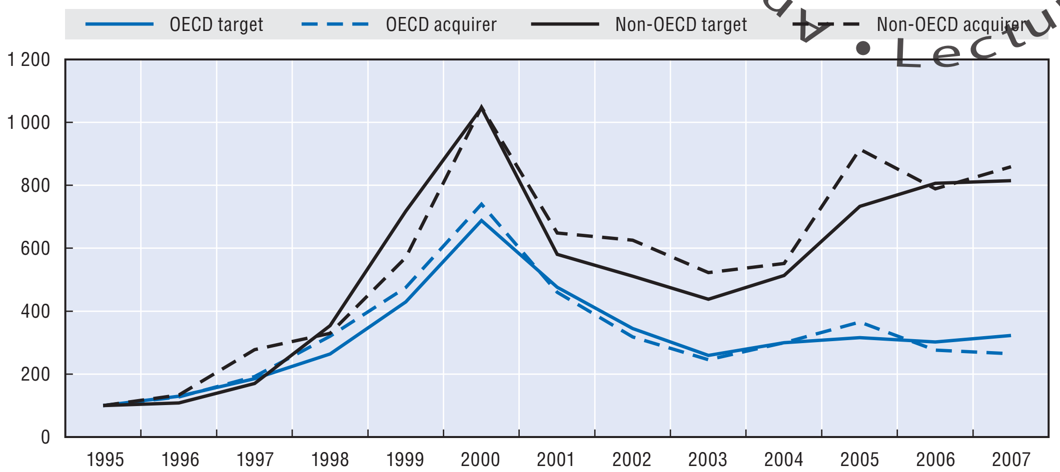
Over the same period, the United States accounted for 31% of all cross-border M&A deals targeting the ICT sector in OECD countries by value, the United Kingdom accounted for 18%, Germany 10% and the Netherlands 5.4%. No other country accounted for more than 5%. Data are incomplete, but countries with the fastest growth in inward ICT-sector M&A deal values over the last decade include Poland, Belgium, Norway, Canada, Italy and Japan. These data match the ICT trade specialisation indicators discussed above and indicate a global rationalisation of production rather than simple market access. The United Kingdom accounted for 28% of outward ICT-sector M&A deals from OECD countries over the last decade by value, and the United States for 15%.

Over the last decade, fewer countries have been originators of ICT-sector M&A deals than have been targets. A total of 97 countries (and regions) were reported as acquirer nationality and 173 as target nationality (Annex Table 2.A1.26), of which 34 were reported as the target nationality for 100 or more M&A deals and just 25 as the acquirer nationality. Moreover, 19 countries were named as net acquirers and 151 as net targets. By number of deals, the largest net acquirer by far was the United States; the others were Singapore, Hong Kong (China), Luxembourg, Japan, Norway, Bermuda, South Africa, Greece, Canada, Kuwait, Iceland, Egypt, Virgin Islands (United States), Bahrain, Jamaica and Qatar (in that order). The largest net targets of ICT sector M&As were China, Germany and the United Kingdom, followed by Australia, India, Brazil, Switzerland, Korea and Spain (Annex Table 2.A1.27).

ICT cross-border M&As are increasingly targeting and originating in non-member countries (Annex Table 2.A1.26 and 2.A1.27). The phenomenon is clearer in terms of number of deals than of values as these tend to be low. The number of cross-border M&A deals targeting the ICT sector in non-member countries has increased by 17% a year since 1997, while those targeting ICTs in OECD countries has increased by 6%; the number in which the ICT sector in non-member countries was acquirer increased by 12% a year, compared with 3% a year for OECD country acquirers (Figures 2.21 and 2.22). In the new wave of globalisation of ICT production, cross-border M&A deals increasingly target services and rapidly emerging, non-member economies.

Figure 2.21. **ICT sector cross-border M&As deals by region, 1995-2007**

Number of deals, index 1995 = 100



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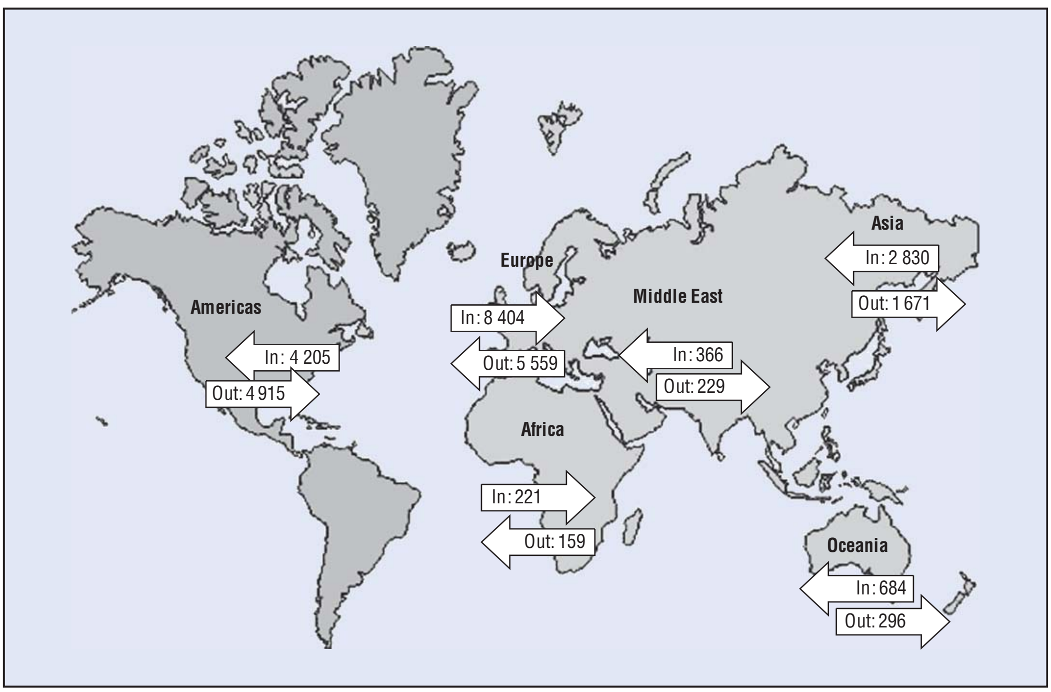
Source: OECD, based on data provided by Dealogic.

Figure 2.22. **ICT sector cross-border M&As deals by region, 1997-2007**

Number of deals inward and outward



StatLink http://dx.doi.org/10.1787/473816747667

Note: Total deals, including intra-regional deals.

Source: OECD, based on data provided by Dealogic.

M&As targeting the ICT sector in the emerging economies have increased from negligible levels in the mid-1990s to be worth hundreds and sometimes thousands of millions of USD (Annex Tables 2.A1.22 and 2.A1.24). In 2006, for example, 127 M&A deals targeting ICT industry entities in China totalled more than USD 3 billion, 44 deals targeting ICT in India worth more than USD 3.7 billion, and 21 deals targeting ICT in Brazil worth almost USD 3.9 billion. During 2005, the BRICS economies were the acquiring base in 55 cross-border deals worth almost USD 4 billion, and in 2006 for 81 deals worth more than USD 9 billion. Major acquisitions in recent years have included South Africa's MTN's acquisition of Lebanon's Investcom, Russian VimpelCom's acquisition of ArmenTel of Armenia and Kazakhstan KarTel, and China's China Network Group acquisition of a major stake in PCCW.

Taking cross-border M&As as indicative of the broader trends in FDI, at least 44% of the outflows from emerging economies since 1990s have targeted enterprises in the service sectors (UNCTAD, 2006). In the telecommunication sector the importance of south-south FDI appears to be increasing. Such investment accounted for over 36% of total flows and close to 20% of the total number of telecommunications projects from 2001 to 2003, compared with only 23% and 11%, respectively, in 1990. For example, Indian ICT companies are very active in acquiring foreign firms. Until mid-2008, Bharti Airtel, India's largest telecommunications company, was in the midst of talks to acquire a majority stake in South Africa's MTN. Since 2006, Indian ICT service firms such as Tata Consultancy and Satyam have also been buying smaller ICT service firms in Europe, Latin America, and Asia.

Activities of affiliates

MNEs' production spans virtually all countries, sectors and economic activities. In 2008, there were an estimated 78 411 parent MNEs worldwide with more than 850 000 foreign affiliates employing almost 73 million people (UNCTAD, 2008b). As globalisation increases, global sales and gross product associated with international production have increased faster than world GDP, and affiliate employment is now three times larger than in 1990 (UNCTAD, 2007).

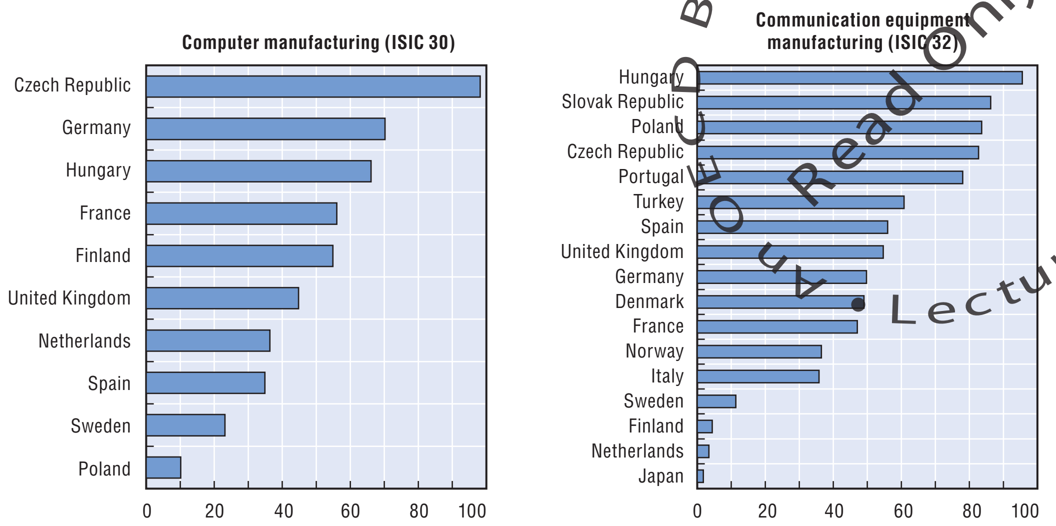
Foreign affiliates typically account for between 25 and 50% of manufacturing industry turnover in OECD countries, ranging from a low of around 3% in Japan to almost 70% in the Slovak Republic. Affiliate shares of manufacturing employment are similar, ranging from lows of around 1% in Japan and 8% in Switzerland to almost 50% in Ireland, 37% in the Czech Republic, 33% in Sweden, 30% in Poland, and around 25% in the United Kingdom, France, Luxembourg, the Netherlands and Norway.

Foreign affiliates' shares in the ICT sector are often higher than their shares in the economy as a whole (Figures 2.23 and 2.24). Their share of computer equipment manufacturing turnover exceeds 90% in Ireland and the Czech Republic, and is between 45 and 70% in Germany, Hungary, France, Finland and the United Kingdom. Employment shares are highest in Ireland and the Czech Republic, where foreign affiliates account for more than 90% of employment, followed by Hungary (70%) and Germany, the United Kingdom and France, where they account for around 50%.

Affiliates' shares of turnover in communication equipment manufacturing exceeded 80% in Hungary, the Slovak Republic, Poland and the Czech Republic, and were between 50 and 60% in Turkey, Spain, the United Kingdom, Germany and Denmark. Their shares of employment in the industry are similarly high at more than 70% in Portugal, Hungary,

Figure 2.23. **Foreign affiliates' share of turnover in ICT manufacturing, 2005**

Percentages



Note: Data refer to 2005 or most recent year.

Source: OECD, *AFA database*.

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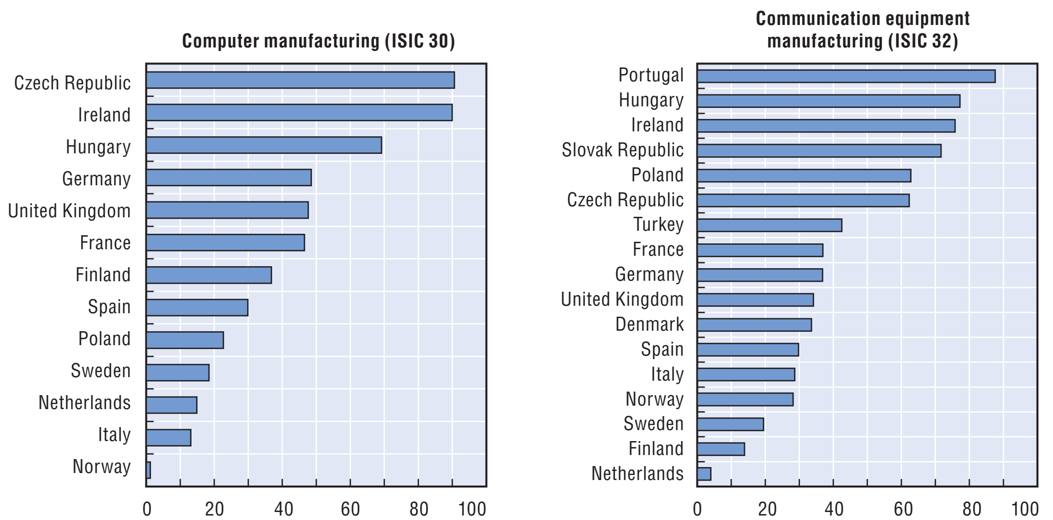
Figure 2.24. **Foreign affiliates' share of employment in ICT manufacturing, 2005**

Percentages



Note: Data refer to 2005 or most recent year.

Source: OECD, *AFA database*.

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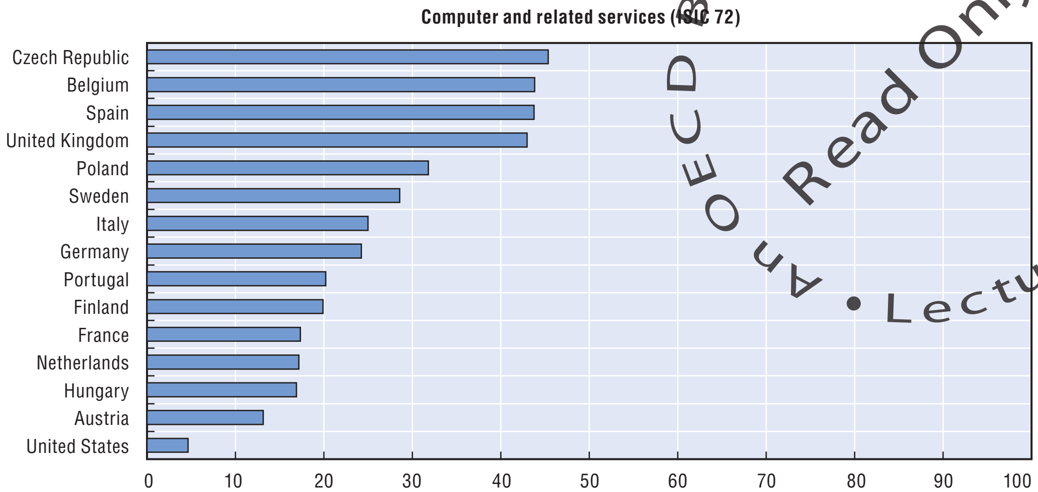
Ireland and the Slovak Republic, and they accounted for more than 95% of industry exports from Poland in 2004, and around 50% from France. Foreign affiliates' shares of turnover in computer and related services are somewhat lower (Figure 2.25), but still exceed 30% in the Czech Republic, Belgium, Spain, and the United Kingdom, and have been increasing in telecommunications services following high levels of M&A activity.

Figure 2.25. **Foreign affiliates' share of turnover in IT services, 2004**

Percentages



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Note: Data refer to 2004 or most recent year.

Source: OECD, *AFA database*.

Activities of foreign affiliates in the United States and activities of US affiliates abroad

Affiliate activities play an increasingly important role in the ICT sector in many countries. The United States (and Sweden, see next section) are among the few countries that provide detailed information on the activities of ICT-sector MNEs. These data are explored to present a picture of the extent and nature of ICT-sector affiliate activities.[21]

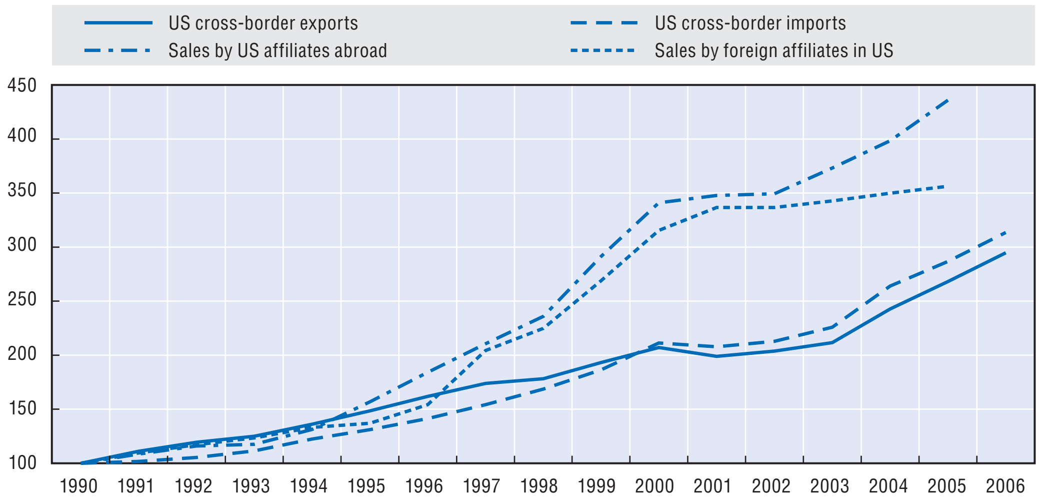
In 2005, foreign affiliates operating in the US ICT sector accounted for 4.6% of all foreign affiliate employment in the United States, 3.6% of affiliate sales and almost 5% of affiliate value added (BEA, 2007). Foreign affiliates spent almost USD 32 billion on R&D in the United States, of which around 10% in the ICT sector (Annex Tables 2.A1.28). Computer and electronic products manufacturing received some of the largest increases in foreign investment, owing in large part to major M&A deals (*e.g.* Alcatel's acquisition of Lucent Technologies) which pushed investments from USD 3.6 billion in 2005 to almost USD 18 billion in 2006. Majority-owned affiliates of US ICT firms operating abroad employed almost 1.2 million people and realised USD 86 billion in gross product (Annex Tables 2.A1.29). Affiliates in computer and electronic products manufacturing employed around 645 000 and realised USD 39 billion in gross product, affiliates in electrical equipment and appliances manufacturing employed 247 000 and realised almost USD 11 billion, and affiliates in information services employed 318 000 and realised more than USD 36 billion.

There are major differences among countries in the scale of the activities of affiliates. In employment terms, the ICT sector accounted for a relatively large share of US affiliate activities in Ireland, Austria, Hungary, Sweden, Korea, Mexico and the Czech Republic. Reflecting recent globalisation trends, ICT-sector US affiliates have relatively large shares of employment and gross product in non-OECD economies, with 33% of employment outside the OECD and 18% of industry gross product.

Sales of US affiliates abroad have become significantly larger than cross-border trade in ICT goods and services. US cross-border exports of domestically produced computer and electronic products were worth USD 135 billion in 2006, compared with sales of US affiliates operating abroad of some USD 230 billion in 2004. Sales of US cross-border and affiliate services have increased since 1990, but affiliate sales increased faster than cross-border sales, by 10.3 and 6.8% a year, respectively (Figure 2.26). In 2005, US cross-border exports of computer and information services were worth USD 8.2 billion, of which USD 2.2 billion were by affiliates (*i.e.* intra-firm trade), while computer systems design and related services sales by US affiliates abroad were worth USD 44.4 billion in 2004; and cross-border exports of telecommunication services were worth USD 4.7 billion, while sales of US affiliates abroad were worth USD 32.2 billion (Koncz *et al.*, 2006).

Figure 2.26. **United States cross-border and affiliate services sales, 1990-2006**

Current prices, index 1990 = 100



StatLink http://dx.doi.org/10.1787/473864666584

Source: US Department of Commerce, 2007.

Activities of foreign affiliates in Sweden and the activities of Swedish affiliates abroad

There were 11 107 foreign-owned enterprises operating in Sweden in 2006, employing 572 715, of which 1 144 (10.3%) were ICT enterprises which employed 57 065 (10%) (Table 2.4, Annex Tables 2.A1.30 and ITPS, 2006, 2007). Most foreign enterprises in Sweden's ICT sector are in services, with 114 ICT manufacturing enterprises employing 9 391, compared to 1 030 ICT services enterprises employing 47 674. The top ten countries' affiliates accounted for 88% of affiliate employment in Sweden's ICT sector and 83% of the total number of enterprises. The United States (244 ICT enterprises with 18 850 employees) was the leading country of origin. Norway (142 enterprises and 6 251 employees) and the United Kingdom (139 enterprises and 7 051 employees) were the other leading players.

Swedish-owned ICT-sector enterprises operating abroad employed a total of 163 308 in 2004, of which 40% were located abroad (Annex Tables 2.A1.31). Not surprisingly, communication equipment manufacturing was a major activity of Swedish affiliates and employed 31 977 abroad in 2004. Swedish ICT equipment manufacturing enterprises (including communications) employed fewer at home (24 431) than abroad (33 970), whereas Swedish-owned ICT services enterprises employed fewer abroad (30 696) than at home (74 211).

Table 2.4. **Foreign-owned enterprises in Sweden's ICT sector, 2006**

Number of enterprises and employees

	Enterprises	Employees
Electronic equipment manufacturing	114	9 391
Wholesale	342	8 195
Computer and related services	603	33 276
Renting office machinery	10	50
Telecommunication services	75	6 153
Total ICT sector	1 144	57 065
All industries	11 107	572 751

StatLink http://dx.doi.org/10.1787/476484088411

Source: ITPS 2007.

Conclusion

Worldwide ICT trade has continued to grow faster than production and sales. Global ICT trade has expanded strongly in recent years and, up to 2007, to levels which are about USD 1.5 trillion higher than the peak of 2000. Weakening economic conditions in leading OECD countries and falling demand in key markets have led growth in ICT trade to slow in 2007 and the first half of 2008. However, ICT exports continued to increase rapidly for some Asian countries in the first half of 2008, boosted by the resilience of OECD ICT imports of new consumer products and portable computers and strong demand from emerging markets.

Global restructuring of ICT production continued in 2007 and 2008, with Eastern Europe (including new EU members), Mexico and non-member developing economies increasingly important as both producers and new growth markets. MNEs' operations, international sourcing, and intra-firm and intra-industry trade have had major impacts on the global ICT value chain, and reorganisation of the supply of ICT services and software and associated trade flows have been major sources of growth.

Asia plays an increasing role in the production networks that import high value electronic components for assembly and re-export. China's role as production and sourcing location for MNEs has intensified since the last *Information Technology Outlook*, and in 2006 China's ICT exports eclipsed the combined exports of the United States and the EU. However, Chinese ICT production and trade is closely tied to Hong Kong (China), Chinese Taipei, Japan, Malaysia, and Singapore and to firms from the United States and Europe. In terms of ICT export performance, Korea has made the greatest strides among OECD countries but Japan also remains very important for ICT trade and production.

ICT-related FDI has increased to historic levels, and about one-sixth of all M&A cross-border deals are in ICTs or are ICT-related. Non-member economies are increasingly active, with ICT-sector cross-border M&As both targeting *and* originating in non-member countries. FDI in ICT services has grown in importance, and emerging economy FDI outflows have been particularly important in this area (about 45% of their outflows since the 1990s).

Rapidly weakening global economic conditions will affect the globalisation of the ICT sector, both the restructuring of global production networks and the origin and destination of investment and associated R&D, production and distribution activities. An important question is whether the demand for new ICT products and related investments in production, coupled with growth in emerging economies will be strong enough to compensate for declining activity in OECD countries. Are countries such as China simply production platforms for re-export to the OECD, or will domestic demand from major emerging production centres, other Asian economies and other countries drive further ICT growth and globalisation?

New production locations are also emerging as the search for low-cost assembly continues, with the re-organisation of the global ICT supply chain against the backdrop of a difficult macroeconomic environment and the rise of new ICT firms and products. As ICT firms from non-OECD economies continually move up the value chain and as wages and welfare in these countries increase, the global distribution of innovation and production activities will continually evolve.

Notes

1. This section initially focuses mainly on trends in goods trade from 1996 to 2006. Developments in 2007 and 2008 are treated separately as the data are not directly comparable owing to changes in classification and use of national sources.
2. All values are expressed in current USD at annual average exchange rates, unless otherwise indicated.
3. Revisions to the Harmonized System (HS) for trade classification take place every four to six years. A classification for 2007 (HS2007) has been agreed and implemented by most/all OECD countries. The earlier classification (HS2002) and HS2007 do not match well for ICT goods, reflecting updates to the latter to reflect changes in the nature of ICT. Any time series data extending to 2007 and beyond should therefore be considered approximate. The OECD Working Party on Indicators for the Information Society (WPIIS) has developed a revised OECD ICT goods classification based on the Central Product Classification, Version 2 which will be available for use from 2009 and will include a correspondence table to HS2007. However this revision will also narrow the scope of ICT goods and thus reduce values for ICT goods trade. "Bridge" or "backcast" time series will show the effect of this change.
4. Defined as: Measuring, testing, and control instruments, Computers, peripherals, and parts, Semiconductors, Telecommunications equipment, Other office and business machines, Televisions, video receivers, and other video equipment, Radio and stereo equipment, including records, tapes, and disks.
5. "US International Trade in Goods and Services May 2008", 11 July, *www.bea.gov/newsreleases/international/trade/tradnewsrelease.htm*.
6. BITKOM at *www.bitkom.de/49038_52810.aspx*.
7. JEITA, *www.jeita.or.jp/english/*
   www.bloomberg.com/apps/news?pid=20601068&sid=azL_czxrlsRo&refer=home.
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12. Note that these export data are affected by currency appreciation in many countries in terms of USD values, and there are problems with the HS2007 trade conversions discussed above (see Note 3 and see Annex Table 2.A1.4. for more detailed data for 2007).
13. MTIC fraud accounted for a substantial proportion of UK communication equipment exports in 2006.
14. See Methodology and Definitions Annex for the definition of Computer and information services.
15. A value greater than 1 indicates a comparative advantage in ICTs, and a value of less than 1 a comparative disadvantage. See Methodology and Definitions Annex for more details.

16. The most widely used measure of intra-industry trade is the Grubel-Lloyd Index. The closer the values of imports and exports the higher the index. Because the ICT goods trade categories used here include both equipment and components they approximate the inputs and outputs of the ICT manufacturing sector. Thus, 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), but it does reveal aspects of the globalisation of the ICT sector. See Methodology and Definitions Annex for more details.
17. The United States is among a handful of countries that report intra-firm trade in detail. US-related party trade includes trade by US companies with their subsidiaries abroad, as well as trade by the US subsidiaries of foreign companies with their parent companies.
18. Detailed analysis of cross-border mergers and acquisitions (M&As) is based on Dealogic data (*www.dealogic.com*). The data include completed deals that are between entities within economies (domestic) and entities based in different economies (cross-border). They are recorded as occurring in the year in which the deals were completed. Country data refer to country of ICT sector bidder and country of ICT sector target and reflect M&A deal outflows and inflows, respectively. Not all deal values are recorded, and not all deals are reported. Consequently, these data provide no more than a guide to M&A activity.
19. See Methodology and Definitions Annex for definitions.
20. The analysis focuses on target country where the ICT sector is the target of deals, and acquirer country where the ICT sector is the acquirer. Hence, data relate to country inflows which target the ICT sector, and country outflows in which the ICT sector is acquirer.
21. While indicative of affiliate activities they do not show the extent of affiliate activities in eastern European member countries and Mexico.

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ANNEX 2.A1

Table 2.A1.1. **World and OECD ICT goods trade, 1996-2007**

USD millions in current prices and percentages

	1996	1998	2000	2002	2004	2006	2007
TRADE							
World total ICT	1 161 862	1 497 516	2 239 666	2 015 861	2 790 459	3 525 497	3 708 225
ICT share of world merchandise trade	13.3	15.0	17.9	15.9	15.5	15.1	13.3
OECD total ICT	1 018 769	1 136 339	1 525 312	1 282 148	1 670 869	1 979 575	1 911 107
OECD ICT share of world merchandise trade	11.6	11.4	12.2	10.1	9.3	8.5	6.9
OECD EXPORTS							
Communication equipment	72 296	92 827	139 713	114 140	138 141	192 376	175 689
IT and related equipment	158 521	177 742	219 386	183 452	218 698	239 122	189 280
Electronic components	165 068	169 711	242 731	185 344	246 683	268 871	262 019
Audio and video equipment	54 785	57 808	66 676	66 608	89 226	112 256	123 825
Other ICT-related goods	53 104	57 254	68 873	69 653	97 158	118 839	125 726
Total ICT	503 774	555 341	737 379	619 197	789 906	931 465	876 539
ICT share of OECD merchandise exports	13.2	13.9	16.6	13.9	13.0	12.4	10.2
ICT share of OECD manufacturing goods (SITC rev3) exports	15.7	16.2	19.5	16.3	15.3	14.9	12.2
OECD IMPORTS							
Communication equipment	56 722	73 101	127 647	97 412	138 864	186 232	200 792
IT and related equipment	198 611	232 893	284 889	246 042	313 464	357 086	307 083
Electronic components	147 590	153 133	229 977	165 501	218 092	240 870	240 843
Audio and video equipment	65 631	71 748	86 230	93 527	130 665	164 499	177 790
Other ICT-related goods	46 441	50 123	59 190	60 468	79 878	99 423	108 059
Total ICT	514 994	580 998	787 933	662 951	880 963	1 048 110	1 034 567
ICT share of OECD merchandise imports	13.3	14.3	16.3	13.9	13.3	12.4	10.9
ICT share of OECD manufacturing goods (SITC rev3) imports	17.1	17.6	20.5	17.4	17.1	16.6	14.5
OECD BALANCE							
Communication equipment	15 574	19 726	12 066	16 729	–722	6 144	–25 103
IT and related equipment	–40 089	–55 152	–65 503	–62 590	–94 766	–117 964	–117 803
Electronic components	17 477	16 578	12 753	19 843	28 590	28 001	21 175
Audio and video equipment	–10 845	–13 940	–19 554	–26 919	–41 440	–52 242	–53 965
Other ICT-related goods	6 663	7 131	9 682	9 184	17 280	19 416	17 667
Total ICT	–11 220	–25 657	–50 555	–43 753	–91 057	–116 646	–158 028

StatLink http://dx.doi.org/10.1787/476484150832

Note: Partly estimated for non-OECD 2007. ICT data in 2007 are not directly comparable with previous years.
Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, November 2008.

Table 2.A1.2. **OECD trade in ICT goods, 1996-2006**

USD millions in current prices and annual growth per cent

	Exports				Imports			
	1996	2001	2006	CAGR	1996	2001	2006	CAGR
Australia	2 180	1 983	2 238	0	9 380	9 136	16 982	6
Austria	3 270	5 237	8 465	10	5 454	7 319	11 015	7
Belgium	8 272	12 209	13 655	5	9 202	14 358	16 829	6
Canada	13 875	15 011	18 048	3	23 526	28 254	35 204	4
Czech Republic	894	3 201	13 498	31	2 761	4 867	14 015	18
Denmark	3 154	4 061	6 778	8	4 651	5 568	10 656	9
Finland	5 935	9 414	14 640	9	4 214	5 465	10 032	9
France	25 892	30 457	38 120	4	28 458	34 402	52 069	6
Germany	42 812	59 083	107 388	10	48 736	67 918	113 155	9
Greece	182	384	700	14	1 593	2 095	3 831	9
Hungary	663	7 510	19 353	40	1 483	8 050	15 285	26
Iceland	..	9	16	..	..	185	344	..
Ireland	13 265	29 734	24 360	6	9 297	18 849	18 460	7
Italy	13 047	12 825	15 377	2	18 452	21 509	31 004	5
Japan	103 213	94 696	125 089	2	47 858	58 321	79 263	5
Korea	34 316	46 793	88 544	10	23 482	30 335	50 995	8
Luxembourg	..	1 552	1 143	..	..	1 646	1 578	..
Mexico	16 422	38 055	53 462	13	14 968	36 593	50 254	13
Netherlands	24 899	34 543	70 049	11	23 938	36 216	65 594	11
New Zealand	232	273	509	8	1 620	1 446	2 576	5
Norway	1 301	1 528	2 173	5	3 206	3 558	6 207	7
Poland	648	1 738	6 124	25	2 989	5 060	12 004	15
Portugal	1 371	2 065	3 907	11	2 616	3 789	6 229	9
Slovak Republic	..	574	5 518	..	..	1 232	4 575	..
Spain	4 969	6 161	8 547	6	10 565	13 276	26 160	9
Sweden	11 407	9 353	16 475	4	9 094	9 073	15 450	5
Switzerland	4 143	4 301	5 512	3	7 267	8 181	10 527	4
Turkey	496	1 188	1 718	13	2 567	3 230	5 511	8
United Kingdom	43 116	53 396	91 282	8	47 144	55 389	82 628	6
United States	123 802	152 150	169 027	3	150 475	193 798	280 177	6
OECD	**503 774**	**639 482**	**931 713**	**6**	**514 994**	**689 118**	**1 048 606**	**7**

StatLink http://dx.doi.org/10.1787/476511507803

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.

Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, July 2008.

Table 2.A1.3. **Balance of OECD trade in ICT goods, 1996-2006**

USD millions in current prices and annual growth per cent

	1996	1998	2000	2002	2004	2006	CAGR
Australia	–7 200	–6 794	–9 558	–7 697	–12 375	–14 744	7.4
Austria	–2 185	–2 724	–2 417	–1 536	–2 127	–2 550	1.6
Belgium	–930	–1 542	–1 660	–2 154	–2 655	–3 175	13.1
Canada	–9 651	–11 994	–13 345	–12 735	–15 716	–17 156	5.9
Czech Republic	–1 867	–1 453	–1 773	–1 048	–186	–517	–12.1
Denmark	–1 496	–1 219	–1 735	–1 256	–2 047	–3 878	10.0
Finland	1 721	3 550	5 262	4 528	4 565	4 608	10.4
France	–2 566	–2 305	–3 877	–3 903	–10 727	–13 949	18.4
Germany	–5 924	–8 130	–7 816	–4 401	1 431	–5 767	–0.3
Greece	–1 412	–1 988	–1 984	–1 699	–2 920	–3 131	8.3
Hungary	–820	38	164	273	2 904	4 067	. .
Iceland	. .	–214	–251	–173	–252	–328	. .
Ireland	3 967	5 078	9 123	9 571	8 109	5 901	4.0
Italy	–5 405	–8 281	–10 673	–9 446	–15 431	–15 627	11.2
Japan	55 355	52 697	56 678	39 917	51 542	45 826	–1.9
Korea	10 834	14 593	22 439	22 738	43 266	37 549	13.2
Luxembourg	. .	. .	–167	17	–248	–435	. .
Mexico	1 454	3 126	1 935	2 944	317	3 208	8.2
Netherlands	962	–1 327	–900	1 753	667	4 455	16.6
New Zealand	–1 388	–1 091	–1 470	–1 192	–1 841	–2 067	4.1
Norway	–1 905	–2 120	–2 212	–2 156	–3 360	–4 033	7.8
Poland	–2 342	–3 087	–3 683	–3 018	–4 319	–5 880	9.6
Portugal	–1 245	–1 773	–1 695	–1 640	–2 098	–2 322	6.4
Slovak Republic	. .	–752	–538	–799	–596	943	. .
Spain	–5 595	–5 996	–8 101	–7 184	–12 176	–17 613	12.2
Sweden	2 314	2 412	4 702	1 618	1 848	1 025	–7.8
Switzerland	–3 124	–3 706	–4 513	–3 821	–4 705	–5 014	4.8
Turkey	–2 071	–2 822	–4 932	–2 099	–4 143	–3 793	6.2
United Kingdom	–4 028	–4 042	–11 862	2 101	–22 218	8 654	. .
United States	–26 674	–33 792	–55 681	–61 260	–85 572	–111 151	15.3
OECD	**–11 220**	**–25 657**	**–50 542**	**–43 760**	**–91 064**	**–116 893**	**26.4**

StatLink http://dx.doi.org/10.1787/476531344722

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.
Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, July 2008.

Table 2.A1.4. **ICT goods trade, 2007**

USD millions in current prices

	Exports	Imports	Balance	Trade
OECD area				
Australia	2 454	18 358	–15 904	20 812
Austria	9 602	11 721	–2 119	21 323
Belgium	12 815	17 683	–4 868	30 497
Canada	18 463	35 896	–17 433	54 359
Czech Republic	17 946	18 473	–528	36 419
Denmark	6 247	9 531	–3 284	15 778
Finland	15 409	10 951	4 459	26 360
France	32 790	48 829	–16 039	81 619
Germany	104 716	105 502	–786	210 218
Greece	700	4 787	–4 087	5 486
Hungary	23 194	19 541	3 653	42 735
Iceland	17	433	–416	450
Ireland	23 532	17 610	5 922	41 142
Italy	15 552	30 440	–14 888	45 991
Japan	112 199	75 797	36 402	187 995
Korea	97 371	54 090	43 281	151 461
Luxembourg	1 143	1 497	–353	2 640
Mexico	53 343	41 928	11 415	95 271
Netherlands	70 621	65 823	4 798	136 443
New Zealand	569	2 815	–2 246	3 384
Norway	2 688	7 018	–4 330	9 706
Poland	8 587	14 001	–5 413	22 588
Portugal	4 300	6 778	–2 479	11 078
Slovak Republic	8 779	8 134	645	16 913
Spain	8 194	30 850	–22 657	39 044
Sweden	15 980	16 591	–611	32 571
Switzerland	6 194	10 907	–4 713	17 101
Turkey	954	6 503	–5 550	7 457
United Kingdom	37 560	68 723	–31 163	106 282
United States	164 623	273 360	–108 737	437 983
EU15, excl. intra-EU trade	176 033	262 809	–86 776	438 843
Accession countries				
Chile	..	..	..	..
Estonia	827	1 193	–366	2 020
Israel	3 256	5 625	–2 369	8 881
Russian Federation	1 680	19 303	–17 623	20 983
Slovenia	761	1 425	–663	2 186
Emerging economies				
Brazil	3 380	14 315	–10 935	17 696
China	355 568	255 195	100 373	610 764
Hong Kong, China	148 084	154 416	–6 332	302 500
India	1 877	18 091	–16 214	19 968
Indonesia	5 998	3 993	2 005	9 991
Malaysia	73 187	52 900	20 287	126 087
Singapore	108 325	80 674	27 651	188 998
South Africa	1 142	7 707	–6 565	8 849
Chinese Taipei	85 342	49 824	35 518	135 166
Thailand	34 150	27 044	7 107	61 194
Vietnam[1]	2 049	3 406	–1 357	5 455

Table 2.A1.4. **ICT goods trade, 2007** *(cont.)*

USD millions in current prices

	Exports	Imports	Balance	Trade
Selected non-member economies				
Saudi Arabia	911	7 186	–6 276	8 097
Romania	1 265	5 126	–3 860	6 391
Argentina	307	4 981	–4 674	5 288
Costa Rica[1]	2 133	2 805	–672	4 938
Colombia	63	3 962	–3 899	4 025
Morocco	837	2 130	–1 294	2 967
Malta	1 492	1 223	269	2 715
Croatia	676	1 781	–1 105	2 457
Pakistan	91	2 357	–2 266	2 449
Bulgaria	442	1 796	–1 354	2 238
Lithuania	700	1 517	–817	2 217
Tunisia	640	1 125	–485	1 765
Kazakhstan	31	1 699	–1 668	1 730
Peru	14	1 630	–1 615	1 644
Jordan	496	1 141	–645	1 637
Paraguay	5	1 532	–1 527	1 537
Serbia	135	1 233	–1 099	1 368
Latvia	312	986	–674	1 297
Oman	448	651	–203	1 099
Ecuador	47	1 039	–992	1 085

StatLink http://dx.doi.org/10.1787/476552254714

1. 2006 data.

Source: OECD, based on data from the joint *OECD-UNSD ITCS database*, November 2008.

Table 2.A1.5. **OECD accession countries trade in ICT goods, 1996-2006**

USD millions in current prices and annual growth per cent

	1996	1998	2000	2002	2004	2006	CAGR
CHILE							
Exports							
Communication equipment	..	5	12	14	9	18	13.8
Computer equipment	..	12	15	15	17	22	9.1
Electronic components	..	1	2	5	5	9	33.5
Audio and video equipment	..	2	1	3	2	5	14.1
Other ICT goods	..	3	5	4	5	7	13.1
Total ICT goods	..	23	34	41	39	61	13.2
Imports							
Communication equipment	..	679	625	511	659	1 145	9.4
Computer equipment	..	533	609	465	590	862	5.3
Electronic components	..	134	161	112	163	228	14.1
Audio and video equipment	..	336	314	259	393	650	5.8
Other ICT goods	..	141	125	127	163	251	5.3
Total ICT goods	..	1 823	1 834	1 474	1 967	3 135	7.3
ESTONIA							
Exports							
Communication equipment	14	286	708	278	420	568	44.9
Computer equipment	62	22	11	16	10	29	–7.3
Electronic components	47	112	239	298	600	663	30.3
Audio and video equipment	27	13	15	8	13	62	8.8
Other ICT goods	12	28	24	25	36	45	14.6
Total ICT goods	161	462	996	625	1 079	1 367	23.8
Imports							
Communication equipment	72	150	145	163	184	212	11.4
Computer equipment	113	95	84	111	122	190	5.3
Electronic components	59	306	701	319	661	812	30.0
Audio and video equipment	73	59	52	61	105	179	9.3
Other ICT goods	37	40	46	38	64	85	8.7
Total ICT goods	355	650	1 028	691	1 135	1 478	15.3
ISRAEL							
Exports							
Communication equipment	1 651	2 432	4 004	2 433	2 766	2 582	4.6
Computer equipment	742	1 054	591	367	530	363	–6.9
Electronic components	735	801	2 326	1 663	1 773	632	–1.5
Audio and video equipment	153	160	256	326	374	270	5.8
Other ICT goods	302	615	744	514	1 023	1 231	15.1
Total ICT goods	3 584	5 061	7 921	5 303	6 466	5 078	3.5
Imports							
Communication equipment	842	759	1 115	838	906	1 000	1.7
Computer equipment	1 057	1 114	1 635	1 218	1 415	1 600	4.2
Electronic components	1 047	991	1 995	921	1 586	1 494	3.6
Audio and video equipment	290	288	424	342	412	558	6.7
Other ICT goods	398	415	704	606	731	791	7.1
Total ICT goods	3 635	3 566	5 874	3 925	5 049	5 442	4.1
RUSSIAN FEDERATION							
Exports							
Communication equipment	..	113	96	110	239	559	21.4
Computer equipment	..	53	51	78	71	99	7.2
Electronic components	..	150	265	306	257	306	8.0
Audio and video equipment	..	48	22	28	32	35	–20.1
Other ICT goods	..	245	364	420	538	519	4.6
Total ICT goods	..	609	799	942	1 137	1 519	5.8

Table 2.A1.5. **OECD accession countries trade in ICT goods, 1996-2006** *(cont.)*

USD millions in current prices and annual growth per cent

	1996	1998	2000	2002	2004	2006	CAGR
Imports							
Communication equipment	. .	1 172	749	1 313	2 174	6 249	17.2
Computer equipment	. .	243	252	634	1 137	2 425	23.1
Electronic components	. .	149	161	408	755	1 195	19.6
Audio and video equipment	. .	133	101	417	822	2 017	22.7
Other ICT goods	. .	890	620	759	1 089	1 959	8.9
Total ICT goods	. .	2 586	1 883	3 532	5 977	13 845	17.1
SLOVENIA							
Exports							
Communication equipment	111	90	78	128	187	134	1.9
Computer equipment	11	15	17	23	49	77	20.9
Electronic components	53	65	119	90	148	123	8.9
Audio and video equipment	51	41	53	53	14	48	–0.5
Other ICT goods	142	141	131	143	220	246	5.7
Total ICT goods	368	351	397	436	619	629	5.5
Imports							
Communication equipment	89	122	190	164	263	227	9.8
Computer equipment	190	212	201	248	361	416	8.2
Electronic components	120	119	166	159	194	175	3.8
Audio and video equipment	56	73	67	77	146	207	13.9
Other ICT goods	81	83	71	86	165	191	8.9
Total ICT goods	537	609	694	734	1 128	1 216	8.5

StatLink http://dx.doi.org/10.1787/476556047876

Note: For Chile and the Russian Federation, CAGR 1997-2006.

Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, September 2008.

Table 2.A1.6. **Emerging economies trade in ICT goods, 1996-2006**

USD millions in current prices and annual growth per cent

	1996	1998	2000	2002	2004	2006	CAGR
BRAZIL							
Exports							
Communication equipment	. .	251	1 145	1 361	1 162	3 112	34.6
Computer equipment	. .	240	366	159	281	355	3.6
Electronic components	. .	183	385	444	391	344	7.9
Audio and video equipment	. .	357	417	269	244	175	–8.8
Other ICT goods	. .	159	201	187	212	409	13.5
Total ICT exports	. .	1 190	2 513	2 420	2 290	4 396	15.8
Imports							
Communication equipment	. .	1 811	1 889	689	922	1 241	–5.3
Computer equipment	. .	1 539	1 786	1 244	1 460	2 520	5.8
Electronic components	. .	2 487	4 029	2 716	4 407	6 776	10.5
Audio and video equipment	. .	598	398	338	543	1 136	1.6
Other ICT goods	. .	1 240	1 032	1 034	1 283	1 583	3.0
Total ICT imports	. .	7 676	9 133	6 020	8 616	13 256	5.1
CHINA							
Exports							
Communication equipment	2 417	3 004	6 675	10 801	25 579	51 627	35.8
Computer equipment	5 317	10 168	16 577	33 253	83 790	125 636	37.2
Electronic components	3 782	5 781	11 263	15 520	34 884	65 666	33.0
Audio and video equipment	6 283	7 501	11 165	17 855	33 309	50 007	23.1
Other ICT goods	785	965	1 316	1 948	2 859	6 057	22.7
Total ICT exports	18 584	27 419	46 996	79 377	180 422	298 993	32.0
Imports							
Communication equipment	2 861	4 427	6 297	6 792	6 904	8 620	11.7
Computer equipment	2 877	5 300	9 883	15 929	28 209	38 104	29.5
Electronic components	7 375	12 149	28 432	44 849	97 302	157 689	35.8
Audio and video equipment	1 889	1 961	2 920	3 978	6 877	10 226	18.4
Other ICT goods	1 848	1 677	3 065	4 900	9 371	11 838	20.4
Total ICT imports	16 850	25 514	50 597	76 447	148 663	226 477	29.7
INDIA							
Exports							
Communication equipment	54	45	68	90	101	298	18.6
Computer equipment	281	70	253	252	347	372	2.8
Electronic components	194	99	197	295	403	576	11.5
Audio and video equipment	96	63	99	139	139	164	5.5
Other ICT goods	34	41	96	163	214	332	25.7
Total ICT exports	659	317	714	939	1 205	1 742	10.2
Imports							
Communication equipment	171	302	481	1 726	3 619	6 285	43.4
Computer equipment	356	729	1 428	1 453	2 535	3 980	27.3
Electronic components	472	557	773	1 102	1 450	2 174	16.5
Audio and video equipment	83	112	167	256	488	922	27.2
Other ICT goods	285	421	451	653	947	1 491	18.0
Total ICT imports	1 368	2 122	3 300	5 189	9 040	14 852	26.9
INDONESIA							
Exports							
Communication equipment	421	402	725	239	438	535	2.4
Computer equipment	699	755	3 009	2 137	2 515	2 314	12.7
Electronic components	518	451	1 344	1 321	1 553	1 550	11.6
Audio and video equipment	1 553	921	2 684	2 828	2 453	2 246	3.8
Other ICT goods	96	46	83	156	317	303	12.2
Total ICT exports	3 287	2 575	7 844	6 680	7 276	6 948	7.8

Table 2.A1.6. **Emerging economies trade in ICT goods, 1996-2006** *(cont.)*

USD millions in current prices and annual growth per cent

	1996	1998	2000	2002	2004	2006	CAGR
Imports							
Communication equipment	1 356	454	256	383	990	1 149	–1.6
Computer equipment	201	137	189	228	336	507	9.7
Electronic components	805	171	164	209	300	248	–11.1
Audio and video equipment	89	42	133	121	178	217	9.3
Other ICT goods	399	237	259	139	261	289	–3.2
Total ICT imports	2 851	1 041	1 001	1 081	2 065	2 411	–1.7
SOUTH AFRICA							
Exports							
Communication equipment	..	194	223	178	233	204	6.2
Computer equipment	..	124	127	96	108	248	7.1
Electronic components	..	25	42	78	142	166	19.5
Audio and video equipment	..	32	50	43	100	141	17.8
Other ICT goods	..	92	79	99	177	196	11.0
Total ICT exports	..	467	521	493	761	955	10.3
Imports							
Communication equipment	..	2 004	1 432	1 216	1 748	2 645	9.1
Computer equipment	..	1 067	1 020	939	2 074	2 563	10.1
Electronic components	..	425	456	347	491	652	4.5
Audio and video equipment	..	375	353	337	742	941	11.3
Other ICT goods	..	367	387	399	633	913	8.6
Total ICT imports	..	4 237	3 648	3 237	5 688	7 714	9.1

StatLink http://dx.doi.org/10.1787/476561008083

Note: South Africa includes the South African Customs Union for 1998. For Brazil and South Africa, CAGR 1997-2006.
Source: OECD, based on data from the joint OECD-UNSD ITCS and COMTRADE *database*, September 2008.

Table 2.A1.7. **Direction of ICT goods exports, 1996-2006**

USD millions in current prices and percentages

From	To	1996	1998	2000	2002	2004	2006	CAGR
Values								
OECD	World	503 774	555 341	737 410	619 210	789 895	931 713	6.3
OECD	OECD	361 233	408 447	539 911	448 340	547 433	638 275	5.9
OECD	Non-OECD (incl. unrecorded)	142 542	146 894	197 499	170 870	242 462	293 438	7.5
Shares								
OECD	World	100	100	100	100	100	100	
OECD	OECD	72	74	73	72	69	69	
OECD	Non-OECD (incl. unrecorded)	28	26	27	28	31	31	

StatLink http://dx.doi.org/10.1787/476605228718

Source: OECD, based on data from the joint OECD-UNSD ITCS and COMTRADE *database*, July 2008.

Table 2.A1.8. **Direction of ICT goods imports, 1996-2006**

USD millions in current prices and percentages

To	From	1996	1998	2000	2002	2004	2006	CAGR
Values								
OECD	World	514 994	580 998	787 952	662 970	880 959	1 048 606	7.4
OECD	OECD	361 704	407 013	533 376	421 849	511 402	570 322	4.7
OECD	Non-OECD (incl. unrecorded)	153 290	173 985	254 575	241 121	369 558	478 283	12.1
Shares								
OECD	World	100	100	100	100	100	100	
OECD	OECD	70	70	68	64	58	54	
OECD	Non-OECD (incl. unrecorded)	30	30	32	36	42	46	

StatLink http://dx.doi.org/10.1787/476606857272

Source: OECD, based on data from the joint OECD-UNSD ITCS and COMTRADE *database*, July 2008.

Table 2.A1.9. **OECD trade in computer and related equipment, 1996-2006**

USD millions in current prices and annual growth per cent

	Exports				Imports			
	1996	2001	2006	CAGR	1996	2001	2006	CAGR
Australia	1 270	756	759	–5.0	4 181	3 630	6 250	4.1
Austria	528	1 033	1 352	9.9	1 793	2 119	3 103	5.6
Belgium	2 402	4 021	4 759	7.1	3 607	5 069	5 725	4.7
Canada	4 919	4 097	3 426	–3.6	8 355	9 785	11 809	3.5
Czech Republic	179	1 002	7 192	44.6	886	1 602	5 771	20.6
Denmark	839	855	1 309	4.5	2 103	1 934	3 559	5.4
Finland	974	326	776	–2.2	1 369	1 237	1 871	3.2
France	8 722	7 720	6 942	–2.3	11 723	12 916	16 444	3.4
Germany	10 374	14 387	28 718	10.7	19 301	26 276	39 343	7.4
Greece	24	72	102	15.6	430	582	1 071	9.6
Hungary	34	2 520	4 403	62.8	322	1 945	3 157	25.7
Iceland	..	1	2	..	..	73	130	..
Ireland	9 605	19 468	17 029	5.9	6 014	10 728	12 474	7.6
Italy	4 439	2 695	1 887	–8.2	6 703	6 990	8 805	2.8
Japan	27 913	22 239	22 343	–2.2	18 362	22 388	25 392	3.3
Korea	5 420	13 125	17 284	12.3	3 638	5 358	7 647	7.7
Luxembourg	0	193	367	..	0	421	574	..
Mexico	3 779	12 759	12 042	12.3	1 973	7 488	11 255	19.0
Netherlands	13 109	22 791	37 149	11.0	13 910	20 715	38 583	10.7
New Zealand	66	90	139	7.7	666	589	1 052	4.7
Norway	345	312	319	–0.8	1 392	1 542	2 387	5.5
Poland	59	86	308	17.9	978	1 474	2 729	10.8
Portugal	53	243	737	30.1	757	1 016	1 406	6.4
Slovak Republic	..	78	882	..	..	324	871	..
Spain	1 498	1 443	1 188	–2.3	3 393	3 938	7 511	8.3
Sweden	777	670	1 713	8.2	3 233	2 741	4 858	4.2
Switzerland	816	948	601	–3.0	3 492	3 839	4 058	1.5
Turkey	14	46	42	11.4	654	674	2 038	12.0
United Kingdom	17 216	17 546	18 965	1.0	18 344	22 275	26 630	3.8
United States	43 146	46 761	46 453	0.7	61 031	73 573	100 763	5.1
OECD	**158 521**	**198 284**	**239 186**	**4.2**	**198 611**	**253 241**	**357 263**	**6.0**

StatLink http://dx.doi.org/10.1787/476630714251

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.

Source: OECD, based on data from the joint OECD-UNSD ITCS and COMTRADE *database*, July 2008.

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Table 2.A1.10. **OECD trade in electronic components, 1996-2006**

USD millions in current prices and annual growth per cent

	Exports				Imports			
	1996	2001	2006	CAGR	1996	2001	2006	CAGR
Australia	131	219	338	9.9	1 225	830	1 196	–0.2
Austria	1 398	2 561	3 283	8.9	1 336	2 148	2 546	6.7
Belgium	1 457	1 897	2 339	4.8	1 738	2 642	2 765	4.8
Canada	3 831	3 617	3 386	–1.2	7 522	6 387	6 280	–1.8
Czech Republic	496	901	2 079	15.4	501	1 720	4 594	24.8
Denmark	453	552	948	7.7	584	977	1 423	9.3
Finland	733	1 170	1 281	5.7	1 587	2 262	3 757	9.0
France	7 670	8 487	11 013	3.7	7 031	8 048	9 914	3.5
Germany	10 198	15 189	24 341	9.1	12 166	17 132	28 171	8.8
Greece	13	20	68	17.5	116	196	313	10.5
Hungary	313	1 359	2 692	24.0	380	3 931	8 237	36.0
Iceland	..	0	0	..	..	13	25	..
Ireland	2 102	6 228	4 686	8.3	1 993	4 876	2 509	2.3
Italy	3 720	4 151	5 046	3.1	4 848	4 635	5 735	1.7
Japan	42 108	38 553	61 952	3.9	15 707	19 458	33 018	7.7
Korea	19 493	18 204	44 524	8.6	12 984	18 596	30 113	8.8
Luxembourg	..	157	232	..	..	192	156	..
Mexico	4 081	4 528	5 850	3.7	8 248	18 598	24 616	11.6
Netherlands	6 110	1 896	10 472	5.5	3 649	3 383	7 693	7.7
New Zealand	38	48	134	13.3	135	187	235	5.7
Norway	158	241	371	8.9	365	408	618	5.4
Poland	287	456	1 132	14.7	575	1 170	4 507	22.9
Portugal	457	843	1 685	13.9	706	1 133	2 541	13.7
Slovak Republic	..	234	446	..	..	365	1 692	..
Spain	737	1 125	1 528	7.6	1 550	2 136	4 478	11.2
Sweden	3 552	2 191	4 265	1.8	2 756	2 403	3 114	1.2
Switzerland	888	1 042	1 413	4.8	1 052	1 253	1 463	3.4
Turkey	43	56	24	–5.8	682	981	920	3.0
United Kingdom	9 927	12 103	10 164	0.2	13 235	12 163	8 448	–4.4
United States	44 672	57 593	63 194	3.5	44 921	40 733	39 821	–1.2
OECD	**165 068**	**185 621**	**268 887**	**5.0**	**147 590**	**178 955**	**240 897**	**5.0**

StatLink http://dx.doi.org/10.1787/476664664418

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.

Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, July 2008.

Table 2.A1.11. **OECD trade in communication equipment, 1996-2006**

USD millions in current prices and annual growth per cent

	Exports				Imports			
	1996	2001	2006	CAGR	1996	2001	2006	CAGR
Australia	485	630	498	0.2	1 606	2 306	4 087	9.4
Austria	466	478	2 062	15.7	651	1 310	2 252	13.2
Belgium	1 216	2 999	1 577	4.9	1 185	2 869	2 186	8.5
Canada	3 560	5 196	7 372	6.7	2 871	4 864	5 779	8.0
Czech Republic	73	509	897	37.0	654	752	1 131	10.9
Denmark	621	1 366	2 017	0.0	811	1 571	3 116	0.0
Finland	3 477	7 029	10 749	12.1	562	1 208	2 592	20.8
France	4 245	8 201	10 552	4.0	2 714	5 929	11 470	11.6
Germany	8 315	14 047	21 155	7.5	4 662	10 391	18 784	11.5
Greece	79	228	370	12.9	459	765	1 221	11.8
Hungary	30	1 730	6 398	0.0	391	764	1 891	0.0
Iceland	. .	0	3	. .	. .	44	70	. .
Ireland	888	2 924	1 029	3.0	419	2 408	1 606	12.9
Italy	2 210	3 747	4 429	6.8	2 475	4 744	7 425	9.7
Japan	10 407	8 057	4 552	–2.7	4 343	4 722	4 638	7.7
Korea	2 099	9 044	19 205	27.1	1 715	2 055	3 047	10.1
Luxembourg	. .	749	182	. .	. .	782	381	. .
Mexico	2 151	9 078	11 037	15.2	1 501	4 536	6 439	13.9
Netherlands	1 576	4 713	5 663	21.6	1 786	6 362	6 417	22.3
New Zealand	81	81	103	3.8	392	354	536	4.3
Norway	470	484	714	4.7	751	830	1 296	7.0
Poland	75	132	701	0.0	662	1 408	2 286	0.0
Portugal	79	136	217	0.0	403	788	1 031	0.0
Slovak Republic	. .	49	322	. .	. .	208	698	. .
Spain	930	1 477	1 290	0.0	2 448	3 519	6 307	0.0
Sweden	5 983	5 145	7 793	4.0	1 306	1 989	3 098	11.8
Switzerland	768	795	992	0.6	1 077	1 361	2 013	7.3
Turkey	108	173	44	–1.6	528	911	1 063	9.5
United Kingdom[1]	7 342	15 623	48 684	–0.8	7 011	10 357	28 064	7.5
United States	14 561	20 400	21 918	5.0	13 339	32 204	55 572	14.8
OECD	**72 296**	**125 224**	**192 526**	**0.0**	**56 722**	**112 311**	**186 495**	**0.0**

StatLink http://dx.doi.org/10.1787/476721120121

1. See Box 2.1 in Chapter 2.

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.

Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, July 2008.

Table 2.A1.12. **OECD trade in audio and video equipment, 1996-2006**

USD millions in current prices an annual growth per cent

	Exports				Imports			
	1996	2001	2006	CAGR	1996	2001	2006	CAGR
Australia	53	71	151	11.1	1 319	1 402	3 509	10.3
Austria	284	466	538	6.6	941	879	1 661	5.8
Belgium	2 552	2 639	3 636	3.6	1 766	2 450	3 927	8.3
Canada	284	381	679	9.1	2 086	3 197	6 209	11.5
Czech Republic	33	625	2 786	55.9	313	349	1 639	18.0
Denmark	645	680	1 240	6.8	844	690	1 723	7.4
Finland	198	146	603	11.7	355	408	1 141	12.4
France	2 417	2 690	3 329	3.3	3 896	3 923	8 343	7.9
Germany	4 415	4 278	8 368	6.6	7 668	7 754	14 964	6.9
Greece	9	27	63	21.0	402	356	892	8.3
Hungary	209	1 660	4 516	36.0	214	1 057	1 435	20.9
Iceland	. .	0	0	. .	. .	27	77	. .
Ireland	399	396	800	7.2	643	420	977	4.3
Italy	846	455	695	–1.9	2 172	2 621	5 201	9.1
Japan	13 753	16 155	20 225	3.9	5 551	7 399	8 765	4.7
Korea	6 831	5 732	5 772	–1.7	1 226	1 671	3 489	11.0
Luxembourg	. .	374	289	. .	. .	199	380	. .
Mexico	5 682	9 531	20 147	13.5	1 913	3 604	4 515	9.0
Netherlands	1 976	1 931	7 636	14.5	2 931	3 794	8 890	11.7
New Zealand	7	7	17	8.9	259	189	514	7.1
Norway	39	158	111	11.0	379	479	1 161	11.9
Poland	169	1 000	3 557	35.6	347	568	1 440	15.3
Portugal	673	745	1 169	5.7	497	524	834	5.3
Slovak Republic	. .	159	3 696	. .	. .	145	811	. .
Spain	1 172	1 356	3 420	11.3	1 852	2 228	5 517	11.5
Sweden	291	478	1 431	17.2	842	1 047	2 832	12.9
Switzerland	135	109	182	3.0	812	829	1 541	6.6
Turkey	310	873	1 594	17.8	268	229	522	6.9
United Kingdom	4 320	2 644	5 763	2.9	4 664	5 611	12 172	10.1
United States	7 082	6 994	9 848	3.4	21 473	30 847	59 428	10.7
OECD	**54 785**	**62 761**	**112 261**	**7.4**	**65 631**	**84 894**	**164 510**	**9.6**

StatLink http://dx.doi.org/10.1787/476758717373

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.

Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, July 2008.

Table 2.A1.13. **OECD trade in other ICT-related equipment, 1996-2006**

USD millions in current prices and annual growth per cent

	Exports				Imports			
	1996	2001	2006	CAGR	1996	2001	2006	CAGR
Australia	241	306	493	7.4	1 049	967	1 941	6.3
Austria	594	699	1 230	7.6	733	864	1 454	7.1
Belgium	644	653	1 343	7.6	906	1 328	2 228	9.4
Canada	1 281	1 721	3 185	9.5	2 691	4 022	5 126	6.7
Czech Republic	113	164	545	17.0	407	443	880	8.0
Denmark	597	607	1 263	7.8	308	396	834	10.5
Finland	552	743	1 232	8.4	341	350	671	7.0
France	2 838	3 359	6 284	8.3	3 094	3 586	5 898	6.7
Germany	9 510	11 181	24 806	10.1	4 939	6 366	11 894	9.2
Greece	56	37	97	5.7	187	195	335	6.0
Hungary	77	241	1 344	33.2	176	353	565	12.4
Iceland	..	7	10	..	..	28	41	..
Ireland	270	718	815	11.7	229	417	894	14.6
Italy	1 833	1 776	3 320	6.1	2 255	2 519	3 838	5.5
Japan	9 031	9 692	16 018	5.9	3 895	4 354	7 451	6.7
Korea	474	688	1 760	14.0	3 920	2 655	6 698	5.5
Luxembourg	..	79	74	..	..	51	87	..
Mexico	728	2 159	4 386	19.7	1 334	2 367	3 428	9.9
Netherlands	2 129	3 210	9 128	15.7	1 661	1 962	4 011	9.2
New Zealand	39	46	116	11.4	168	127	239	3.6
Norway	288	332	657	8.6	320	299	745	8.8
Poland	57	63	425	22.2	427	440	1 042	9.3
Portugal	109	98	99	–0.9	253	329	418	5.1
Slovak Republic	..	54	172	..	..	191	503	..
Spain	633	761	1 120	5.9	1 321	1 457	2 347	5.9
Sweden	805	869	1 274	4.7	957	893	1 548	4.9
Switzerland	1 537	1 407	2 325	4.2	834	898	1 452	5.7
Turkey	21	40	14	–3.9	435	437	968	8.3
United Kingdom	4 310	5 480	7 706	6.0	3 889	4 983	7 314	6.5
United States	14 340	20 403	27 613	6.8	9 711	16 440	24 593	9.7
OECD	**53 104**	**67 593**	**118 854**	**8.4**	**46 441**	**59 716**	**99 442**	**7.9**

StatLink http://dx.doi.org/10.1787/476761550034

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.
Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, July 2008.

Table 2.A1.14. **OECD trade in software goods, 1996-2006**

USD millions in current prices and annual growth per cent

	Exports				Imports			
	1996	2001	2006	CAGR	1996	2001	2006	CAGR
Australia	61	50	80	2.7	403	299	466	1.4
Austria	217	882	1 241	19.1	155	296	667	15.7
Belgium	158	307	380	9.2	328	417	658	7.2
Canada	303	207	291	–0.4	832	997	1 151	3.3
Czech Republic	144	30	371	9.9	73	135	178	9.3
Denmark	82	157	196	9.1	145	206	240	5.1
Finland	30	53	66	8.0	115	125	284	9.5
France	428	443	819	6.7	972	916	1 318	3.1
Germany	784	865	3 924	17.5	1 226	1 174	2 218	6.1
Greece	27	10	49	6.1	64	60	233	13.9
Hungary	15	26	76	17.7	9	99	102	27.2
Iceland	. .	0	0	. .	. .	10	21	. .
Ireland	3 565	2 972	2 022	–5.5	636	294	268	–8.3
Italy	89	61	180	7.3	558	856	1 419	9.8
Japan	254	301	467	6.3	560	606	636	1.3
Korea	27	185	169	20.3	438	538	582	2.9
Luxembourg	. .	46	92	. .	. .	45	104	. .
Mexico	36	50	230	20.4	180	389	383	7.8
Netherlands	506	1 125	1 581	12.1	505	489	886	5.8
New Zealand	8	5	15	5.6	74	52	128	5.7
Norway	20	26	59	11.5	149	168	361	9.3
Poland	37	35	242	20.5	16	62	266	32.2
Portugal	4	4	18	16.0	59	129	192	12.6
Slovak Republic	. .	10	23	. .	. .	34	89	. .
Spain	53	138	141	10.2	267	330	755	11.0
Sweden	88	363	622	21.6	269	327	569	7.8
Switzerland	305	166	222	–3.1	487	755	604	2.2
Turkey	11	6	4	–10.3	42	137	76	6.1
United Kingdom	1 019	1 066	1 968	6.8	1 095	1 466	1 967	6.0
United States	3 087	2 951	3 307	0.7	714	868	1 007	3.5
OECD	**11 360**	**12 539**	**18 851**	**5.2**	**10 370**	**12 278**	**17 829**	**5.6**

StatLink http://dx.doi.org/10.1787/476780082101

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.

Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, July 2008.

Table 2.A1.15. **Trade in ICT services, 1996-2006**

USD millions in current prices

	Communications		Computer and Information		Communications		Computer and Information	
	Exports 1996	Imports 1996	Exports 1996	Imports 1996	Exports 2006	Imports 2006	Exports 2006	Imports 2006
Australia	752	843	167	173	641	657	1 049	922
Austria	338	362	84	171	1 350	1 096	1 501	1 059
Belgium	..	..	..	..	2 039	1 596	2 848	1 979
Canada	1 282	1 243	788	529	2 302	1 955	4 033	2 020
Czech Republic	77	63	28	22	436	453	885	538
Denmark	..	..	..	..	801	763	1 216	1 491
Finland	155	194	888	615	432	544	1 488	1 126
France	582	417	509	482	3 698	2 076	1 936	1 966
Germany	2 025	2 692	1 602	2 379	4 318	6 146	9 385	8 947
Greece	71	78	362	55	385	359	203	254
Hungary	42	24	93	58	389	411	485	543
Iceland	23	24	17	2	12	46	89	17
Ireland	86	254	105	306	515	945	20 682	656
Italy	536	944	207	590	3 159	4 585	873	1 699
Japan	1 378	1 869	1 223	2 443	436	733	966	3 126
Korea	643	706	6	76	466	778	240	773
Luxembourg	..	..	..	..	1 363	1 340	2 210	668
Mexico	846	..	..	..	466	107	..	..
Netherlands	648	668	638	651	4 002	3 487	3 902	3 746
New Zealand	..	..	29	58	..	195	184	270
Norway	216	172	122	149	388	299	1 239	1 200
Poland	315	203	28	135	385	456	409	584
Portugal	275	168	40	110	679	471	186	300
Slovak Republic	20	19	8	16	255	98	170	200
Spain	642	443	1 279	976	1 411	2 239	3 961	2 094
Sweden	166	127	121	119	1 602	1 754	3 567	2 245
Switzerland	516	727	..	..	1 101	802	..	..
Turkey	0	74	..	..	416	296	11	14
United Kingdom	1 652	2 094	1 705	518	7 835	7 304	11 949	4 889
United States	3 543	8 792	2 775	422	6 578	5 163	10 096	11 092
OECD	**..**	**..**	**14 296**	**12 839**	**..**	**47 151**	**85 764**	**54 418**
Emerging economies								
Brazil	227	91	4	112	205	102	102	2 005
China	315	134	..	..	738	764	2 958	1 739
India	..	..	..	..	2 191	899	29 186	2 199
Indonesia	278	187	..	..	1 103	571	118	596
Russian Federation	563	365	..	..	803	917	632	613
South Africa	86	126	..	..	305	246	129	127

StatLink http://dx.doi.org/10.1787/476806181407

Note: Communication services include telecommunications, postal and courier services. Computer and information services include IT and subscription services.

Source: *OECD Statistics on International Trade in Services*, Volume I, detailed tables by Service Category, Sept. 2008.

Table 2.A1.16. **Growth in the value of electronics production, 2005-2008**

Per cent per annum

	Electronic data processing	Office equipment	Control and instrument	Medical and industrial	Radio and radar	Telecoms	Consumer	Components	Total
Australia	1.09	2.62	3.67	4.05	5.54	–0.76	–1.83	3.71	2.42
Austria	–4.83	0.00	10.39	3.53	3.13	7.47	–2.27	1.80	2.86
Belgium	–1.41	..	2.95	5.74	–0.65	–7.12	–3.78	2.07	–0.51
Brazil	27.26	14.41	14.98	8.88	16.81	15.75	14.80	14.28	21.24
Bulgaria	14.05	2.70	13.04	12.00	15.37	7.72	1.06	9.39	10.67
Canada	1.73	6.07	8.91	9.10	8.64	–1.33	–6.52	2.01	4.78
China	15.80	10.74	25.39	15.38	17.81	15.55	14.40	15.17	15.86
Croatia	10.33	0.00	6.27	6.27	9.14	5.27	..	14.05	8.17
Czech Republic	11.29	–1.94	9.99	7.07	11.64	8.02	28.69	–2.84	12.76
Denmark	6.64	..	8.63	10.79	2.60	11.03	1.36	2.26	6.93
Egypt	7.07	3.61	6.15	10.82	10.46	12.90	2.63	3.37	6.28
Estonia	14.67	0.00	–0.33	7.22	4.31	3.67	..	5.49	4.75
Finland	–3.15	..	7.34	8.49	–4.28	–2.85	5.27	0.25	–2.22
France	–13.80	6.74	7.71	9.47	–0.76	0.22	–3.81	1.82	–0.36
Germany	0.39	–4.15	8.62	6.19	–1.19	0.99	–4.19	9.08	4.76
Greece	11.84	3.45	6.38	18.98	7.72	10.85	0.00	21.14	10.54
Hong Kong, China	–18.53	–15.75	–4.75	–2.15	–8.33	–13.01	–10.46	–7.12	–10.23
Hungary	7.99	0.00	10.63	7.52	7.33	2.01	21.52	3.80	10.38
India	21.70	7.72	13.48	10.75	65.17	11.34	9.05	5.28	19.93
Indonesia	–0.66	–0.61	3.78	5.76	4.42	–11.13	–3.21	2.99	0.19
Ireland	7.67	1.72	11.64	2.47	14.14	–3.82	7.99	3.25	6.03
Israel	1.33	–11.17	5.96	10.70	2.81	0.82	–2.23	2.41	3.20
Italy	–2.43	–23.31	5.26	10.63	–2.48	3.09	7.34	3.11	2.14
Japan	–3.05	–7.02	–3.98	2.22	–5.16	–7.22	1.50	0.49	–1.31
Korea	–5.00	–9.33	9.08	16.71	–2.42	–2.81	–3.88	0.84	–1.13
Lithuania	7.24	10.06	7.56	32.64	43.42	37.00	–0.93	–19.66	0.68
Malaysia	13.67	34.03	16.39	23.52	20.89	11.31	–6.43	5.63	8.58
Mexico	3.06	10.72	5.90	1.50	7.67	–5.65	20.78	3.39	10.34
Netherlands	–2.82	–9.29	3.19	16.34	–8.16	2.33	–7.17	–1.15	1.76
New Zealand	5.70	–12.21	3.27	7.92	8.54	2.10	–8.53	10.90	5.99
Norway	0.99	..	5.53	7.72	4.70	5.17	..	20.10	6.58
Philippines	4.07	9.20	3.72	10.98	–5.94	–0.67	–4.16	3.93	3.34
Poland	5.98	2.17	2.96	4.91	7.31	4.01	31.06	–8.45	15.84
Portugal	–6.88	0.00	22.00	22.00	8.76	2.67	7.51	10.82	5.59
Puerto Rico	–11.26	–3.13	1.22	–15.93	4.32	0.50	–3.29	–6.62	–11.93
Romania	13.83	0.00	9.65	11.17	8.01	2.21	–2.27	5.90	6.43
Russian Federation	14.92	2.91	6.99	6.14	11.24	5.27	11.04	7.76	9.55
Saudi Arabia	3.31	–1.34	4.87	2.62	7.41	2.89	–3.85	3.82	3.93
Singapore	–9.12	–4.22	4.23	17.92	5.76	0.15	–12.17	8.34	1.52
Slovak Republic	7.60	3.57	9.35	4.59	7.96	1.91	61.82	12.82	40.17
Slovenia	10.97	0.00	8.13	6.40	2.44	1.90	3.23	1.54	3.99
South Africa	0.48	–0.32	2.40	0.00	2.60	0.93	4.27	–1.09	1.32
Spain	–1.52	–10.93	1.61	6.99	4.70	–3.45	–4.44	7.97	0.61
Sweden	–3.15	..	3.65	10.96	–2.69	0.56	9.49	1.22	0.06
Switzerland	–2.19	–10.74	6.76	6.85	0.53	–0.41	2.05	2.57	3.85
Chinese Taipei	–14.05	–9.62	18.17	33.19	3.23	–16.50	–2.16	10.02	7.38
Thailand	16.49	–2.90	18.59	17.74	6.62	1.26	12.05	13.97	14.07
Turkey	15.48	–5.80	0.66	3.98	1.64	0.48	0.82	6.73	2.01
United Kingdom	–21.47	–15.48	6.50	7.34	5.58	2.64	–7.60	–2.76	–1.34
Ukraine	11.32	3.23	5.07	9.31	7.00	3.70	3.45	5.36	6.52
United States	–1.21	–1.27	3.78	4.30	2.94	–0.78	–4.22	2.18	1.76
Venezuela	3.31	0.33	10.81	7.93	3.31	1.99	–2.57	9.35	4.90
Vietnam	35.29	6.35	10.85	7.60	11.76	–1.08	15.56	14.17	18.44
World	**6.64**	**0.45**	**6.09**	**7.55**	**4.75**	**2.88**	**9.34**	**4.94**	**5.86**

StatLink http://dx.doi.org/10.1787/476812275200

Source: OECD, based on data provided by Reed Electronics Research.

Table 2.A1.17. **Share of ICT goods in total merchandise exports, 1996-2006**

Per cent

	1996	1998	2000	2002	2004	2006
Australia	3.6	3.4	3.2	2.7	2.5	1.8
Austria	5.7	6.7	7.9	8.0	7.1	6.3
Belgium	4.9	5.4	6.2	4.9	4.4	3.7
Canada	6.9	6.8	8.2	4.8	4.5	4.7
Czech Republic	4.1	5.3	7.3	12.4	13.8	14.2
Denmark	6.5	8.1	8.5	9.8	7.8	7.5
Finland	14.6	20.0	25.4	22.0	19.0	18.9
France	9.1	10.7	12.1	9.1	7.9	8.0
Germany	8.2	8.7	10.5	10.0	10.0	9.6
Greece	1.5	2.4	4.4	3.7	3.8	3.3
Hungary	5.2	20.7	27.7	26.0	30.6	26.1
Iceland	. .	0.2	0.6	0.6	0.6	0.4
Ireland	29.1	29.0	34.5	30.8	22.7	22.4
Italy	5.2	4.9	5.3	4.5	4.1	3.7
Japan	25.1	24.1	25.8	22.8	22.0	19.3
Korea	26.5	25.6	35.7	33.9	33.9	27.2
Luxembourg	. .	. .	14.9	15.1	10.1	8.1
Mexico	17.2	21.0	23.0	22.6	22.0	21.4
Netherlands	14.0	18.8	22.9	18.0	20.1	18.9
New Zealand	1.6	2.5	2.2	2.2	2.3	2.3
Norway	2.7	3.7	2.4	2.3	2.0	1.8
Poland	2.7	4.6	4.5	5.4	4.5	5.6
Portugal	5.9	6.0	7.8	7.8	8.1	9.0
Slovak Republic	. .	3.6	3.9	4.3	6.8	13.2
Spain	4.9	5.2	5.4	4.7	4.5	4.0
Sweden	13.7	15.6	19.1	12.4	12.0	11.2
Switzerland	5.2	5.2	5.8	4.1	4.0	3.7
Turkey	2.2	3.9	4.0	4.8	4.9	2.0
United Kingdom	17.0	17.8	19.8	18.5	12.6	20.5
United States	19.9	19.9	23.4	19.1	18.3	16.3
OECD	**13.2**	**13.9**	**16.6**	**13.9**	**13.0**	**12.4**

StatLink http://dx.doi.org/10.1787/476837100418

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999.

Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, July 2008.

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Table 2.A1.18. **Revealed comparative advantage in ICT goods exports, 1996-2006**

Balassa Method

	1996	1998	2000	2002	2004	2006
Australia	0.27	0.24	0.19	0.19	0.19	0.15
Austria	0.43	0.48	0.47	0.57	0.55	0.51
Belgium	0.37	0.38	0.37	0.35	0.34	0.30
Canada	0.52	0.49	0.49	0.34	0.35	0.38
Czech Republic	0.31	0.38	0.44	0.89	1.07	1.15
Denmark	0.49	0.58	0.51	0.70	0.60	0.61
Finland	1.11	1.44	1.53	1.58	1.46	1.53
France	0.69	0.77	0.73	0.66	0.61	0.64
Germany	0.62	0.63	0.63	0.72	0.77	0.77
Greece	0.12	0.17	0.26	0.26	0.30	0.27
Hungary	0.40	1.49	1.66	1.87	2.36	2.11
Iceland	. .	0.01	0.04	0.04	0.05	0.04
Ireland	2.21	2.08	2.08	2.21	1.75	1.81
Italy	0.39	0.35	0.32	0.32	0.32	0.30
Japan	1.90	1.73	1.55	1.64	1.69	1.56
Korea	2.01	1.84	2.15	2.43	2.61	2.20
Luxembourg	. .	. .	0.90	1.09	0.78	0.65
Mexico	1.30	1.51	1.38	1.62	1.69	1.73
Netherlands	1.06	1.35	1.38	1.29	1.55	1.53
New Zealand	0.12	0.18	0.13	0.16	0.18	0.18
Norway	0.20	0.27	0.14	0.16	0.16	0.14
Poland	0.20	0.33	0.27	0.38	0.35	0.45
Portugal	0.45	0.43	0.47	0.56	0.63	0.73
Slovak Republic	. .	0.26	0.23	0.31	0.52	1.07
Spain	0.37	0.37	0.33	0.34	0.35	0.32
Sweden	1.04	1.12	1.15	0.89	0.93	0.90
Switzerland	0.39	0.37	0.35	0.29	0.31	0.30
Turkey	0.16	0.28	0.24	0.34	0.38	0.16
United Kingdom	1.29	1.28	1.19	1.33	0.97	1.66
United States	1.51	1.43	1.40	1.37	1.41	1.32
OECD	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**

StatLink http://dx.doi.org/10.1787/476856538156

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999. Balassa Index = (Country ICT export/Country Total export)/(OECD ICT export/OECD Total export).

Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, July 2008.

Table 2.A1.19. **Grubel and Lloyd Index for ICT goods, 1996-2006**

	1996	1998	2000	2002	2004	2006
Australia	0.38	0.36	0.30	0.31	0.26	0.23
Austria	0.75	0.75	0.81	0.88	0.88	0.87
Belgium	0.95	0.93	0.93	0.91	0.91	0.90
Canada	0.74	0.71	0.77	0.65	0.64	0.68
Czech Republic	0.49	0.68	0.71	0.90	0.99	0.98
Denmark	0.81	0.86	0.83	0.90	0.85	0.78
Finland	0.83	0.74	0.71	0.70	0.75	0.81
France	0.95	0.97	0.95	0.93	0.86	0.85
Germany	0.94	0.92	0.94	0.97	0.99	0.97
Greece	0.20	0.21	0.33	0.31	0.29	0.31
Hungary	0.62	1.00	0.99	0.98	0.91	0.88
Iceland	. .	0.03	0.08	0.13	0.13	0.09
Ireland	0.82	0.84	0.79	0.79	0.79	0.86
Italy	0.83	0.74	0.71	0.71	0.66	0.66
Japan	0.63	0.61	0.70	0.73	0.74	0.78
Korea	0.81	0.73	0.78	0.74	0.66	0.73
Luxembourg	. .	. .	0.93	0.99	0.91	0.84
Mexico	0.95	0.93	0.97	0.96	1.00	0.97
Netherlands	0.98	0.98	0.99	0.97	0.99	0.97
New Zealand	0.25	0.35	0.28	0.35	0.33	0.33
Norway	0.58	0.59	0.56	0.56	0.50	0.52
Poland	0.36	0.46	0.44	0.59	0.61	0.68
Portugal	0.69	0.62	0.69	0.71	0.73	0.77
Slovak Republic	. .	0.51	0.63	0.61	0.86	0.91
Spain	0.64	0.65	0.60	0.62	0.57	0.49
Sweden	0.89	0.90	0.83	0.91	0.93	0.97
Switzerland	0.73	0.69	0.68	0.66	0.68	0.69
Turkey	0.32	0.42	0.31	0.62	0.60	0.48
United Kingdom	0.96	0.96	0.90	0.98	0.80	0.95
United States	0.90	0.89	0.87	0.81	0.78	0.75
OECD	**0.99**	**0.98**	**0.97**	**0.97**	**0.95**	**0.94**

StatLink http://dx.doi.org/10.1787/476860177160

Notes: No data for the Slovak Republic prior to 1997. Belgium includes Luxembourg prior to 1999. GLI = [1 – !Mi – Xi! / (Mi + Xi)].

Source: OECD, based on data from the joint OECD-UNSD ITCS and *COMTRADE database*, July 2008.

Table 2.A1.20. **ICT sector cross-border M&A deals, 1997-2007**

Number of deals

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Target											
Communications equipment	62	61	80	102	90	93	63	76	65	70	92
IT equipment	55	55	60	80	41	30	24	38	47	37	48
Electronics	87	134	164	246	225	199	164	193	190	197	225
IT services	213	375	728	1 275	816	619	445	527	610	567	594
IT wholesale	84	105	119	155	108	70	65	58	85	67	62
Telecommunications	158	252	485	669	402	293	236	301	323	363	356
Media and content	48	91	198	347	218	129	112	95	153	172	169
Total cross-border ICTs	707	1 073	1 834	2 874	1 900	1 433	1 109	1 288	1 473	1 473	1 546
ICT share of all	18%	18%	24%	31%	24%	21%	19%	21%	19%	17%	15%
Acquirer											
Communications equipment	53	100	91	160	92	86	61	98	113	74	79
IT equipment	45	57	77	95	59	42	46	43	63	38	46
Electronics	103	131	143	234	199	163	118	150	179	115	116
IT services	175	294	514	876	522	351	313	363	503	376	359
IT wholesale	57	70	87	122	63	68	40	27	62	42	46
Telecommunications	135	251	433	589	344	242	164	240	247	251	238
Media and content	39	74	124	255	169	97	79	59	92	81	81
Total cross-border ICTs	607	977	1 469	2 331	1 448	1 049	821	980	1 259	977	965
ICT share of all	15%	17%	19%	25%	18%	15%	14%	16%	16%	12%	10%

StatLink http://dx.doi.org/10.1787/476873137458

Source: OECD, based on data provided by Dealogic.

Table 2.A1.21. **ICT sector cross-border M&A deal values, 1997-2007**

(USD millions in current prices)

	1997	2000	2001	2002	2003	2004	2005	2006	2007
Target									
Communications equipment	2 617	22 288	14 513	1 670	3 415	3 182	4 738	23 450	9 279
IT equipment	2 591	13 938	3 737	2 892	703	1 566	3 227	1 645	1 955
Electronics	4 973	25 557	18 121	6 515	5 772	9 748	15 164	15 069	35 905
IT services	4 655	41 335	19 851	7 403	7 009	13 985	22 058	21 463	30 587
IT wholesale	4 694	5 355	1 411	2 013	343	1 908	2 093	2 587	2 713
Telecommunications	19 053	306 591	131 772	54 715	42 543	58 364	76 886	104 133	78 484
Media and content	7 334	29 121	14 321	21 727	9 054	2 699	10 010	11 127	11 287
Total cross-border ICTs	45 916	444 184	203 726	96 935	68 840	91 452	134 176	179 473	170 210
ICT share of all	14%	34%	30%	20%	17%	17%	17%	17%	10%
Acquirer									
Communications equipment	10 207	36 662	5 143	3 467	1 774	4 833	7 877	26 447	25 200
IT equipment	1 466	7 072	1 345	1 429	644	1 289	2 957	1 613	1 938
Electronics	5 526	20 721	17 473	2 910	4 800	6 911	4 556	8 885	13 523
IT services	4 039	35 745	12 922	11 981	4 353	9 843	10 486	10 040	12 346
IT wholesale	1 754	2 655	633	433	1 215	857	1 099	1 565	861
Telecommunications	16 309	466 134	127 857	37 591	22 217	32 608	64 793	82 251	62 558
Media and content	7 940	34 896	14 570	7 452	4 915	2 438	5 742	4 390	13 709
Total cross-border ICTs	47 241	603 885	179 943	65 264	39 919	58 780	97 509	135 192	130 135
ICT share of all	14%	47%	27%	13%	10%	11%	13%	13%	8%

StatLink http://dx.doi.org/10.1787/477008600273

Source: OECD, based on data provided by Dealogic.

Table 2.A1.22. **ICT sector cross-border M&A deals by target country, 1997-2007**

Number of deals

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Australia	26	60	75	103	73	37	26	29	39	24	32
Austria	9	10	23	44	26	13	16	19	18	11	20
Belgium	8	18	23	44	32	17	16	15	18	17	17
Canada	45	66	119	135	111	113	61	48	64	60	73
Czech Republic	1	7	10	31	12	12	11	11	14	11	11
Denmark	19	21	42	56	32	29	21	42	23	27	29
Finland	12	6	32	43	38	31	19	20	22	14	20
France	55	69	73	134	100	66	62	85	63	55	47
Germany	57	86	99	184	129	123	95	107	112	104	86
Greece	1	0	2	6	5	3	3	5	3	6	3
Hungary	13	0	21	29	14	8	7	10	10	10	9
Iceland	0	0	0	3	2	1	1	2	1		0
Ireland	2	13	22	45	36	36	15	17	19	18	16
Italy	10	25	40	65	23	21	14	16	17	13	21
Japan	9	14	28	39	31	21	28	34	21	29	57
Korea	1	21	25	25	21	13	14	18	18	31	33
Luxembourg	0	4	13	8	4	5	2	2	5	1	6
Mexico	8	13	16	15	7	8	6	6	1	7	1
Netherlands	36	31	55	87	59	36	34	24	55	23	34
New Zealand	5	9	26	31	19	12	10	11	7	6	12
Norway	7	9	29	51	25	21	16	21	22	22	28
Poland	2	1	13	22	16	12	7	7	11	18	6
Portugal	9	3	10	7	6	5	3	5	7	9	9
Slovak Republic	0	0	6	8	1	2	3	1	7	2	5
Spain	16	13	53	78	44	27	19	20	26	25	26
Sweden	17	18	46	86	86	61	35	51	48	50	47
Switzerland	16	17	41	92	51	27	24	26	30	27	36
Turkey	1	5	5	4	2	3	0	0	4	9	6
United Kingdom	94	147	185	329	226	143	120	114	111	148	129
United States	124	171	264	432	315	215	154	209	230	204	230
OECD	**603**	**857**	**1 396**	**2 236**	**1 546**	**1 121**	**842**	**975**	**1 026**	**981**	**1 049**
Emerging economies	29	70	160	281	124	140	120	146	193	222	217
Brazil	12	27	54	60	14	15	8	7	10	21	15
China	6	9	37	91	45	65	57	95	113	127	133
Hong Kong, China	14	17	50	54	29	20	22	24	33	34	38
Indonesia	1	2	2	8	6	4	0	3	9	3	12
India	4	20	47	91	38	39	31	34	53	44	56
Russian Federation	1	5	8	24	14	8	17	5	12	24	12
South Africa	6	9	14	15	13	13	7	5	5	6	1
Chinese Taipei	0	3	17	29	20	6	8	10	14	21	18
World	**707**	**1 073**	**1 834**	**2 874**	**1 900**	**1 433**	**1 109**	**1 288**	**1 473**	**1 473**	**1 546**
Non-OECD	**104**	**216**	**438**	**638**	**354**	**312**	**267**	**313**	**447**	**492**	**497**

StatLink http://dx.doi.org/10.1787/477016572468

Source: OECD, based on data provided by Dealogic.

Table 2.A1.23. **ICT sector cross-border M&A deals by country of acquirer, 1997-2007**

Number of deals

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Australia	9	14	29	44	31	22	23	15	27	13	29
Austria	0	3	3	23	21	15	11	8	8	9	9
Belgium	9	35	34	44	15	8	11	9	7	8	11
Canada	61	102	104	140	107	74	55	85	72	49	61
Czech Republic	0	0	0	0	1	1	1	1	0	1	4
Denmark	6	6	21	50	28	15	7	10	19	11	11
Finland	3	12	22	53	42	37	27	14	13	17	14
France	20	36	56	102	98	77	36	48	80	45	58
Germany	18	29	67	190	90	44	37	53	68	38	50
Greece	0	2	1	9	11	8	6	2	17	1	2
Hungary	0	0	7	2	3	2	0	0	6	2	1
Iceland	0	0	0	2	1	1	2	3	6	1	0
Ireland	3	12	14	28	20	7	2	5	14	15	9
Italy	2	12	10	40	57	21	15	6	14	12	12
Japan	18	17	49	51	29	28	24	34	46	32	26
Korea	3	3	4	1	4	8	7	4	6	9	0
Luxembourg	3	4	8	34	14	4	6	6	14	15	1
Mexico	3	1	1	3	6	7	7	10	6	6	13
Netherlands	21	33	46	73	33	27	21	24	29	25	29
New Zealand	0	0	4	11	3	1	1	3	8	3	6
Norway	8	20	27	60	30	33	12	27	27	24	25
Poland	0	0	3	1	0	0	1	1	4	1	10
Portugal	0	2	4	9	3	1	1	0	3	3	1
Slovak Republic	0	0	0	1	0	1	0	0	0		1
Spain	7	7	25	47	26	13	6	24	13	16	5
Sweden	16	39	72	99	50	32	32	28	61	46	38
Switzerland	6	15	11	38	34	20	17	22	18	13	8
Turkey	0	0	0	1	1	1	3	0	1	1	1
United Kingdom	67	84	136	232	139	105	98	93	113	82	72
United States	249	400	557	660	376	267	211	296	312	266	226
OECD	**532**	**888**	**1 315**	**2 048**	**1 273**	**880**	**680**	**831**	**1 012**	**764**	**733**
Emerging economies	17	22	33	52	37	22	31	32	55	81	60
Brazil	1	0	0	0	3	1	3			2	0
China	2	2	1	5	5	3	7	7	6	13	16
Hong Kong, China	14	9	32	80	43	54	39	34	56	36	33
India	0	0	4	31	18	10	15	15	34	36	30
Indonesia	0	0	2	0	0	0	0	0	0	0	0
Russian Federation	0	1	0	0	1	2	5	7	6	16	7
South Africa	14	19	28	16	10	6	1	3	9	14	7
Chinese Taipei	3	5	11	11	10	10	9	6	12	12	13
World	**607**	**977**	**1 469**	**2 331**	**1 448**	**1 049**	**821**	**980**	**1 259**	**977**	**965**
Non-OECD	**75**	**89**	**154**	**283**	**175**	**169**	**141**	**149**	**247**	**213**	**232**

StatLink http://dx.doi.org/10.1787/477046684235

Source: OECD, based on data provided by Dealogic.

Table 2.A1.24. **ICT sector cross-border M&A deal values by target country, 1997-2007**

USD millions in current prices

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Australia	2 082	589	3 328	1 699	8 725	692	1 019	1 203	706	627	3 266
Austria	771	2 694	36	627	184	231	17	453	704	1 879	162
Belgium	46	31	967	5 972	4 590	591	161	545	381	300	882
Canada	386	1 762	13 096	15 998	5 090	3 729	1 843	1 639	3 116	10 018	5 725
Czech Republic	0	287	214	969	503	140	348	273	6 575	1 998	546
Denmark	263	3 519	1 589	3 864	563	1 411	37	2 465	280	221	918
Finland	0	68	245	519	256	8 534	279	458	949	235	113
France	4 304	2 830	6 002	5 905	4 303	1 736	3 322	5 152	4 285	3 807	4 573
Germany	1 612	3 956	5 071	76 315	22 286	3 998	11 935	4 734	3 471	7 488	5 488
Greece	0	0	1	16	89	315	381	1 364	50	506	4 638
Hungary	0	162	95	3 997	64	920	382	366	609	280	1 169
Iceland	0	0	0	6	7	26	9	24	0	0	0
Ireland	83	168	1 694	3 949	5 811	711	116	486	991	5 215	645
Italy	504	1 972	9 220	6 598	347	144	1 252	654	792	394	6 809
Japan	542	405	4 206	3 972	12 537	388	5 368	6 336	7 260	1 016	5 418
Korea	0	2 294	1 399	2 891	4 920	2 682	637	1 242	1 526	0	545
Luxembourg	0	277	1 013	2 399	1	8 081	109	19	4 844	1 065	3 100
Mexico	867	457	11	4 304	1 192	1 810	37	223	213	68	0
Netherlands	4 000	12 223	4 742	22 095	2 454	6 737	4 512	817	10 238	491	8 018
New Zealand	30	413	956	44	142	1 013	156	62	2	71	81
Norway	279	29	1 305	4 438	501	213	301	61	540	1 997	4 792
Poland	9	1	877	6 275	1 404	288	112	63	3 589	639	1 052
Portugal	455	0	112	33	924	276	769	954	242	1 273	905
Slovak Republic	0	0	41	911	180	8	13	15	318	24	83
Spain	1 246	197	533	12 963	2 780	2 697	2 668	239	12 014	1 303	2 974
Sweden	514	112	2 317	4 228	922	1 753	1 277	1 677	1 578	4 919	1 807
Switzerland	636	2 654	703	6 819	8 583	96	2 719	2 285	6 067	1 105	3 753
Turkey	0	23	0	72	0	1	0	0	8 440	5 718	702
United Kingdom	2 554	4 459	60 170	95 980	11 818	2 927	7 983	7 012	11 141	39 300	11 113
United States	13 983	28 652	104 729	65 086	75 730	13 844	11 516	22 443	15 212	40 090	39 295
OECD	**35 166**	**70 236**	**224 672**	**358 944**	**176 904**	**65 990**	**59 279**	**63 264**	**106 133**	**132 047**	**118 572**
Emerging economies	2 346	22 209	10 873	52 599	7 067	14 012	2 821	9 634	5 917	11 868	23 566
Brazil	884	18 053	2 325	15 581	5 048	2 243	956	782	188	3 874	1 805
China	124	3 019	7 301	34 236	1 636	10 607	1 303	7 199	2 329	3 062	4 890
Hong Kong, China	1 893	1 933	3 492	4 344	4 570	1 443	762	528	2 855	721	533
India	14	221	357	2 169	161	516	244	1 323	2 932	3 709	15 182
Indonesia	13	90	2	200	657	1 179	0	42	1 055	2	402
Russian Federation	0	196	16	296	197	10	111	158	413	1 068	1 689
South Africa	1 324	721	874	317	25	636	207	172	55	155	0
Chinese Taipei	0	67	124	2 015	853	26	120	183	411	1 504	441
World	**45 916**	**102 185**	**255 226**	**444 184**	**203 726**	**96 935**	**68 840**	**91 452**	**134 176**	**179 473**	**170 210**
Non-OECD	**10 750**	**31 949**	**30 553**	**85 240**	**26 822**	**30 946**	**9 561**	**28 189**	**28 043**	**47 426**	**51 638**

StatLink http://dx.doi.org/10.1787/477124034558

Source: OECD, based on data provided by Dealogic.

Table 2.A1.25. **ICT sector cross-border M&A deal values by country of acquirer, 1997-2007**

USD millions in current prices

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Australia	5 899	501	2 585	1 041	12 718	576	1 320	248	689	386	3 005
Austria	0	14	0	227	185	42	72	1	1 970	49	1 214
Belgium	75	308	303	1 663	398	89	2	297	523	36	755
Canada	1 017	13 530	2 674	26 877	3 397	545	1 847	2 933	1 834	1 270	3 636
Czech Republic	0	0	0	0	0	0	0	0	0	0	0
Denmark	416	56	764	2 699	1 454	78	1 196	749	250	160	621
Finland	120	739	2 165	2 686	794	304	112	368	244	766	74
France	1 807	7 813	9 879	85 806	12 006	9 196	9 239	3 336	18 527	19 756	7 539
Germany	1 101	2 938	15 637	21 053	42 585	2 843	1 373	5 005	5 722	2 158	25 358
Greece	0	818	0	144	30	13	278	3	1 247	1	1
Hungary	0	0	43	0	1	0	0	0	0	0	78
Iceland	0	0	0	0	16	20	51	0	24	0	0
Ireland	22	157	189	609	443	70	0	15	67	175	96
Italy	914	6 078	2 482	11 697	3 553	239	690	352	666	700	6 406
Japan	1 869	765	1 387	12 821	10 066	3 028	321	597	2 886	1 105	778
Korea	170	6	0	0	24	50	101	122	0	84	1 339
Luxembourg	145	0	773	6 990	5 281	127	80	309	1 279	3 649	1 019
Mexico	36	2	57	153	771	569	2 739	1 429	1 505	3 941	1 959
Netherlands	887	1 257	4 102	23 744	6 162	2 445	180	496	2 198	2 169	2 107
New Zealand			823	269	215	1	0	0	27	42	623
Norway	161	427	821	3 579	492	1 201	52	976	1 309	3 854	1 411
Poland	0	0	5	0			9	15	5	39	97
Portugal	0	3 163	156	2 452	1 234	854	82	0	4	144	6
Slovak Republic	0	0	0	0	0	0	0	0	0	0	0
Spain	1 773	7 832	2 284	39 370	3 447	1 848	15	6 397	8 207	34 176	499
Sweden	78	1 599	1 072	6 659	691	8 327	456	1 756	3 508	2 870	4 338
Switzerland	9	393	2 364	453	1 150	38	92	387	317	186	5 513
Turkey				0	0	61	0	0	0	5	161
United Kingdom	8 260	6 376	70 567	222 737	39 139	4 040	8 119	7 566	9 397	8 913	17 411
United States	14 801	19 891	35 319	50 297	20 724	14 166	7 272	12 414	14 999	18 774	15 627
OECD	**39 558**	**74 662**	**156 451**	**524 027**	**166 976**	**50 767**	**35 698**	**45 770**	**77 404**	**105 408**	**101 671**
Emerging economies	2 275	1 995	505	2 118	355	119	1 036	893	3 980	9 009	2 958
Brazil	59	0	0	0	1	0	49	0	0	2	0
China	1 186	1 660	0	39	127	22	540	155	2 864	561	1 012
Hong Kong, China	570	3 616	7 363	42 522	1 037	12 427	532	4 723	793	1 542	646
India	0	0	9	430	96	27	73	100	503	1 007	1 139
Indonesia	0	0	80	0	0	0	0	0	0	0	0
Russian Federation	0	0	0	0	1	5	374	615	463	1 181	807
South Africa	1 030	335	496	1 649	130	64	0	24	150	6 258	0
Chinese Taipei	42	85	340	1 344	469	99	290	345	552	284	1 497
World	**47 241**	**81 651**	**183 203**	**603 885**	**179 943**	**65 264**	**39 919**	**58 780**	**97 509**	**135 192**	**130 135**
Non-OECD	**7 683**	**6 988**	**26 752**	**79 858**	**12 967**	**14 496**	**4 220**	**13 010**	**20 105**	**29 784**	**28 464**

StatLink http://dx.doi.org/10.1787/477126364806

Source: OECD, based on data provided by Dealogic.

Table 2.A1.26. **ICT sector cross-border M&A deals by economy: Top 50 targets and acquirers, 1997-2007**

Number of deals

Target	Count	Acquirer	Count
United States	2 548	United States	3 820
United Kingdom	1 746	United Kingdom	1 221
Germany	1 182	Canada	910
Canada	895	Germany	684
France	809	France	656
China	778	Sweden	513
Sweden	545	Hong Kong, China	430
Australia	524	Netherlands	361
Netherlands	474	Japan	354
India	457	Singapore	348
Switzerland	387	Norway	293
Spain	347	Australia	256
Denmark	341	Finland	254
Hong Kong, China	335	Switzerland	202
Japan	311	Italy	201
Israel	288	India	193
Italy	265	Belgium	191
Finland	257	Spain	189
Norway	251	Denmark	184
Brazil	243	Israel	182
Ireland	239	Ireland	129
Belgium	225	South Africa	127
Korea	220	Austria	110
Austria	209	Luxembourg	109
Singapore	195	Chinese Taipei	102
New Zealand	148	Malaysia	94
Chinese Taipei	146	China	67
Czech Republic	131	Bermuda	64
Hungary	131	Mexico	63
Russian Federation	130	Greece	59
Argentina	119	Korea	59
Poland	115	Russian Federation	45
Malaysia	105	New Zealand	40
Thailand	100	Portugal	27
South Africa	94	Hungary	23
Mexico	88	International	23
Portugal	73	Egypt	22
Philippines	59	Poland	21
Romania	59	Iceland	19
Chile	58	United Arab Emirates	17
Colombia	52	Kuwait	14
Indonesia	50	Argentina	13
Luxembourg	50	Brazil	10
Bulgaria	49	Cyprus	10
Estonia	41	Czech Republic	9
Ukraine	40	Estonia	9
Turkey	39	Philippines	9
Greece	37	Thailand	9
Lithuania	33	Turkey	9
United Arab Emirates	33	Jamaica	8

StatLink http://dx.doi.org/10.1787/477184144488

Source: OECD, based on data provided by Dealogic.

Table 2.A1.27. **ICT sector cross-border M&A deals by economy: Largest acquirers and targets, 1997-2007**

Number of deals

Country	Target of M&A deals	Acquirer in M&A deals	Net
Largest net acquirers:			
United States	2 548	3 820	1 272
Singapore	195	348	153
Hong Kong, China	335	430	95
Luxembourg	50	109	59
Japan	311	354	43
Norway	251	293	42
Bermuda	26	64	38
South Africa	94	127	33
Greece	37	59	22
Canada	895	910	15
Kuwait	2	14	12
Iceland	10	19	9
Egypt	16	22	6
Bahrain	2	4	2
Jamaica	7	8	1
Qatar	3	4	1
Largest net targets:			
Poland	115	21	–94
Austria	209	110	–99
Argentina	119	13	–106
Israel	288	182	–106
Hungary	131	23	–108
New Zealand	148	40	–108
Ireland	239	129	–110
Netherlands	474	361	–113
Czech Republic	131	9	–122
France	809	656	–153
Denmark	341	184	–157
Spain	347	189	–158
South Korea	220	59	–161
Switzerland	387	202	–185
Brazil	243	10	–233
India	457	193	–264
Australia	524	256	–268
Germany	1 182	684	–498
United Kingdom	1 746	1 221	–525
China	778	67	–711

StatLink http://dx.doi.org/10.1787/477205848458

Source: OECD, based on data provided by Dealogic.

Table 2.A1.28. **ICT sector foreign affiliates operating in the United States, 2005**

(USD millions and percentage shares)

	Employees ('000)	Compensation to employees	Total assets	Sales	Value added	Exports of affiliates	Imports by affiliates	R&D by affiliates
All industries	**5 086**	**355 870**	**5 883 782**	**2 495 380**	**539 869**	**169 238**	**452 968**	**31 694**
Manufacturing	***1 987***	***151 447***	***1 095 936***	***1 001 845***	***242 355***	***97 333***	***160 323***	***21 818***
Computers and electronic products	143	10 514	55 176	57 621	14 234	. .	14 405	2 878
Computers and peripheral equipment	14	1 227	4 225	9 452	1 569	1 842	3 898	160
Communications equipment	14	1 280	5 952	6 958	1 078	981	754	582
Audio and video equipment	. .	. .	. .	. .	. .	. .	. .	
Semiconductors and other electronics	36	2 754	17 815	19 207	4 654	5 119	5 241	583
Magnetic and optical media	. .	. .	. .	. .	. .	. .	. .	
ICT share of manufacturing	2.80%	3.00%	0.90%	2.30%	2.60%	. .	3.20%	9.10%
ICT services	***93***	***8 034***	***75 861***	***33 245***	***11 577***	***3***	***5***	***165***
Telecommunications	37	2 635	66 254	20 799	5 106	. .	. .	. .
Information services and data processing	. .	. .	. .	. .	. .	. .	. .	. .
Computer systems design services	55	5 399	9 607	12 446	6 471	3	5	165
Total ICT sector	236	18 548	131 037	90 866	25 811	3	14 410	3 043
ICT share of total	4.60%	5.20%	2.20%	3.60%	4.80%	. .	3.20%	9.60%

StatLink http://dx.doi.org/10.1787/477206011511

Note: ICT sector based on 4 digit NAICS. ICT goods includes imports for domestic consumption and domestic exports. ICT services include affiliated and total cross-border trade in computer and information services.

Source: US Department of Commerce, 2007.

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Table 2.A1.29. **US foreign affiliates operating overseas, 2004**

USD millions and thousands of employees

	All Industries		Computer and electronic products		Electrical equipment appliances and components		Information	
	Employees	Gross product	Employees	Gross product	Employees	Gross product	Employees	Gross product
Australia	271.9	29 853	3.3	205	5	273	14.5	1 199
Austria	33.3	4 576	2.6	448	0.5	66	1.9	510
Belgium	120	18 343	1.1	96	3.8	316	5.1	357
Canada	1 065.1	94 205	38.5	2 701	11.4	730	26	1 921
Czech Republic	60.3	2 974	8.3	152	22.8	60	0.7	142
Denmark	38.3	5 475	1.3	79	0.3	33	0.9	108
Finland	19.6	2 899	3.5	171	0.2	15	75	
France	562.8	47 717	24.8	1 783	10	840	12.6	1 450
Germany	601.7	74 184	29.9	2 680	32	2 835	13	1 507
Greece	15.8	2 778	0.1	11	0	0	1.1	44
Hungary	51.3	2 337	4.7	64	12.8	231	2.4	204
Iceland	. .		. .		. .		. .	
Ireland	82.8	27 022	19.9	5 083	1.3	122	4.7	2 613
Italy	238.5	29 292	9.6	1 005	10	799	10.4	713
Japan	227.6	46 491	18.5	2 276	2.2	454	13.2	2 292
Korea	79.9	6 902	14.8	1 059	0.8	89	1.7	250
Luxembourg	9.8	–636	0	0	0	0	0.5	169
Mexico	785.2	22 383	81.4	1 089	33.9	574	13.6	853
Netherlands	175.1	28 220	5.3	547	1.8	–335	11.3	1 860
New Zealand	46.4	3 065	0.6	34	0.2	13	3.6	216
Norway	33.4	14 329	0.7	102	0.2	1	5.3	521
Poland	90.7	4 604	2.5	77	. .	. .	2.8	361
Portugal	31.3	5 179	2.2	160	0.1	4	1.1	107
Slovak Republic	. .		. .		. .		. .	
Spain	197.2	14 821	6.9	409	8.9	415	5.7	454
Sweden	101.2	11 028	4.5	326	0.7	106	5	1 897
Switzerland	67.3	17 636	2.9	419	2.7	276	1.8	1 007
Turkey	25.6	3 698	. .	. .	. .	125	0.2	61
United Kingdom	1 166.3	132 527	31.1	2 437	13.3	830	82.3	10 600
United States	. .	. .	. .	. .	. .	. .	. .	. .
Other countries	**2 418.8**	**182 434**	**325.8**	**15 705**	**72**	**1 646**		
Total	**8 617.2**	**834 336**	**644.8**	**39 118**	**247**	**10 518**	**318.3**	**36 514**

StatLink http://dx.doi.org/10.1787/477231551373

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

Source: US Department of Commerce, 2006.

Table 2.A1.30. **Country origin of foreign-owned enterprises in Sweden's ICT sector, 2006**

Numbers and percentage shares

	ICT		All industries		ICT share	
	Enterprises	Employment	Enterprises	Employment	Enterprises	Employment
United States	244	18 850	1 260	109 620	19.4	17.2
Norway	142	6 251	1 472	42 093	9.6	14.9
United Kingdom	139	7 051	1 218	67 138	11.4	10.5
Netherlands	89	2 202	1 166	51 308	7.6	4.3
Denmark	74	1 304	1 186	36 038	6.2	3.6
Germany	63	1 473	873	50 189	7.2	2.9
Finland	62	5 440	721	56 577	8.6	9.6
Luxembourg	54	1 356	..	..	..	..
France	51	4 957	357	42 343	14.3	11.7
Japan	26	1 434	124	6 461	21	22.2
Top 10	944	50 318	8 377	461 767	11.3	10.9
Other countries	*200*	*6 647*	*2 730*	*110 984*	*7.3*	*6*
Total	1 144	57 065	11 107	572 751	10.3	10

StatLink http://dx.doi.org/10.1787/477256650118

Source: ITPS 2007.

Table 2.A1.31. Swedish-owned ICT sector enterprises operating overseas, 2004

Numbers and percentage shares

	Enterprises	Employees	Industry share	Location shares
Total				
ICT equipment manufacturing	11	58 401	4	
Office machinery	4	3 471	0.2	
Communication equipment	7	54 930	3.8	
ICT services	69	104 907	7.3	
Communications and post	5	74 761	5.2	
Computer and related services	64	30 146	2.1	
Total ICT	80	163 308	11.3	
All industries	856	1 446 294	100	
Abroad				
ICT equipment manufacturing		33 970	3.6	58.2
Office machinery		1 993	0.2	57.4
Communication equipment		31 977	3.4	58.2
ICT services		30 696	3.2	29.3
Communications and post		17 725	1.9	23.7
Computer and related services		12 971	1.4	43
Total ICT		64 666	6.8	39.6
All industries		953 635	100	65.9
Sweden				
ICT equipment manufacturing		24 431	5	41.8
Office machinery		1 478	0.3	42.6
Communication equipment		22 953	4.7	41.8
ICT services		74 211	15.1	70.7
Communications and post		57 036	11.6	76.3
Computer and related services		17 175	3.5	57
Total ICT		98 642	20	60.4
All industries		492 659	100	34.1

StatLink http://dx.doi.org/10.1787/477281647334

Source: ITPS 2007.

ISBN 978-92-64-05553-7
OECD Information Technology Outlook 2008

Chapter 3

ICT Research and Development and Innovation

The ICT sector is in the lead for R&D expenditures, employment, and patents. The software and semiconductor segments are particularly R&D-intensive. The share of ICT R&D conducted in non-ICT industries is also high (about one-quarter of total ICT R&D) and in some non-ICT sectors, ICT R&D spending (especially software-related) makes up a large share of total R&D budgets. The United States and Japan still have a large lead in terms of ICT R&D expenditures by businesses, but countries such as Korea and some non-OECD economies are catching up. The organisation of ICT R&D is continuing to develop and change around new kinds of business collaboration and internationalisation.

Introduction

The information and communication technology (ICT) sector undertakes large investments in research and development (R&D) and is very innovative. In terms of R&D expenditures, patents and venture capital investments, it exceeds other industries by a large margin. ICT R&D also spills over to many other products and industries. ICT research is increasingly undertaken in other industries and the outputs used to meet challenges in areas such as the environment and health. Overall it is an important driver of innovation and growth and for increasing the competitiveness of OECD economies.

This chapter analyses recent developments in ICT R&D and innovation in five areas. It first addresses ICT-related R&D research challenges and priorities. Second, it looks at the patterns of ICT-related business R&D expenditures and employment in OECD countries (at both the aggregate and firm level). Next it considers the organisation of ICT-related business R&D before turning to the increasingly crucial nature of ICT-related R&D for innovation in non-ICT products and sectors. Finally, recent developments in ICT-related patents are analysed.

While ICTs are increasingly essential as a tool in most research fields (*e.g.* cloud computing in genomic research or virtual simulations to conceptualise and test products before they are built), this issue is not covered here.

ICT R&D challenges and priorities

The importance of ICT R&D to the wave of innovation which has shaped the last 50 years is widely acknowledged by firms and governments.[1] While ICT-related research challenges and priorities are evolving, it is possible to identify eight broad priorities (Figure 3.1 and Box 3.1).[2]

Some of these have been on ICT R&D agendas for some time, especially those clustered around the physical foundations of computing and computing systems and software engineering. Quantum and optical computing, robotics and artificial intelligence also remain important for addressing long-term challenges. In practice, research and innovation in a given area lead to the emergence of new topics: for example, the rapidity with which complementary metal-oxide semiconductor technology (CMOS) is being miniaturised has made nanotechnology research part of core ICT R&D; and increasing demand for high-speed broadband is driving research into all-optical networks and optical computing. The growing ubiquity of ICTs gives areas such as artificial intelligence and virtual reality renewed impetus for research on natural language processing and the integration of natural and virtual environments.

Scientific and technological progress is also leading to new ICT R&D clusters. Progress in biotechnology, nanotechnology, cognitive sciences and interdisciplinary research fosters synergy and convergence and opens up new research areas (see Chapter 7 in OECD, 2006a, 2004; and van Lieshout *et al.*, 2005). These trends are having a major impact on ICT research, as hardware, software and ICT systems and networks increasingly imitate

Figure 3.1. **ICT R&D priorities**
(clusters of topics and subtopics)

Physical foundations of computing	• Miniaturisation of CMOS (complementary metal-oxide semiconductor) technology, use of nanotechnology • "Beyond CMOS": Optical and quantum computing, spintronics • Flexible electronics for increased applicability of computing devices
Computing systems and architectures	• High-end computing and storage (upscaling) • Embedded systems, Systems-on-a-chip, Systems-in-package (downscaling) • Robotics, autonomous computing systems
Converging technologies and scientific disciplines	• Converging research agendas of ICT, nano-, biotechnologies and other scientific disciplines • ICTs imitating natural information processing • ICTs enabling scientific research
Network infrastructures	• Wired and wireless broadband technologies • Next-generation networks, mobile ad-hoc networks • RFID (radio frequency identification) in sensor-based networks, Internet of Things • Network reliability, quality of service
Software engineering and data management	• Software development paradigms, artificial intelligence • Use of ICTs to increase productivity of software engineering • Management of large and heterogenous data sources • Natural language processing
Digital content technologies	• Data mining in complex sources, multimedia content extraction, semantic web • Content digitisation, digital preservation and access • Participative web and networked collaboration • Customised and context-oriented information
Human-technology interfaces	• Productivity gains through improved user interfaces • ICT accessibility and usability • Interaction with all human senses • Augmented, immersive, and virtual realities
ICT and Internet security and safety	• Security of computing systems, networks, applications, and services • Security of critical information systems • Data integrity, confidentiality and issues of privacy • Internet crime, cyberterror

natural processes in order to raise efficiencies. Merging ICT research with other scientific disciplines and applications opens up new possibilities, such as ICT-enabled biomarkers and biosensors to improve medical diagnostics, brain-computer interfaces to operate computers and other applications via brain activity, bio-computing using living tissue for information processing, quantum cryptography for Internet security and reverse engineering the brain through cognitive computing.

Research and innovation also underpin the growing importance of digital content technologies beyond end-user demand for multimedia entertainment. The development, distribution and use of digitised information (*e.g.* geospatial information, digital libraries, medical image processing, pattern recognition, networked collaboration) have become an essential part of science, communications, business, education, health and almost all areas of production and consumption.

Furthermore, ICT research and innovation help to address pressing socio-economic challenges. OECD governments, businesses and research institutions increasingly structure ICT R&D projects and funding around the following themes: health care, independent living and social inclusion, the environment, emergency and disaster management, transport/mobility, and defence (Figure 3.2). Existing technologies are being

Box 3.1. **Examples of ICT R&D priorities**

Physical foundations of computing: Research into physical foundations helps to achieve better performance and to improve the cost and energy efficiency of computing devices. Miniaturisation and nanotechnology applications are increasing the density and number of transistors on integrated circuits (Moore's law), thereby increasing their performance and storage capacity. Efforts are being made to identify more efficient ways to process information than electron-based semiconductor technology, *e.g.* spintronics ("spin transport electronics", which exploits the spin of electrons and the associated magnetic moment) and optical and quantum computing. Research into organic materials for computing will enable low-cost mass production of integrated circuits and can increase possibilities for ICT applications by creating non-rigid semiconductors and displays, *e.g.* for wearable computing.

Computing systems and architectures: Research in this area aims at improving computing through better integration of single components (processor, memory, connectors, etc.). Like performance, cost and energy efficiency are important objectives. Systems that can effectively (and autonomously) scale up or down computing resources in response to sudden changes in requirements are part of this agenda. Embedded systems increase flexibility and applicability by incorporating the hardware and software necessary to fulfil a given function on a single chip and help to save power. Research into robotics and other systems with autonomous decision-making capabilities further increase the adaptability of computing systems.

Converging technologies and scientific disciplines: Research objectives in nanotechnology, biotechnology and information technologies (but also cognitive and social sciences) are increasingly linked to form clusters around specific challenges. This is improving the innovation potential of ICTs, *e.g.* by using nanotechnology to achieve further miniaturisation, and is increasing application opportunities, *e.g.* ICTs in health care. Trends include imitating natural information processing, *e.g.* cognitive networks and genetic programming, and facilitating scientific research and convergence, *e.g.* genome sequencing and medical image processing, through robot experiments and computer-aided simulation. The merging of various disciplines and ICTs is evolving, *e.g.* tissue computing, cognitive computing and mining of online social networking activities by social scientists.

Network infrastructures: Here the aim is to meet challenges to network infrastructures resulting from patterns of Internet use by consumers and businesses. High-speed, reliable, flexible and cost-efficient networks are needed to support the rise in data traffic and the number of connected people and objects. Research on wired and wireless broadband technologies focuses on high-bandwidth data delivery, *e.g.* high definition video. Next-generation networks will improve flexibility by detaching physical infrastructures from digital content transport. Flexibility will be taken further by mobile *ad-hoc* networks, personal area networks, and sensor-based inter-objet communication, *i.e.* the "Internet of Things". Increased dependence on the Internet and other network infrastructures facilitates research into issues of reliability and quality of service.

Software engineering and data management: Software engineering is undergoing significant changes triggered by trends in ubiquitous computing. The challenge is to exploit effectively advances in hardware (*e.g.* through operating systems, compilers) and to develop software engineering environments that result in more reliable software for systems, devices and networks. Research into new programming paradigms is needed to solve complex computing problems. Inspiration for artificial intelligence is drawn from natural information processing, *e.g.* neural networks. Database management systems are adapting to trends in distributed computing and storage. Advances in these fields improve the efficiency of software engineering, *e.g.* through automated quality assurance (bug tracking and testing), collaborative programming environments, and open-source development. Research into natural language processing (*e.g.* for automated speech translation) addresses challenges in terms of efficient information processing and data storage.

Box 3.1. **Examples of ICT R&D priorities** (*cont.*)

Digital content technologies: Researchers try to facilitate the discovery of patterns in exponentially growing sources and formats of digital information. New types of digital content are increasingly difficult to interpret in automated ways, (*e.g.* three-dimensional images from medical applications in virology, neurology), a problem that is exacerbated by the fact that both the content and form of information sources often change rapidly. Research is enhancing existing data mining technologies through automated multimedia content extraction and semantic web technologies. Improved content production technologies (*e.g.* three-dimensional capturing) and approaches (*e.g.* networked collaboration) facilitate digital knowledge creation. Research into effective and interoperable compression and conversion technologies are improving access to digital content and are important for efficient distribution over the Internet.

Human-technology interfaces: Interfaces for interaction between human users and computing hardware and software have not markedly changed in the last decade, but research is diminishing the role of "traditional" access barriers, most notably specialised ICT skills. Simplification of user interfaces, research into patterns of ICT usage and intuitive ways to create and access digital information aim at improving productivity and the accessibility of hardware and software with special focus on disadvantaged user groups. Information representation is an important aspect, including research into three-dimensional and holographic displays, tangible digital information and augmented and immersive virtual realities (*e.g.* for simulation purposes).

ICT and Internet security and safety: Research is being conducted to match increased use and application of ICTs with adequate levels of security for computing systems, networks, applications and users and their data. To match these requirements, R&D efforts aim at integrating security concerns early into the design of ICTs as well as at weaving ICT security into overall organisational security, especially for critical information infrastructures. Significant impetus for improving the integrity and confidentiality of digital information as well as the privacy of individual users comes from natural processes (*e.g.* quantum cryptography, self-healing computing systems, and intrusion detection inspired by immunology). Technological solutions to prevent and tackle criminal activity such as online fraud and identity theft and terrorist activities are being sought, including digital investigation and retaliation.

Note: These clusters have been compiled after analysing and combining OECD national ICT R&D policy projects, R&D projects of the top 250 firms, and the ICT research literature.

applied in these areas; sensor-based networks, for example, facilitate remote patient monitoring and monitoring of traffic, pollution and geological phenomena.

Other factors in the emergence of new topics and ICT research agendas include usage considerations, changing government priorities and changing public perceptions. There is a long history of research into human-technology interfaces, but the rapid proliferation of ICTs and demands for universal accessibility and usability have renewed this as a research priority. ICT and Internet security and safety are not new research areas but now receive greater attention.[3] ICT research also increasingly includes foreseeing societal, organisational and legal implications and fostering social acceptance of ICT research outputs (MIC, 2007; PCAST, 2007).

The following sections quantify business ICT R&D efforts in the pursuit of these ICT research priorities and show how these efforts are being organised.

Figure 3.2. **Socio-economic applications of ICT research**

Healthcare
- Healthcare management, patient files, health databases, clinical information systems
- Telemedicine, remote health monitoring, drug delivery using RFID and biosensors
- Detection of adverse health events, early warning systems
- Remote surgery using haptic interfaces, virtualisation, and advanced network technologies
- Data mining in medical images
- Bioinformatics and biomedical computing
- Collaborative networking and grid computing in medical research, simulated surgeries

Emergency and disaster management
- Remote, sensor-based detection systems connected to geo-spatial information systems
- Mobile *ad-hoc* networks for immediate disaster relief
- Interoperability of observation and monitoring systems
- Holistic warning systems integrating disaster-specific solutions

Independent living and social inclusion
- Accessibility of ICT solutions for the young, the elderly, impaired users
- Improved usability through advanced software and hardware interfaces, *e.g.* natural language control, brain-computer interfaces
- Mobile monitoring, dectection of adverse health events through sensor-based and wearable computing
- Smart home technologies to assist elderly and chronically ill patients
- Adapted online services to assist administrative tasks

Transport and mobility
- Traffic monitoring and control systems
- Personalised traffic information
- Driver assistance systems using sensors, embedded systems and augmented reality technologies
- Software optimisation for freight route planning
- Sensor and satellite-based navigation and positioning systems
- Adaptative safety systems using RFID
- Teleworking solutions

Environmental challenges
- Energy-efficient ICTs for data centres and Internet infrastructures
- ICTs for energy-intensive industries
- Digitalisation and digital delivery of goods and services
- Pollution monitoring using adaptive sensor networks
- Improved product design for recyclability
- Tracking waste streams using sensors
- Environmental information systems for decision-makers, businesses, citizens

Defence
- Command-and-control systems
- Real-time language translation
- Surveillance robots, *e.g.* unmanned armoured vehicles (UAVs)
- Augmented reality systems to assist decision-making in theatres
- Sensor-based threat detection, *e.g.* biochemical substances
- Electronic warfare, *e.g.* ragio frequency jamming
- Combat simulations using immersive virtual reality technologies
- Mobile *ad-hoc* networks in theatres

ICT sector R&D expenditures and employment

R&D expenditures in the ICT sector continue to increase and business expenditures are higher than a decade ago in absolute terms and as a share of GDP.[4] ICT services and software development in particular have seen significant increases, compensating for expenditure declines in ICT manufacturing. Firm-level analysis shows that the ICT sector is one of the most R&D-intensive, with R&D expenditures of the top ICT firms rising consistently and holding up well during downturns. Most expenditures are for electronics (33%) and IT equipment (19%), but semiconductor firms are the most R&D-intensive and software firms have the most growth in R&D expenditure. The bulk of R&D activities are in the United States, the European Union (EU) and Japan, but Korea's ICT R&D expenditures and personnel have grown strongly. Moreover, while they are often still at comparatively low absolute levels of R&D expenditures, non-OECD economies are increasingly important.

OECD aggregate R&D expenditures

Total OECD public and private R&D investment in 2006 climbed to USD 818 billion, up from USD 468 billion in 1996 (OECD, 2008a).[5] In 2006, the non-OECD economies for which data are available accounted for 18.3% of total R&D expenditure (current USD PPP), up from 14.6% in 2001.[6] In nominal terms, business enterprise expenditure on R&D (BERD) reached USD 563 billion for the OECD area in 2006 and accounts for about 70% of total OECD R&D.[7] From 1996 to 2006 BERD in the OECD area increased by 4% annually (in constant USD, Figure 3.3); the pace of growth slowed in 2001 and 2002 and then picked up again between 2001 and 2006 to 2.4% annual compound growth. In the United States – with USD 242 billion, the biggest spender accounting for almost half of the OECD total – BERD

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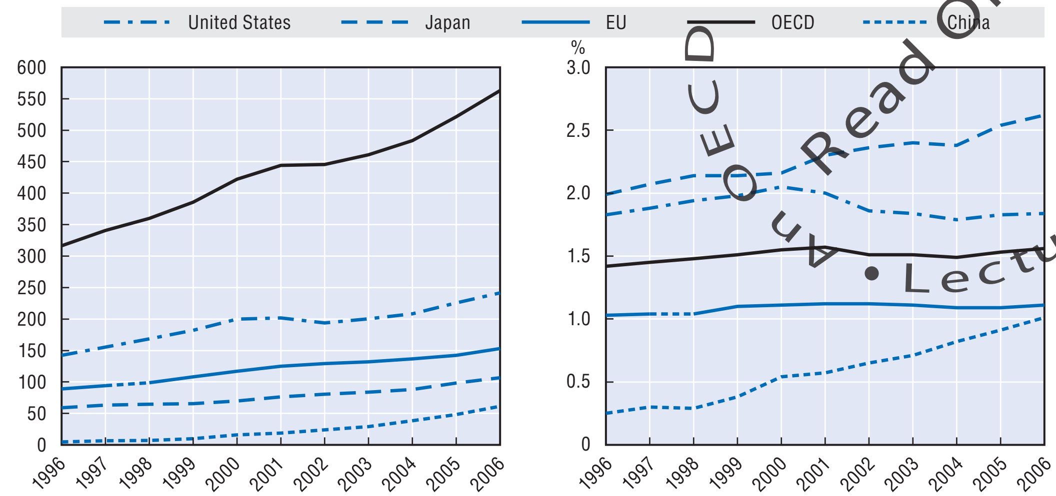
Figure 3.3. **Business R&D spending, 1996-2006**

Billions of USD (constant 2000 PPP USD)

As a % of GDP



StatLink http://dx.doi.org/10.1787/473875308073

Source: Main Science and Technology Indicators (MSTI 2008/1), August 2008. New PPPs used for China, Japan and the United States.

increased by 1% annually between 2001 and 2006, in the European Union (EU27) by 2%, in Japan by 4.4% and in China by 23% (in constant USD). China's catch-up in absolute terms to USD 62 billion BERD (current USD) and as percentage of GDP (about 1%) has been remarkable.

While manufacturing continues to account for the bulk of business R&D, investment in services R&D is increasing and made up 25% of OECD business R&D in 2004.[8]

Most company R&D is for product and process development. Companies spend less on applied research and even less on basic research, and the shares seem to be declining. In the United States, for example, corporate basic and applied R&D as share of total business R&D stood at about 23% (4% basic and 20% applied) in 2005 as opposed to more than 30% (7% basic and 23% applied) in 1975 (National Science Board, 2008). Anecdotal evidence indicates that firms have reduced their share of basic research in total R&D in response to competition and shorter product cycles (OECD, 2008b).

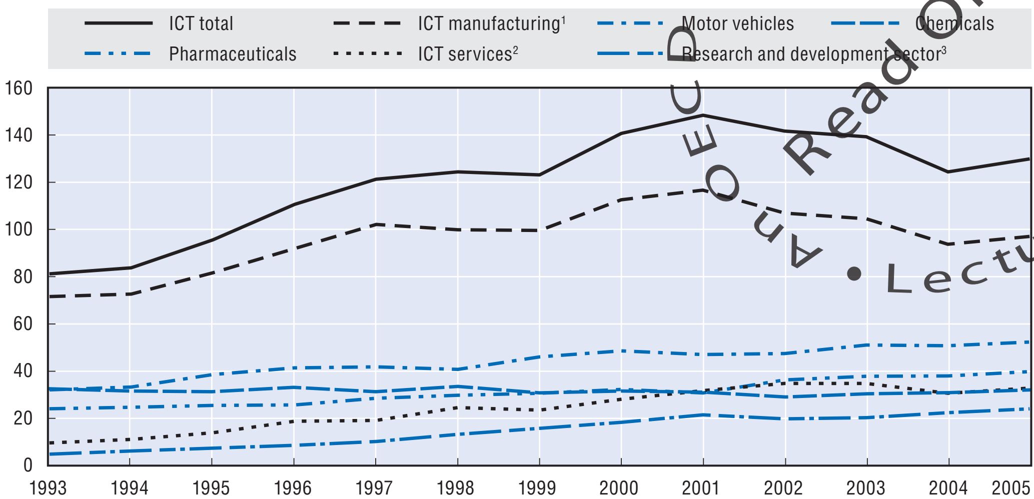
ICT-related business R&D expenditures

The ICT sector leads other sectors in R&D expenditures, number of patents and venture capital investments. It is the most important of the five sectors that dominate business sector R&D (Figure 3.4). In 2004, for example, ICT manufacturing accounted for more than a quarter of total manufacturing business R&D expenditure in most OECD countries. It accounted for more than half in Finland, and Korea (63% and 57%, respectively), and more than 30% in the United States (39%), Australia (32% in 2002-03), Canada (39% in 2005), Japan (36% in 2005) and Ireland (34%).[9]

In 2005 the OECD21[10] ICT goods and services sector spent about two and a half times as much on R&D (USD 130 billion) as the automotive sector (USD 52 billion) and more than triple the pharmaceutical sector (USD 40 billion). R&D in the ICT goods sector increased strongly until 2001, but then fell in constant terms, mirroring the more general evolution of the ICT

Figure 3.4. **Growth of the largest R&D-spending sectors in the OECD area, 1993-2005**

Billions of constant PPP dollars at 2000 prices



StatLink http://dx.doi.org/10.1787/473884588556

1. Office, accounting and computing machinery (ISIC 30); Radio, TV and communication equipment (ISIC 32); Medical, precision and optical instruments (ISIC 33).
2. Telecommunications (ISIC 642) and in some cases ISIC 64; Computer and related services (ISIC 72).
3. Research and development (ISIC 73): Research and experimental development on natural sciences and engineering and on social sciences and humanities.

Note: Includes Austria, Australia, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, Portugal, Spain, the United Kingdom and the United States.

Source: OECD estimates based on *ANBERD* and *RDS databases*, June 2008.

sector and overall business R&D. However, as of 2004 business ICT manufacturing R&D picked up, but has still not reached the levels of 2001.

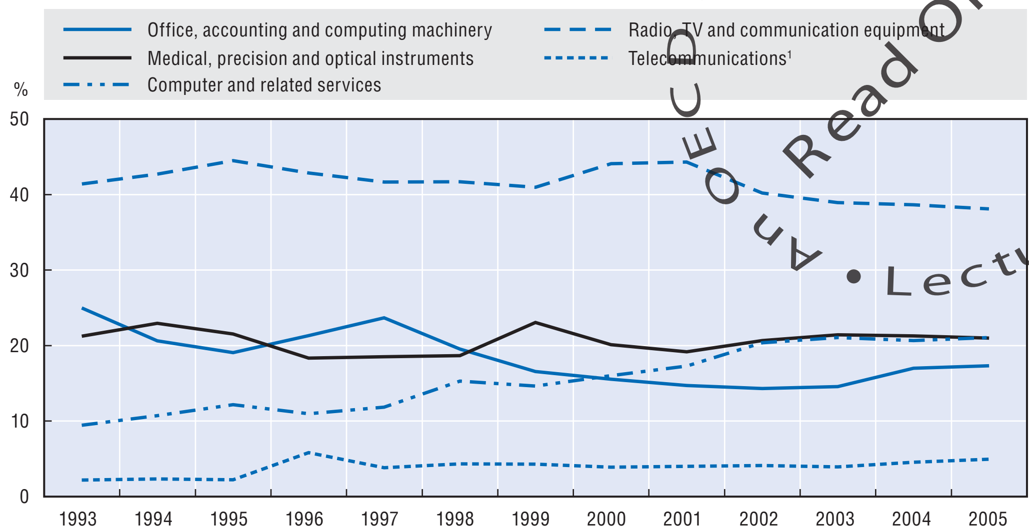
The decline in the ICT goods sector since 2001 (constant terms) has been partly compensated by an increase in ICT services, which has grown very rapidly since the 1990s. It surpassed the chemical sector in 2001 and almost reached the level of expenditure in the pharmaceutical sector; following a drop between 2002 and 2004, ICT services R&D has grown again.[11] According to preliminary official data it grew faster in 2006 and 2007 so that goods and services combined were at levels similar to 2001 (constant terms). In the United States, ICT services R&D expenditures are now close to USD 30 billion, or 14% of total US business R&D, as compared to computer and electronic products at USD 42.5 billion (21%) or chemicals at USD 43 billion (21%) (National Science Board, 2008; Jankowski, 2001).

Together, radio, television and communication equipment (including electronic components and semiconductors) and office, accounting and computing machinery (38 and 17%, respectively, in 2005) account for over half of total ICT R&D, a share that rises and falls with the output cycle of the semiconductor industry (Figure 3.5). There has been a very significant increase in the share of services in Computer and related activities (largely software and IT services) (21% in 2005, up from 9% in 1993).

In ICT manufacturing, Finland, Korea, Japan, Sweden and the United States have higher than average shares of R&D expenditure in GDP. Finland and Korea have increased their shares since 1997 and estimates for 2006 show a further pick-up for Korea. As a share of GDP, Denmark, Finland, Ireland and Sweden have the greatest specialisation in ICT services R&D (Figure 3.6). Estimates for 2006 show pronounced upturns for Korea and

Figure 3.5. **ICT sub-sector R&D expenditures as a share of total OECD area ICT R&D, 1993-2005**

As a percentage of total OECD ICT R&D



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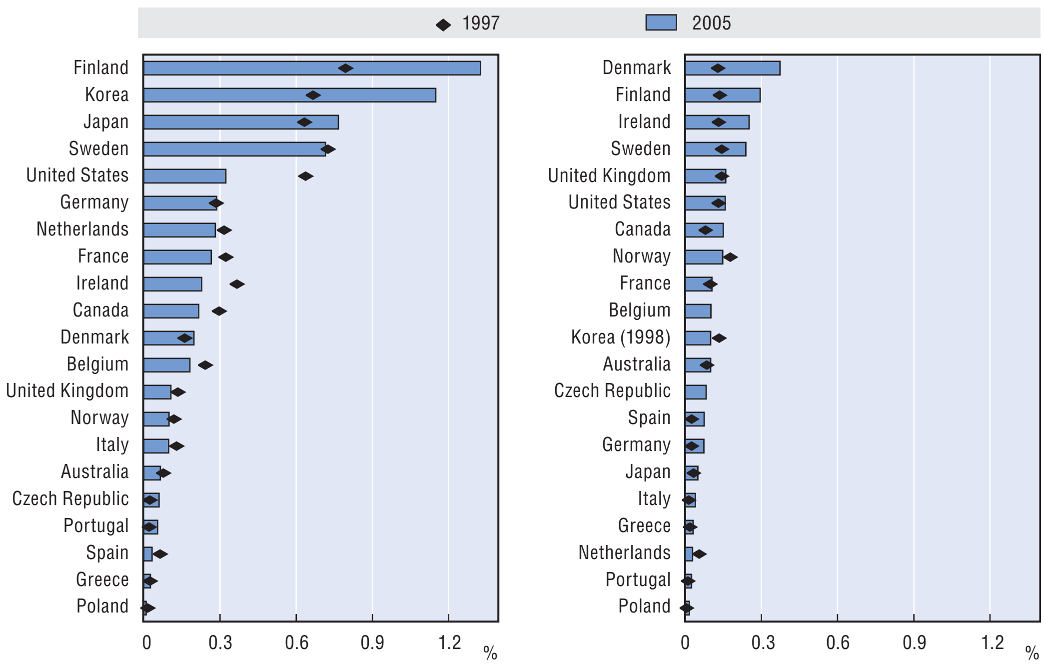
1. Telecommunications (ISIC 642, and in some cases ISIC 64). Data for Japan and Germany are not available.
Note: Includes Austria, Australia, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, Portugal, Spain, the United Kingdom and the United States.
Source: OECD estimates based on *ANBERD* and *RDS databases*, June 2008.

Figure 3.6. **Business R&D expenditure for ICT goods and services, as a share of GDP, 1997 and 2005**

Business R&D expenditure by selected ICT manufacturing industries, 1997 and 2005
As a percentage of GDP

Business R&D expenditure by selected ICT services industries, 1997 and 2005
As a percentage of GDP



StatLink http://dx.doi.org/10.1787/474078101812

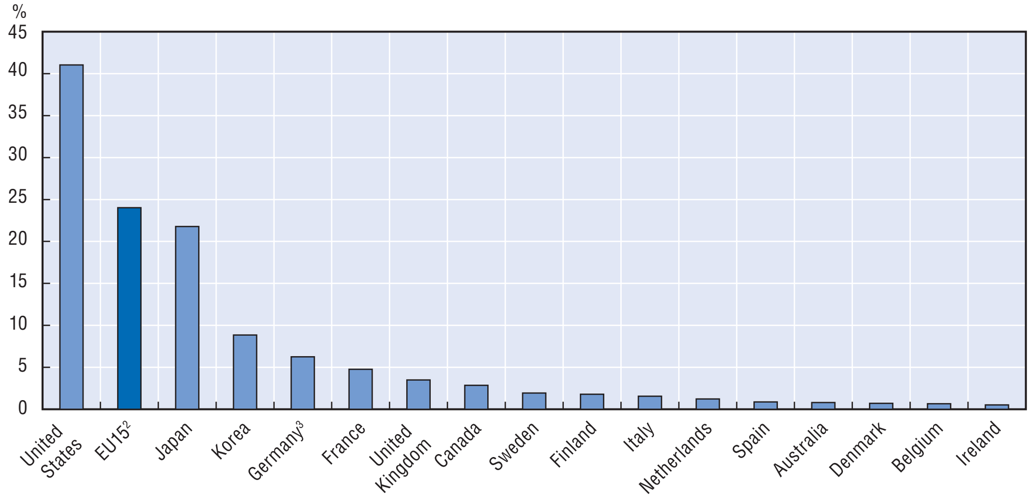
Note: When data for class 642 (Telecommunications) are unavailable, division 64 (Post and telecommunications) is used. Class 642 has the major share of division 64 R&D expenditure; for example in the United States, class 642 accounts for 97-98% of the R&D in division 64.
Source: OECD estimates based on *ANBERD* and *RDS databases*, June 2008. See also OECD (2007a).

Norway. In 2006, increases in the Czech Republic's shares of ICT R&D expenditure in GDP for both ICT goods and services are significant, although from low levels.

The United States still accounts for 40% of all OECD R&D expenditures in ICT manufacturing and services (Figure 3.7).[12] The EU15 accounts for a little under a quarter of the total, Japan for 22% and Korea for 9%, with the larger OECD members making up the bulk of the remainder. By 2005, Korea's ICT R&D expenditures exceeded those of Europe's leading R&D spender, Germany, and Australia and Canada have both seen a decrease in their shares over the last years.[13] Despite the decline in R&D expenditure for computers and office machinery in the United States, computer and electronic products manufacturing still accounts for the largest share of total US business R&D (about 19% according to National Science Board, 2008).

Figure 3.7. **Share of selected OECD countries in total OECD area ICT sector R&D expenditures,[1] 2005**

Percentage of total OECD ICT R&D



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1. Office, accounting and computing machinery (ISIC 30); Radio, TV and communication equipment (ISIC 32); Medical, precision and optical instruments (ISIC 33); Telecommunications (ISIC 642); Computer and related services (ISIC 72).
2. Excluding Austria and Luxembourg. German R&D expenditures in telecommunications (ISIC 642) are not available.
3. Excluding telecommunication services (ISIC 642).

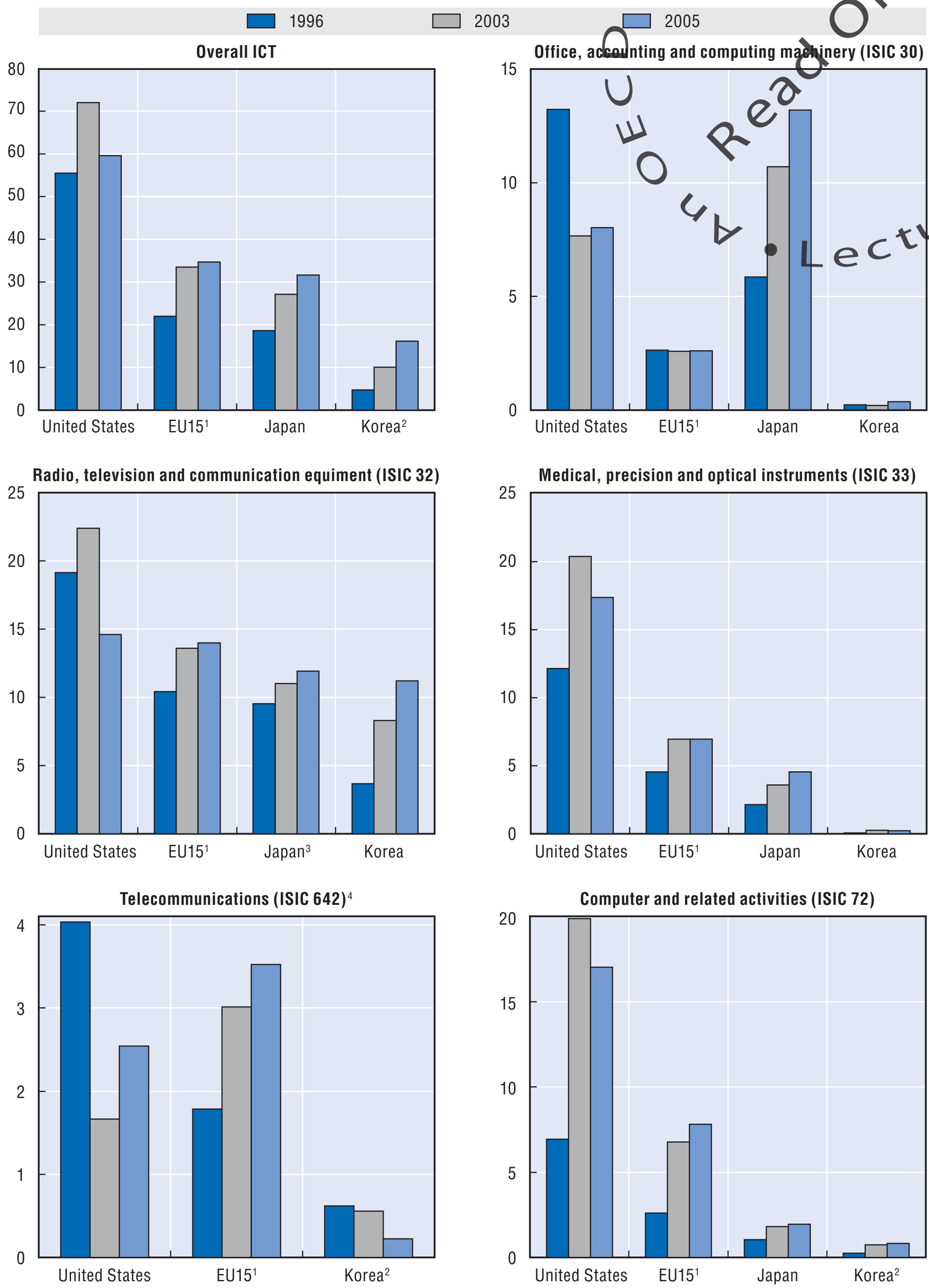
Source: OECD estimates based on *ANBERD* and *RDS databases*, June 2008.

Figure 3.8 shows R&D expenditures of the main geographic areas in each of the ICT component sectors.[14] The United States continues to lead in Radio, television and communication equipment (ISIC 32), Medical and precision instruments (ISIC 33), and Computer and related activities (ICT services, ISIC 72). After a rapid increase in absolute spending in Japan and a strong decline in the United States, Japan has taken the lead in Office, accounting and computing machinery (ISIC 30). Telecommunications (ISIC 64) is the only segment in which the EU15 spends more than the United States, but the expenditures are relatively low, at around USD 3.5 billion.

R&D in computer services (ISIC 72) increased most sharply in the United States, tripling between 1996 and 2003. In Europe it doubled but was still only a third of that of the United States, while levels remain low in Japan and Korea. The lower overall R&D intensity of European firms may be due to their specialisation in less R&D-intensive sectors such as telecommunications while the United States specialises in more R&D-intensive sectors such as software (see below and Lindmark *et al.*, 2008).

Figure 3.8. **R&D expenditures in the United States, the EU15, Japan and Korea by ICT sub-sectors, 1996, 2003 and 2005**

Billion of current PPP dollars



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1. Austria and Luxembourg not available.
2. 1998 instead of 1996.
3. Post and telecommunications (ISIC 64) is included.
4. Post and telecommunications (ISIC 64) when (ISIC 642) is not available. Data for Germany and Japan are not available.

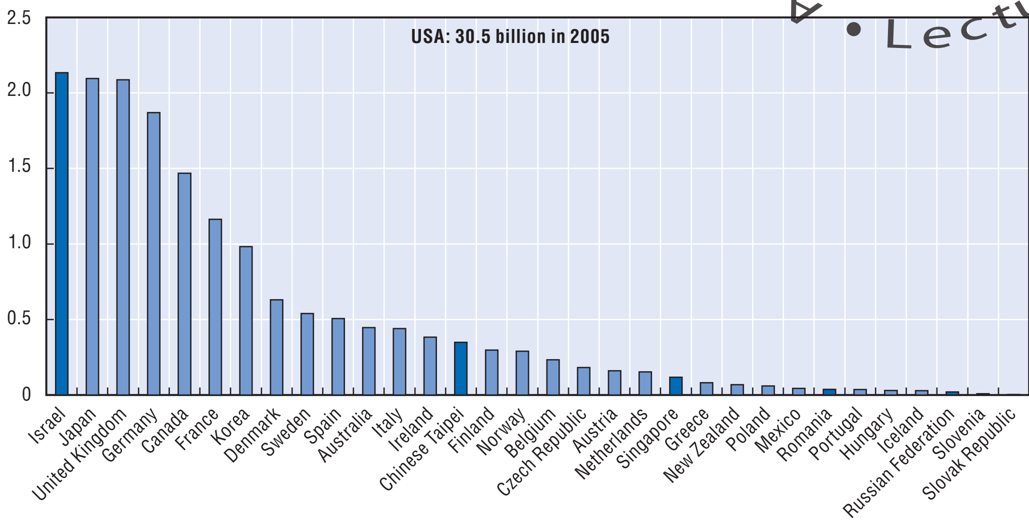
Source: OECD estimates based on *ANBERD* and *RDS databases*, June 2008.

Firm-level data show that expenditure on software R&D has risen most rapidly. In Canada, for example, year-on-year growth is higher than in any other ICT sub-sector (CAD 657 million intramural R&D expenditures in 2006) (Industry Canada, 2007). However, expenditure on software R&D can differ significantly depending on how it is reported (see Annex Box 3.A1.1). The data also usually do not take account of the increasing amount of software R&D outside the software sector (see below).

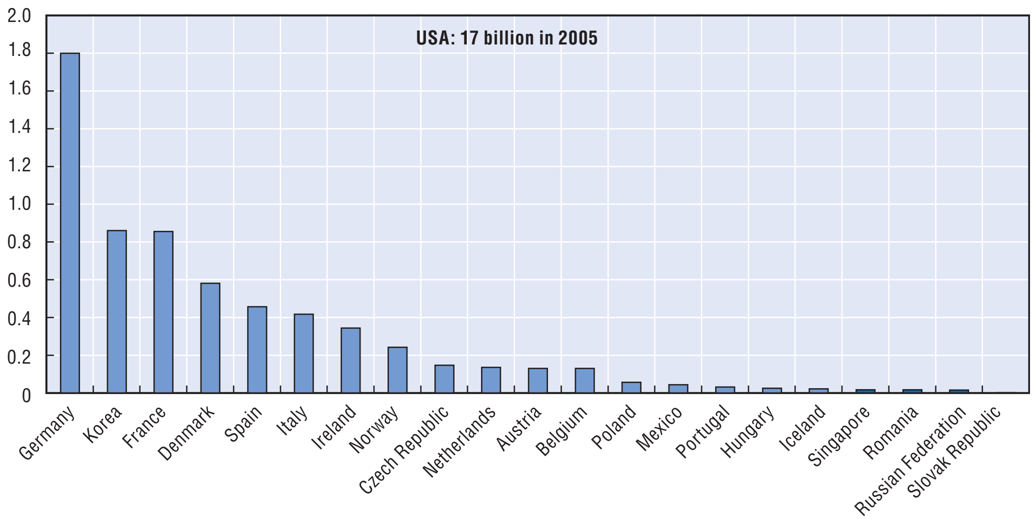
Figure 3.9. **R&D expenditures in the computer services and software sector, 2006**

Billions of current PPP USD

BERD in computer and related services, 2006 or latest available year[1]



BERD in software consultancy and supply, 2006 or latest available year[2]



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1. 2005 for Australia, France, Denmark, Germany, Greece, Iceland, Ireland, the Netherlands, Mexico, New Zealand, Portugal, Russian Federation, Spain, Sweden, the United States. 2004 for Austria.
2. 2005 for Denmark, Germany, Iceland, Ireland, the Netherlands, Norway, Mexico, Portugal, Russian Federation, Spain, the United States. 2004 for Austria, France.

Note: Figures for the United States from the National Science Foundation. Data not comparable to OECD estimates in Figure 3.8.

Source: OECD, *RDS database*, June 2008.

Data on business R&D in computer and related services for 2006 show that the United States leads by a large margin (USD 30.5 billion), fifteen times more than Israel (USD 2.1 billion), Japan (USD 2 billion), the United Kingdom (USD 2 billion) and Germany (USD 1.9 billion) (Figure 3.9). The same applies to business R&D in software consultancy and supply; the United States (USD 17 billion) carries out around ten times more than Germany (USD 1.8 billion), followed by Korea and France (USD 0.9 billion each). In the United States, industries associated with software and computer-related services account for roughly 15% of all business-funded industrial R&D.

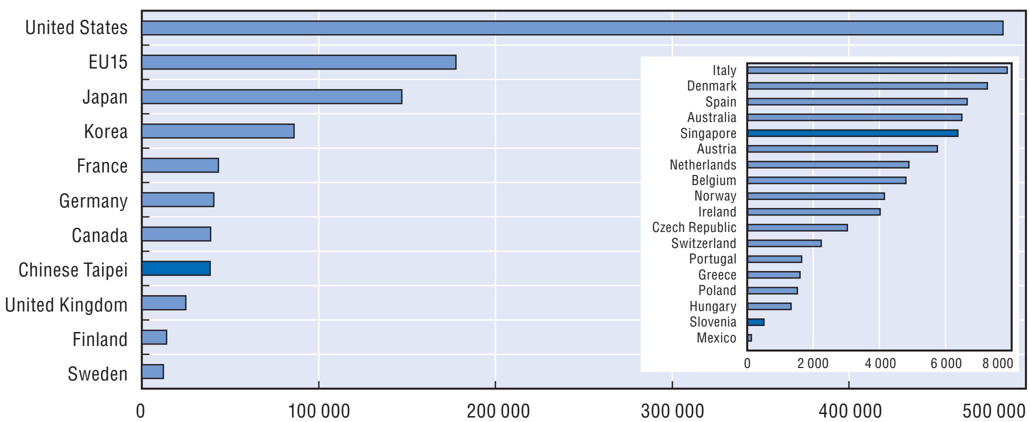
ICT R&D employment

The output and competitiveness of ICT research and the ICT sector depend on highly qualified research personnel and skilled employees. In 2006 there were 943 000 R&D personnel in the ICT sector in the OECD25.[15] With 487 000 researchers, the United States has a wide lead in total numbers (Figure 3.10), followed by Japan (147 000), and Korea (86 000), and the overall ranking of all OECD countries has hardly changed since 2002 (OECD, 2006a). Data for non-OECD economies are available only for Chinese Taipei (38 500), Singapore (6 400), and Slovenia (500). Chinese Taipei has slightly fewer ICT R&D personnel than Canada. The OECD countries with the largest share of ICT R&D personnel in total R&D personnel are Ireland (54%), Korea (53%), Finland (51%), Denmark (39%) and Canada (39%) (Figure 3.11). Chinese Taipei (68%) and Singapore (40%) have a very high specialisation in ICT researchers.

In most OECD countries the availability of highly trained research personnel for the ICT industry is an increasing policy concern (*e.g.* Eutema, 2007, for Austria; BMWI, 2007, for Germany; MTI, 2007, for Norway; PCAST, 2007, for the United States; MIC, 2005, for Japan). Attracting students (especially women) to pursue research and engineering degrees in OECD countries is an ongoing challenge (see Chapter 7, Box 7.7).

Figure 3.10. **ICT R&D researchers, 2006 or latest available year**

Full time equivalents



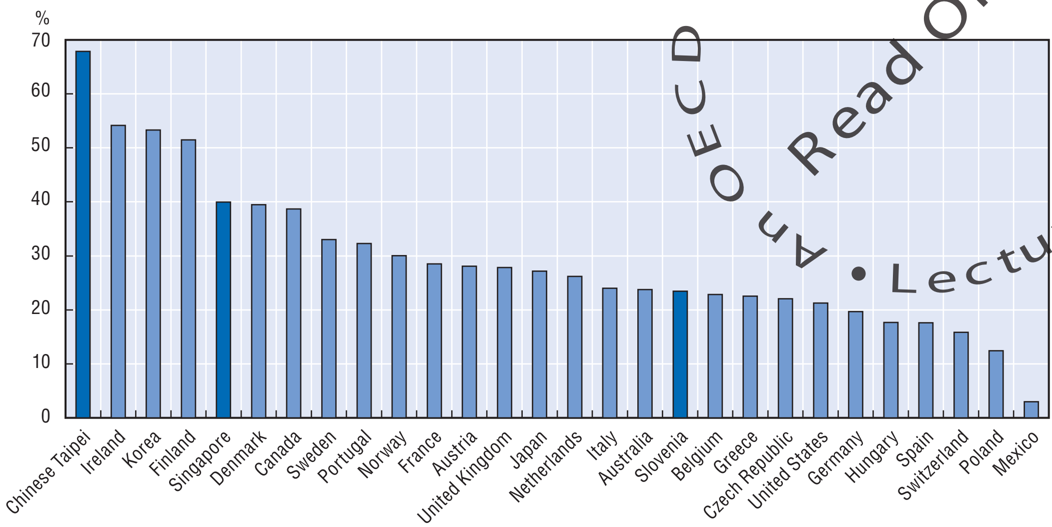
StatLink http://dx.doi.org/10.1787/474234772518

Note: EU15 excludes Luxembourg.

Source: OECD, estimates based on *RDS database*, April 2008.

Figure 3.11. **Share of ICT R&D researchers in total R&D researchers, 2006 or latest available year**

Percentages



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Source: OECD, estimates based on *RDS database*, April 2008.

R&D spending of top ICT firms

A complementary view of ICT R&D can be drawn from looking at the R&D activities of large ICT firms. The top 250 ICT firms are mainly large multinational enterprises (MNEs) from OECD countries operating in this high-technology sector and may be expected to have very large R&D expenditures (Dunning, 1977; Bae and Noh 2001; Ho *et al.*, 2006). These tend to be pro-cyclical, growing most in periods of economic expansion and retracting during downturns, but R&D of the top ICT firms has grown consistently over the last decade and held up well during the downturn, reaching USD 151 billion in 2006 (see Box 3.2). R&D expenditures of the top ICT firms are significantly higher than those of R&D-intensive firms in the chemicals, pharmaceuticals or automotive sectors (see also Jaruzelski and Dehoff, 2007).

In 2006 the top 100 R&D-performing firms (ranked by absolute R&D expenditures in 2006, see Chapter 1 and Box 3.2) spent an average of 6.7% of revenue on R&D. This is slightly less than the average R&D intensity of the top 100 ICT R&D spending firms in 2001 (close to 7%) (OECD, 2002a).[16] Only firms in the pharmaceutical sector display higher R&D intensities (Jaruzelski and Dehoff, 2007).

At firm level, revenue growth and R&D expenditure are moderately well correlated in the ICT sector (Figure 3.12), a correlation which is harder to demonstrate for other industry sectors. Annual revenue growth between 2000 and 2006 of the top ICT firms reporting R&D expenditures averaged about 6% (compound annual growth rate – CAGR). During the same period, R&D expenditures by these firms increased by around 5% a year, with a slight fall from 2001 to 2002 but a strong 9% increase from 2005 to 2006.

The bulk of ICT R&D in the top 250 ICT firms is conducted by US (43%) and Japanese (26%) firms, followed by firms from Germany (11%), Korea (8%) and other European countries (Figure 3.13, left-hand bar chart and right-hand pie chart). Firms from Chinese Taipei, in particular, have overtaken firms from Canada and the United Kingdom. Despite

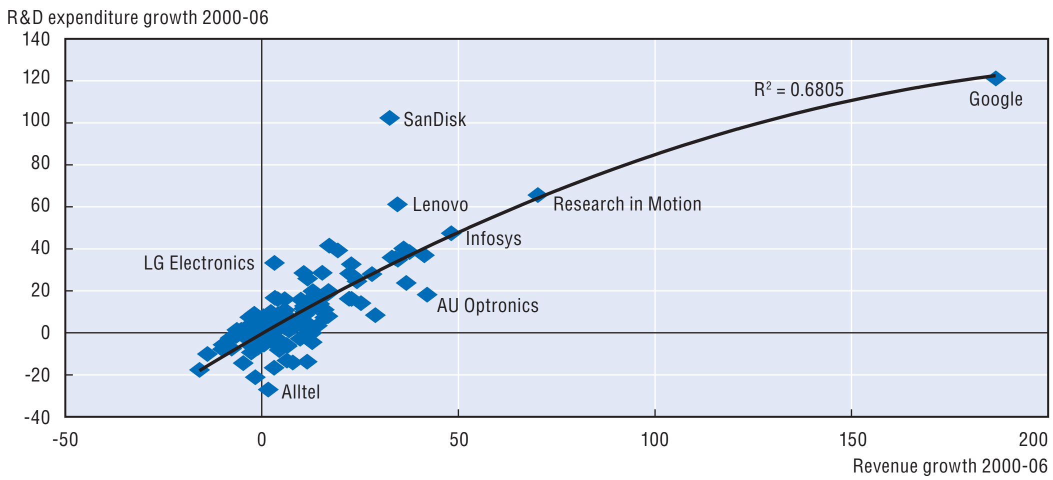
Box 3.2. **Defining the top ICT R&D spending firms**

The sample of around 170 firms is drawn from the top 250 ICT firms which report R&D expenditures for the years 2000 to 2006. It excludes small and medium-sized ICT enterprises which are often much more R&D-intensive (sometimes owing to low revenues). A few caveats apply (see Chapter 1, Box 1.1): First, the sample excludes a number of non-reporting high-revenue firms from the telecommunications, software and ICT services sectors. The impact is likely to be small, however, because firms that do not report R&D expenditures often spend little on R&D. Second, firms reporting R&D expenditure may choose different accounting standards or change from one set of standards to another with impacts on the absolute level of reported R&D spending – in particular the switch from US Generally Accepted Accounting Principles (GAAP) to International Financial Reporting Standards (IFRS).* Third, while for most OECD firms R&D expenditures come from SEC filings or audited annual reports, R&D expenditures for non-OECD firms, *e.g.* China, Chinese Taipei and India, often come from company statements or other sources that may not always conform to the same standards as audited accounts. Finally, R&D expenditures of non-US firms are converted from the respective currency into USD and are subject to exchange rate fluctuations, notably the large depreciation of the USD in the last two years which results, for example, in a relative overstatement of EU ICT firm R&D.

* The GAAP prescribe that most R&D spending be stated as incurred, *i.e.* reported as operating costs; IFRS treat research expenses as incurred costs, but prescribe capitalisation of development costs under a set of conditions (technological feasibility, commercial intention and ability) in which case these costs must be reported as intangible assets and thus become subject to amortisation and impairment losses in the current and subsequent years. Consequently, for a given firm, R&D expenditures according to the GAAP are usually reported as being higher than those according to IFRS. Beside GAAP and IFRS, domestic accounting principles may differ in their treatment of R&D expenditures.

Figure 3.12. **Top ICT firms, growth of revenue and R&D expenditure, 2000-06**

Percentages



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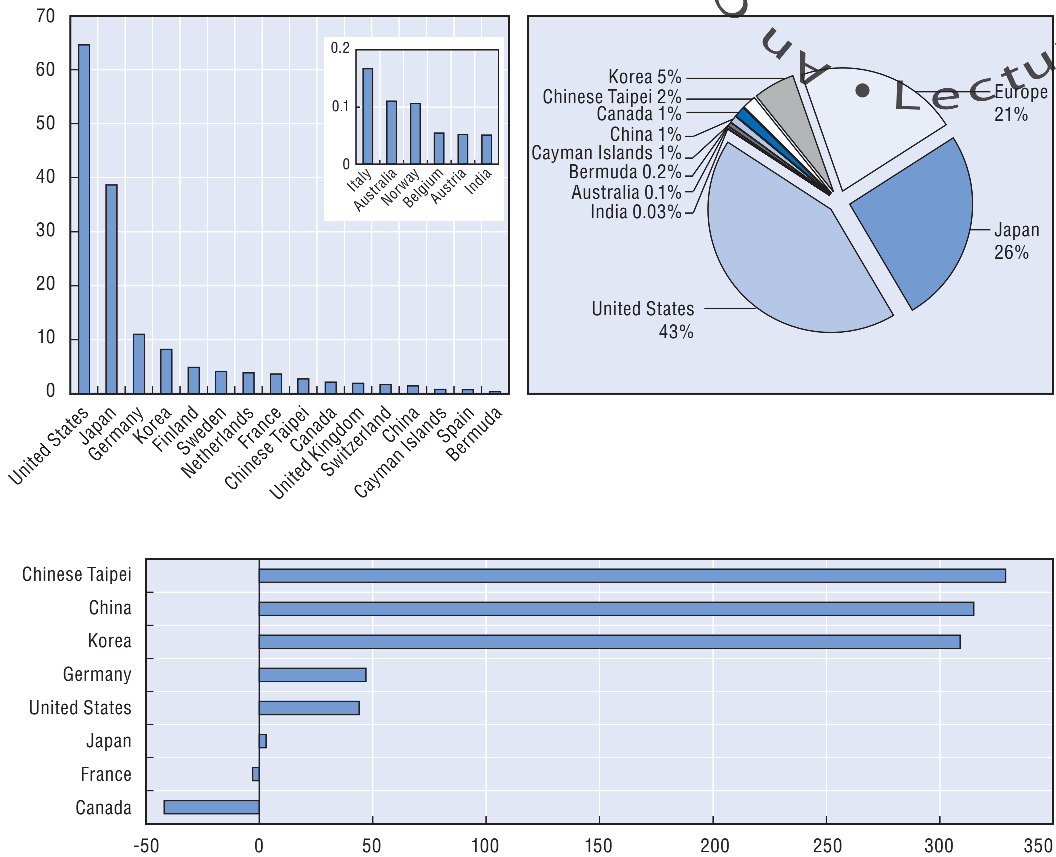
Source: OECD Information Technology Outlook database.

rapid growth, Chinese ICT firms still have a relatively small share of the R&D expenditures of top 250 ICT firms.

Korean firms have caught up to firms of other advanced OECD countries. Despite initially high starting levels, German and US firms have also significantly increased their

R&D spending. Japan had a slight increase, and France a slight decrease. Canada has also seen a drop owing to spending declines by Nortel Networks and Celestica. In terms of growth in R&D spending 2000-06, firms from Chinese Taipei and China are leading, albeit from low levels (Figure 3.13, bottom bar chart).

Figure 3.13. **R&D expenditures of top ICT firms, 2006 (left: in USD billions, right: in percentage of total) and growth of R&D expenditures of top ICT firms, 2000-06 (bottom, in percentage, current terms)**



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Note: Europe includes reporting firms in the sample from Germany, Finland, Sweden, the Netherlands, France, the United Kingdom, Switzerland, Spain, Italy, Norway, Belgium, Austria and Denmark in descending order.

Source: *OECD Information Technology Outlook database*.

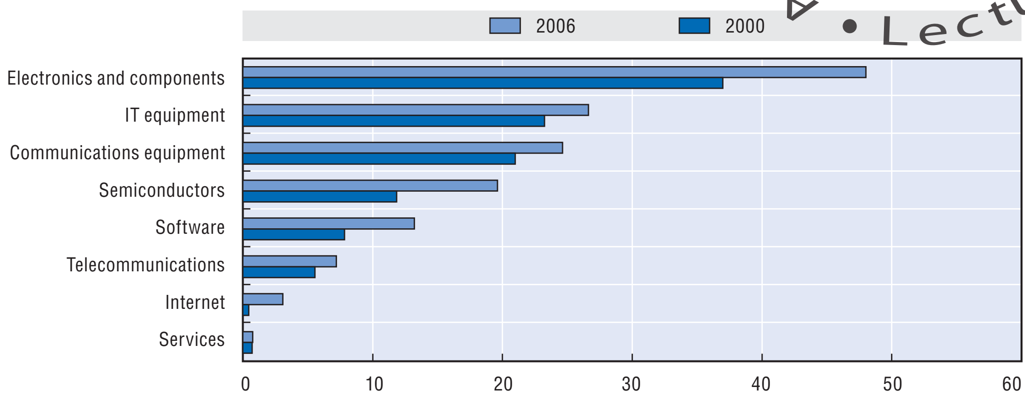
Other than China and India, ICT companies from OECD enhanced engagement countries (Brazil, Indonesia and South Africa) and OECD accession countries (Chile, Estonia, Israel, the Russian Federation and Slovenia) are not in the top R&D spending group. In some cases, this may be due to lack of reporting (*e.g.* some Israeli and Russian ICT firms potentially qualify for inclusion but no figures are available). In most cases, however, R&D expenditures or revenues of these countries' ICT firms are not high enough.

Sector distribution of ICT R&D spending of top ICT firms

For the top 100 R&D-spending ICT firms, the largest shares are in electronics (33%), IT equipment (19%), communication equipment (17%) and semiconductor firms (14%) (Figure 3.14 shows absolute expenditure levels; see also Box 3.2 for underreporting of services). Telecommunication firms have progressively reduced their R&D expenditures and make up only about 5% of the top 100 total in 2006 (OECD, 2007b). Compared to the top 100 R&D spenders in the *OECD Information Technology Outlook* 2002 (OECD, 2002a), the relative importance of communication equipment firms has declined most. The largest growth of R&D expenditures over the period 2000-06 was in sectors with lower initial shares: Internet, software and semiconductor firms.

Figure 3.14. **Reported R&D expenditures of top 100 ICT R&D spending firms, by sector, 2000 and 2006**

Current USD billions



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Source: *OECD Information Technology Outlook database.*

Top ICT R&D spenders by firm

Microsoft, Samsung, IBM and Intel lead the list of ICT firms ranked by R&D expenditures (Table 3.1; Siemens ranked in the top five in 2006, but comparable figures for 2007 are not available[17]). In 2007, Samsung overtook IBM in reported R&D spending (see Box 3.3). The first three firms were also top R&D spenders across all industries in 2006, just behind Toyota Motor (USD 7.7 billion), Pfizer (USD 7.6 billion), and Ford Motor Corp. (USD 7.2 billion) in the automotive and pharmaceutical sectors.

Table 3.1. **Top ICT R&D spenders: Absolute expenditure, 2006 and 2007**

USD millions

	Company	Country	Industry	R&D 2006	R&D 2007
1	Microsoft	United States	Software	6 584	7 121
2	Siemens	Germany	Electronics and components	6 312	n.a.
3	Samsung Electronics	Korea	Electronics and components	6 004	6 451
4	IBM	United States	IT equipment	6 107	6 153
5	Intel	United States	Semiconductors	5 873	5 700
6	Nokia[1]	Finland	Communications equipment	4 896	n.a.
7	Matsushita (Panasonic)	Japan	Electronics and components	4 854	4 909
8	Sony	Japan	Electronics and components	4 675	4 619
9	Cisco Systems	United States	Communications equipment	4 067	4 499
10	Motorola	United States	Communications equipment	4 106	4 429

StatLink http://dx.doi.org/10.1787/477300670664

1. From 2007, Nokia consolidates financial information for Nokia Siemens Networks, a joint venture between Nokia and Siemens. Nokia's reported 2007 R&D expenditure of USD 7 730 million is therefore not comparable to earlier expenditures.

Source: *OECD Information Technology Outlook database.*

Box 3.3. **Samsung R&D and innovation**

Korean ICT firms (mainly LG Electronics, Samsung Electronics and SK Telecom) have caught up very rapidly in terms of R&D spending. Samsung is now the world's second largest semiconductor company behind Intel Corp. (partly owing to earlier appreciation of the Korean won against the USD), and the 11th largest global R&D spender in 2006. Samsung is the third largest ICT firm in terms of R&D expenditure (USD 6.5 billion in 2007) just after Microsoft and Siemens and before IBM and Intel. Its growth of R&D expenditure is a multiple of that of other top 10 firms, with growth of around 25% (CAGR, USD terms) between 2000 and 2007 (as compared to 10% for Microsoft and 3% for IBM). This places Samsung within the top 20 fastest-growing spenders on R&D. R&D expenditure as a percentage of sales also rose from 4% in 2000 to close to 10% in 2007. A quarter of Samsung's workforce (36 000 employees) is involved in R&D with facilities in Korea, India, China, the Russian Federation, the United States and Japan. Samsung's research activities focus on semiconductors, solid-state drives (SSDs), flash memory, liquid crystal displays (LCDs), printers, mobile WiMAX technology and cell phones. Mirroring similar R&D research trends in other ICT firms, the company has developed research in biotechnology (biochips) and other fields that link ICTs with natural sciences (convergence of IT, biotechnology and nanotechnology).

Source: Based on *OECD Information Technology Outlook database* and company information.

Compared to the list of the top 10 in the *OECD Information Technology Outlook 2002* (OECD, 2002a), Ericsson, Lucent Technologies and Nortel Networks (all communication equipment manufacturers) dropped out and were replaced by Samsung, Nokia and Sony. Compared to the top 250 ICT firms named in the *OECD Information Technology Outlook 2002*, the current list of top ICT R&D spenders contains a much higher number of Korean, Chinese Taipei and Chinese firms.

In terms of growth in R&D spending, the leaders are Google (114%, Internet firm), SanDisk (91%, IT equipment), Research in Motion (63%, communication equipment), Lenovo (54%, IT equipment) and Nvidia (42%, electronics) (all CAGR, in current USD terms), followed by a group of Internet, service, and software firms despite their smaller number in the overall top 250 (Table 3.2). China and India each have one firm in the top 10 in terms of growth.

Table 3.2. **Top ICT R&D spenders: Expenditure growth, 2000-07**

Percentages, CAGR, based on current USD

	Company	Country	Industry	Growth 2000-07
1	Google	United States	Internet	114
2	SanDisk	United States	IT equipment	91
3	Research in Motion	Canada	Communications equipment	63
4	Lenovo	China	IT equipment	54
5	Nvidia	United States	Electronics and components	42
6	Infosys	India	Services	40
7	Yahoo	United States	Internet	39
8	e-bay inc	United States	Internet	35
9	Symantec/Veritas	United States	Software	35
10	Jabil Circuit	United States	Electronics and components	34

StatLink http://dx.doi.org/10.1787/477317104847

Source: *OECD Information Technology Outlook database*.

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Non-OECD firms are over-represented in terms of growth of R&D, in part because of their low starting level (Table 3.2). Apart from Lenovo (China) and Infosys (India) which are in the top 10, there are a significant number of IT, electronic equipment and semiconductor firms from Chinese Taipei (Lite-on Technology, AU Optronics, Taiwan Semiconductor, Benq/Qisda) and communication equipment firms from China (Huawei, ZTE) among the top 50 (see OECD, 2006a Chapter 3).

Semiconductor and hardware firms (communication and IT equipment, electronics) are the most R&D-intensive in terms of R&D expenditures per employee (Table 3.3). Broadcom (semiconductors) leads with USD 213 000 per employee, followed by Qualcomm (communication equipment), Nvidia (electronics and components), and SanDisk (IT equipment). Google has greatly increased R&D spending per employee to reach sixth place in 2007. Software firms such as Electronic Arts, Microsoft, Adobe Systems and Intuit are also spending leaders (on the R&D intensity of the computer and video game industry, see OECD, 2005a). US ICT firms dominate the top 50 with notable exceptions such as Nintendo (Japan), Advantest (Japan), ASM Lithography (the Netherlands), Samsung (Korea), LG Electronics (Korea), Qimonda (Germany), Nortel Networks (Canada), Nokia (Finland) and Ericsson (Sweden). Few other European or Japanese firms are among the top 50. None of the biggest R&D spenders is among the top 10 for R&D expenditure per employee and as a share of sales, suggesting either that they specialise in R&D or are at an early stage in the growth cycle before R&D efforts become new saleable products.

Table 3.3. **Top ICT R&D spenders: R&D expenditures per employee, 2007**

USD

	Company	Country	Industry	R&D expenditure per employee 2007
1	Broadcom	United States	Semiconductors	212 541
2	Qualcomm	United States	Communication equipment	142 891
3	Nvidia	United States	Electronics and components	135 440
4	SanDisk	United States	IT equipment	131 778
5	Electronic Arts	United States	Software	131 772
6	Google	United States	Internet	126 153
7	Advanced Micro Devices	United States	Semiconductors	112 485
8	Juniper Networks	United States	Communication equipment	105 971
9	LSI Corp	United States	Semiconductors	105 765
10	Nintendo	Japan	Electronics and components	93 924

StatLink http://dx.doi.org/10.1787/477370442428

Source: OECD Information Technology Outlook database.

Trends in R&D intensity

R&D expenditure as a share of sales revenues is another measure of R&D intensity. Semiconductor firms lead by this measure (Table 3.4). The top 10 firms in this ranking spent between one-fifth and one-third of revenue on R&D.

On average, in 2006, semiconductor and software firms were the most R&D-intensive, with average R&D spending equivalent to around 15% of revenues (Figure 3.15). Communication equipment firms are also relatively R&D-intensive. Semiconductor firms had a strong increase in R&D intensity between 2000 and 2006 while IT equipment, services and telecommunication firms have seen an overall decrease. The leading

Table 3.4. **Top ICT R&D spenders: R&D intensity (R&D expenditure as share of sales), 2000 and 2007**

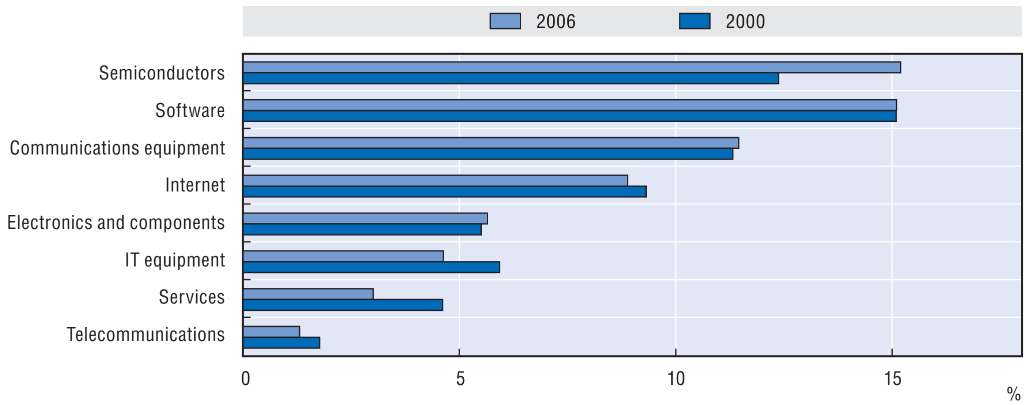
	Company	Country	Industry	R&D intensity 2000 (%)	R&D intensity 2007 (%)
1	Broadcom	United States	Semiconductors	23	36
2	Electronic Arts	United States	Software	18	34
3	Advanced Micro Devices	United States	Semiconductors	14	31
4	LSI Corp	United States	Semiconductors	14	25
5	Juniper Networks	United States	Communications equipment	13	22
6	NXP	Netherlands	Semiconductors	n.a.	21
7	Qualcomm	United States	Communications equipment	11	21
8	Analog Devices	United States	Electronics and components	16	20
9	Freescale Semiconductor	United States	Semiconductors	17	20
10	Adobe Systems	United States	Software	20	19

StatLink http://dx.doi.org/10.1787/477425685188

Source: OECD Information Technology Outlook database.

Figure 3.15. **Average R&D intensity of top ICT firms by sector, 2000 and 2006**

Percentages



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Source: OECD Information Technology Outlook database.

telecommunications firms reporting R&D include former monopoly incumbents (*e.g.* BT and SK Telecom), some of which are required by law to conduct R&D (OECD, 2007b).

IT equipment firms such as Apple, Dell and Hewlett Packard are often seen as leading innovators, but with R&D intensity below 5% they are at the lower end of the top 100 ranking of R&D intensity. Apple's very strong revenue growth coupled with slower increases in R&D have led to declining R&D intensities in recent years (3.3% in 2007), even though it is well known for product innovations, leading design and strong branding. Other IT equipment firms with strong consumer product operations from Chinese Taipei and China such as Benq/Qisda, Lenovo, ASUStek and Acer are also at the lower end of the ranking of R&D intensity, but they tend to innovate most in process technology and supply arrangements. Internet firms such as Amazon and Expedia have stronger R&D intensities (over 5%) but are still far from other US Internet firms such as Google (13%) or Yahoo! (16%).

Firms from the United States dominate the list of the most R&D-intensive, but there are exceptions, such as NXP (the Netherlands, semiconductors). Other European firms in the top 50 include the semiconductor manufacturers STMicroelectronics (Switzerland), Infineon Technologies (Germany) and the software firm SAP (Germany). A few non-US

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communication equipment firms (*e.g.* Nortel Networks of Canada, Ericsson of Sweden) are also on the list. Only one Japanese firm, Advantest (IT equipment), has been in this top 50 ranking for some years, and some other Japanese companies (*e.g.* Rohm, Pioneer, Omron, Yokogawa Electric) have oscillated between 50th and 60th place.

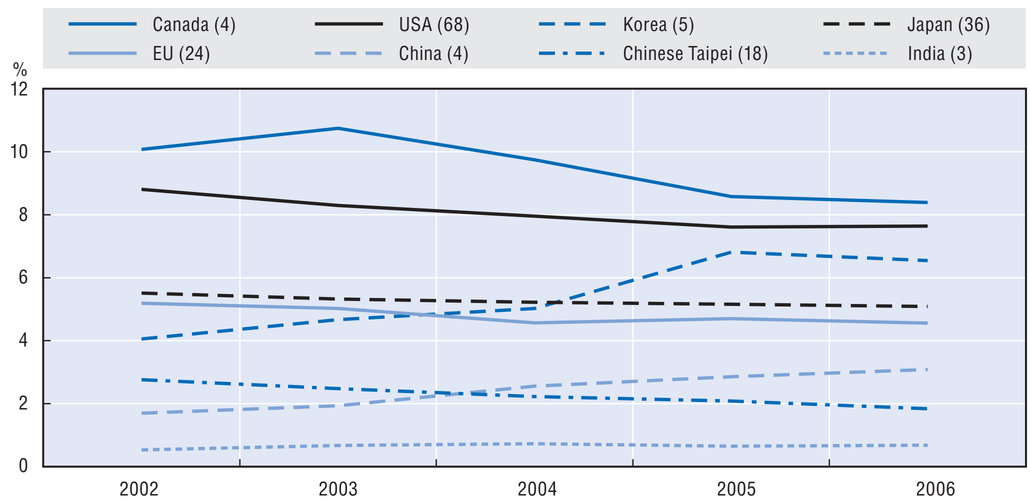
There are two Chinese communication equipment firms (ZTE and Huawei) in the top 50 most R&D-intensive ICT firms, sharing top positions with firms such as Juniper Networks, Tellabs, Qualcomm, Motorola, Avaya and Cisco (all United States), Nortel Networks, Research in Motion (both Canada), Ericsson (Sweden), Alcatel-Lucent (France) and Nokia (Finland).

The leading countries in terms of average R&D intensity of top R&D-performing firms are Sweden (Ericsson, TeliaSonera), Switzerland (STMicroelectronics, Swisscom), Finland (Nokia), Canada (CGI Group, Nortel Networks, Celestica, Research in Motion) and the United States, with averages of between 11 and 7% (in decreasing order of intensity). But the R&D intensity of ICT firms from the United States is based on the averages of nearly 70 ICT firms in the sample, many more than for other countries. Only US Internet or software firms (and the German SAP) are among the top R&D spenders in absolute terms or in R&D intensity. Korean firms have an average R&D intensity of 6.5%. Japan is ninth (R&D intensity of 5.1% in 2006), but it also has many ICT firms in the sample (36). Average R&D intensities of reporting firms from Australia and the United Kingdom are low (mostly telecommunication firms).

Over time the average R&D intensities of countries' top ICT firms have shifted (Figure 3.16). Canada and the United States lead in intensity but have experienced some declines (to an average of about 8%). Japan and the European Union have considerably lower R&D intensities (around 5%). The strongest increase in R&D intensity has occurred for Korean firms (6.5%, now ahead of Japanese and European firms and close to the United States) and Chinese ICT firms (3%, overtaking Chinese Taipei firms). However, the IT equipment firm

Figure 3.16. **R&D intensity of ICT firms, by economy/region, 2002-06 (only top ICT firms reporting R&D)**

Percentages, figures in brackets are number of firms in the sample



StatLink http://dx.doi.org/10.1787/474428823676

Note: Given the increased internationalisation of corporate R&D, some R&D performed by ICT firms is conducted abroad and not in the home country. EU includes R&D reporting firms from Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden, and the United Kingdom.

Source: *OECD Information Technology Outlook database*.

Lenovo (China) has a low R&D intensity (1.5%) compared to OECD IT equipment firms – Sandisk (11%), Sun Microsystems and NEC (both 7%), IBM (6%), Toshiba (6%) – and it is behind many Chinese Taipei firms. No Chinese semiconductor firm is in the top 250 list.

Indian firms (ICT services firms TCS, Wipro and Infosys) have increased their R&D intensities but these remain below 1%; they are among the few ICT services firms in the top 250 by revenue. Their R&D intensities are still relatively low compared to US ICT services firms such as DST systems (7%), ADP (7%) and SunGard (6%). India has no ICT equipment or semiconductor firms with R&D expenditures or revenues comparable to the group of top ICT firms.

Overall, firms from Chinese Taipei are not very R&D-intensive despite its large PC-related market shares; Acer and ASUSTeK have low R&D intensities (0.1% and 1.4%, respectively), and the overall R&D intensity of its ICT firms has decreased significantly (from almost 3% to less than 2%). This can be explained by the strong increase in revenue for IT equipment and electronics firms combined with more moderate growth of R&D expenditures. Currency fluctuations and transfers of ICT-related R&D activities from Chinese Taipei to China (see OECD, 2006a, Chapter 3) may also play a role. The Taiwan Semiconductor Manufacturing Company is relatively R&D-intensive (around 5%), but less so than OECD semiconductor firms which spend between 15 and 35% of revenue on R&D. In electronics and components Chinese Taipei's United Microelectronics R&D intensity is equivalent to that of OECD firms.

Firms from the OECD accession country Israel are not in the top 250 ICT R&D list, although its software firms, which focus mainly on enterprise and security software, Internet applications and computer-assisted design (CAD) software (*e.g.* Check Point, Nice Systems, Emblaze, Retalix) are R&D-intensive (Figure 3.9 shows the high volume of software R&D in Israel).

Trends in the organisation of ICT R&D

The ICT sector is R&D-intensive but is also innovative in terms of how it organises R&D. It has benefited from partnerships with public research and employed a mix of internal and external and national and international R&D strategies. While all have been used for many years, the organisation of R&D has been changing: collaboration and internationalisation of R&D are seen as major sources of innovation for the industry and there are signs that they are increasing. Moreover, public support for ICT-related R&D continues to be a major priority (see Chapter 7). However, the lack of internationally comparable data remains an issue if trends are to be identified more clearly.

The importance of publicly funded research

The move from initial basic research to applications can take several decades, and unanticipated results from basic research have been important building blocks for developing new products. Publicly funded research has long been a stimulus for business R&D and the development of key technologies such as semiconductors or networking technologies (NRC, 2003; MIC Japan, 2005).[18] In particular, national space and defence R&D programmes have funded a significant amount of ICT-related research in the past, underpinning applied ICT hardware and software research and new fields such as bioinformatics and nanotechnology. Often-cited examples that began from publicly funded

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basic research and became commercial products are the Internet, graphical user interfaces, global positioning systems, and web search technologies.

Because of the complex interactions between research, development and innovation, the ICT sector has always relied heavily on publicly funded R&D and on partnerships involving government, public sector research organisations, industry and universities (for long-term basic scientific research). ICT firms are often part of regionally concentrated clusters or set up labs close to universities to benefit from spillovers of public ICT-related R&D. In the United States, for example, 70% of the R&D performed by all domestic and foreign computer and electronic firms in 2005 took place in four locations,[19] all in close proximity to public research institutes (National Science Board, 2008). The relative importance of access to public research results increases in times of falling company budgets for basic research.

In recent years OECD countries have substantially increased their overall public funding for R&D (OECD, 2008a). Data on government budget appropriations or outlays for R&D (GBAORD) show that between 2000 and 2006, government R&D budgets in the OECD area expanded by 6.8% annually, faster than GDP, although with considerable differences among countries.[20] The composition of public R&D also varies considerably, as some countries have large defence R&D budgets (*e.g.* 0.6% of GDP in the United States, and 0.2% of GDP in the United Kingdom and France).[21]

In spite of the importance of public research for the ICT sector, internationally comparable official figures on publicly funded ICT-related R&D are not available.[22] Government appropriations for ICT-related R&D and related activities cannot be broken down by sub-sector or by ICT-related socio-economic objectives. Although broad socio-economic objectives such as "Non-oriented research in mathematics and computer science" are directly or indirectly related to ICT research, ICT-specific data are difficult to produce.

Most OECD governments have multi-annual funding programmes for ICT R&D to promote research and (international) co-operation between the private and public sectors (Table 3.5). ICT R&D budgets in the United States (NITRD), Japan (Council for Science and Technology Policy's ICT-related R&D budget), and at the EU level (ICT-related funding in the Seventh Framework Programme – FP7) are each over USD 1 billion a year.[23] These programmes alone are equivalent to around 5% of the R&D expenditures of the top ICT firms discussed above (close to 5% for the United States and the EU, close to 4% for Japan), and most of these expenditures complement those of business by focusing on basic or exploratory research which would not otherwise be undertaken by the business sector. Furthermore, most of these programmes are only a part of total public funding available for ICT-related research and are often accompanied by public research project funding at sub-national or national level. General public policy measures, *e.g.* R&D tax concessions and incentives, education and training, and support for university and public institutional research are also important for the direct promotion and indirect support of ICT-related R&D in the business sector. Other countries' funding for ICT research also has high priority, as stand-alone policies (*e.g.* Germany's ICT 2020), or as a major pillar of wider science, technology and innovation policies (*e.g.* Spain's Ingenio 2010, Canada's Mobilizing Science and Technology to Canada's Advantage). Non-OECD countries such as China and India are also increasing public support for ICT-related research. These programmes are usually part of national science and technology agendas, but compared to the United States, Japan and the EU, annual funding explicitly for ICT-related research is still low.

Table 3.5. **ICT R&D promotion and public funding in selected OECD and non-member economies**

ICT R&D funding programmes	
United States: Networking and Information Technology Research and Development (NITRD) Programme *Funding (proposed): USD 3 billion (2008)* • High-end computing infrastructure and applications • High-end computing R&D • Cybersecurity and information assurance • Human-computer interaction and information management • Large-scale networking • High-confidence software and systems • Socio-economic implications of IT and workforce development • Software design and productivity • Prioritised application areas: health care, public safety, environmental protection, space sciences, defence	**Japan: Third Science and Technology Basic Plan** *Funding for ICT-related R&D projects (approved): JPY 161 billion (USD 1.4 billion) (2008)* • High-speed, highly reliable information systems (mobile networks, optical networks, high-speed low consumption networked devices, distributed computing, digital authentication, IPv6, RFID) • Next-generation ICTs (advanced human-computer interfaces, quantum cryptography, robotics, organic devices) • R&D infrastructures (high-end databases and computing, networked collaboration, Earth Simulator, satellite communication systems) • Prioritised application areas: environment and energy, mobility, disaster prevention and public security, health care and welfare, education and human resources, e-government.
European Union: Seventh Framework Programme (EU FP7), Co-operation *Funding for ICT-related R&D projects (approved): EUR 9.1 billion (USD 12.5 billion) (2007-13)* • Pervasive and trusted network and service infrastructure • Cognitive systems, interaction, robotics • Components, systems, engineering • Digital libraries and content • Future and emerging technologies • Prioritised application areas: sustainable and personalised health care, transport and mobility, environmental sustainability and energy efficiency, independent living and inclusion	**Germany: ICT 2020 – Research for innovations** *Funding (planned): EUR 380 million (USD 520 million) a year* • Electronics and microsystems (nanostructures) • Software systems and knowledge processing (simulated reality, human-computer interaction) • Communication technologies and networks (grid computing) • ICT security and reliability • ICT in complex systems (embedded systems) • Internet of Things and services (RFID) • Future developments (organic computing, photonics) • Prioritised application areas: automotive, mobility, engineering, health care and medical engineering, logistics, energy and environment
Canada: Networks of Centres of Excellence, and others *Figures indicate approved yearly funding* • Canadian Institute for Photonic Innovations (USD 4 million) • Geomatics for informed decisions (USD 3 million) • Mathematics of IT and complex systems (USD 4 million) • Intelligent sensing for innovative structures (USD 2 million) • New media research networks (USD 4 million) • New Media R&D Initiative (USD 1 million)	**Finland: TEKES research programmes** *Figures indicate approved yearly funding* • Converging networks (USD 23 million) • Future healthcare (USD 34 million) • Modelling and simulation (USD 12.3 million) • Mobile enterprise solutions programme (USD 18 million) • Ubiquitous communication (USD 23 million) • Application of IT in mechanical, civil and automation engineering (USD 0.5 million)
India: Eleventh 5-year plan (2007-12) *Figures indicate proposed yearly funding for ICT-related R&D programmes* • Advanced computing, *e.g.* grid computing (USD 24 million) • Robotics and automation (USD 6 million) • Sensors and integrated systems (USD 12 million) • Distributed sensors and networks (USD 10 million) • ICT security technologies (USD 27 million) • Telemedicine, instrumentation, diagnostics (USD 5 million) • Centre for photonics (USD 10 million) • Centre for molecular and medical imaging (USD 10 million) • Centre for mathematical and computational sciences (USD 24 million)	**China: National Guidelines for Medium- and Long-term Plan for Science and Technology Development (2006-20)** *Funding for ICT-related R&D programmes by the National Natural Science Foundation of China: USD 345 million (2006)* • Electronics, information theory and processing (electromagnetic fields, nano-electronics, bioinformatics, adaptive signal processing) • Computer science (system architectures, software engineering, natural language processing, virtual reality, embedded systems) • Network and information security • Automation science (control theory, pattern recognition, artificial intelligence, robotics, environmentally sustainable industrial production processes) • Semiconductors, photonics (nanotechnology, high-speed optical networks, quantum optics, photonics in health and medical research) • Interdisciplinary research between information and mathematics (theoretical studies on number representation, software engineering)

Note: Spending cannot be directly compared between countries. Sub-national funding programmes are not included, *e.g.* in federal states. Examples of research topics indicated in parentheses are not exhaustive. 2007 exchange rates are used.

Sources: OECD Information Technology Policy questionnaire and official ICT research strategy documents.[24]

Finally, national ICT diffusion strategies include plans to boost R&D as a driver of innovation. Examples include the u-Korea Master Plan (2006-10) and Turkey's and Switzerland's Information Society Strategies. Non-OECD economies are also including

R&D promotion in national ICT strategies, *e.g.* Singapore's Intelligent Nation 2015 (see Chapter 7).

Collaborative R&D and "open innovation"

The terms "collaborative R&D" and "open innovation"[25] are increasingly used to characterise new forms of R&D and innovation which rely less on traditional in-house R&D and more on collaborating on research and innovation with universities, public laboratories, other firms and other knowledge sources. Major incentives include cost and risk reduction (especially for pre-competitive R&D) and possibilities to enter new markets with jointly developed technologies (Freeman and Soete, 2007). Such collaboration is increasingly international and spans various ICT sectors and adjacent industries (*e.g.* biotechnology).

Externally organised R&D activities of the ICT business sector have mainly taken the form of:

- Partnerships, framework agreements or contract R&D with universities, R&D laboratories and research institutes, often with a focus on longer-term R&D (including the creation of joint laboratories or high-technology zones by ICT firms on university campuses).[26]
- The involvement of PhD and postdoctoral researchers in the work of company R&D labs.
- R&D partnerships, industrial technology alliances and consortia of ICT firms (some focused on upstream research and some on product co-development).
- Prospecting for new ideas from individuals and start-ups with promising research (including through venture capital, incubation and acquisitions, and new participative web strategies).

These trends have strengthened with the increased internationalisation of collaboration and the development of global innovation networks. ICT R&D has become more modularised and increasingly takes place outside the OECD region. The internationalisation of R&D in general is also driven by the increasing use of ICTs as the basic international science and technology infrastructure (*e.g.* broadband research networks), by programmes that encourage international research collaboration (*e.g.* the EU FP7's focus on co-operation with entities from Asian countries) and by specialised organisations (*e.g.* the International Technology Roadmap for Semiconductors).[27] Long-standing public research organisations (Fraunhofer ICT institutes in Germany, Battelle in the United States, VTT in Finland, TNO in the Netherlands) also increasingly form global research alliances or public-corporate R&D consortia.

At the firm level, Asia is becoming the target for new collaboration, both within Asia (*e.g.* co-development of optical storage media by Samsung and Toshiba) and between OECD ICT firms and Asian partners. Chinese and Indian firms in particular have become strategic research partners for OECD ICT firms (*e.g.* Siemens and China's Huawei; Ericsson and China's Datang Telecom on alternative 3G network protocols; Agilent and China's Chengdu Quianfeng on communications test equipment; Microsoft and India's Infosys on enterprise resource planning software; Yahoo and India's Tata on cloud computing). OECD ICT firms also collaborate with Asian universities (*e.g.* Philips with China's Zhejiang University, US Xybernaut with Beijing University of Aeronautics for software solutions). A few alliances are also forming between Indian and Chinese ICT firms (mainly in the area of software and

ICT services) and between Russian and Chinese ICT firms (*e.g.* Russia's Sitronics Corp. and ZTE for global navigation satellite systems).

Second, R&D partnerships and alliances have encompassed different ICT sub-sectors, often with links to universities. Semiconductors and microelectronics pioneered such collaboration in the ICT sector in the 1970s (see Box 3.4). Recent examples include: *i)* the Reliable Adaptive Distributed Systems Laboratory (RAD Lab) at the University of Berkeley, which is supported by Google, Sun, Microsoft, Siemens, Oracle, Cisco and others;

Box 3.4. **Semiconductor research collaboration**

Semiconductor and microcomputer research collaborations in the 1970s and 1980s were early examples of public-private research partnerships in the ICT sector, which were initiated by government and later inspired collaboration in other sectors. The first such initiative was the very large-scale integration (VLSI) consortium (1976-80), initiated by the Japanese Ministry of International Trade and Industry (MITI) (which provided around 40% of the USD 350 million budget); it included Fujitsu, NEC, Hitachi, Mitsubishi, and Toshiba. Subsequently, the growing market shares of Japanese semiconductor manufacturers led the US government to initiate similar collaboration, notably the Semiconductor Research Corporation (SRC)[1] in 1982 and SEMATECH in 1987, the latter with funding from the public research agency DARPA, which provided around half of the consortium's budget.[2]

Semiconductor R&D industry alliances are still formed, increasingly for related nanotechnology research. Purely domestic research alliances continue, *e.g.* the STARC and SELETE programmes in Japan,[3] and Japan's Toshiba, NEC and Fujitsu have also joined forces and agreed to spend JPY 3 billion (USD 29 million) from 2006 to 2010 to develop non-volatile memory technologies (STT-MRAM). Korea initiated a state-backed R&D programme: from 2004, KRW 52.58 billion (USD 54 million) are to be spent over eleven years on semiconductor research, of which the Korean government pays half. Some national collaboration has become international – sometimes with less or no government support. In 1998, for instance, SEMATECH started to include foreign companies such as Hyundai, Infineon, STMicroelectronics, and DARPA funding was subsequently ended. New alliances were also formed, such as the Common Platform consortium composed of IBM and Samsung and partnering with Infineon, Freescale, STMicroelectronics and Toshiba to jointly develop CMOS manufacturing processes.

International semiconductor collaboration also includes joint research by companies, universities and private research institutes. Some of these ventures are publicly co-funded, such as that of IBM and STMicroelectronics at Crolles, France, which is supported by tax concessions. The State University of New York at Albany's College of Nanoscale Science and Engineering has attracted a number of company collaborations (*e.g.* the recently announced IBM-Hitachi alliance), some of which benefit from public grants. The Interuniversity Microelectronics Centre in Belgium is a private research institute with almost all of the top semiconductor manufacturers among its core technology partners (*e.g.* Intel, Samsung, STM, NXP Semiconductors, TSMC, Hynix) and with government support of various kinds.

1. Founding members: AMD, CDC, DEC, General Instrument, Honeywell, HP, IBM, Intel, Monolithic Memories, Motorola, National Semiconductor.
2. Founding members: AMD, AT&T, DEC, Harris, HP, Intel, IBM, LSI Logic, Micron, Motorola, National Semiconductor, NCR, Rockwell International, Texas Instruments.
3. STARC and SELETE are both formed by: Fujitsu, Matsushita, NEC, Oki, Renesas, Rohm, Sanyo, Seiko-Epson, Sharp, Sony, Toshiba; see *www.starc.jp* and *www.selete.co.jp*.

Sources: Grindley *et al.* (1994); Katz and Ordover (1990); NIST (2006); Samuels (1987); and company information.

ii) RESERVOIR, a research initiative led by IBM in the field of cloud computing, with support from the EU FP7, involving ICT firms from the United States (*e.g.* Sun Microsystems), the EU (*e.g.* SAP, Telefonica), and European universities; *iii)* Microsoft and Intel's joint funding of academic research into software development for parallel computing, business intelligence and RFID; and *iv)* the joint laboratory for large-scale computer network research formed by the Chinese companies Baidu and Huawei.[28] Collaboration between ICT firms on horizontal topics such as the environment is also increasingly common (*e.g.* the StEP initiative for e-waste, and the Green Grid project in which companies from various ICT sub-sectors are developing technologies with minimum environmental impact).

Third, ICT R&D is becoming more interdisciplinary, with more research involving nanotechnology, biotechnology and ICT firms. Such collaboration has not been widely publicised (*e.g.* Sun Microsystems and SimBioSys for pharmaceuticals; the BioIT Alliance, co-founded by Microsoft, HP, Sun and pharmaceutical and biotechnology companies; Google's investment in 23andMe, a company providing personalised genome analysis).

Finally, an increasing number of research partnerships have formed around open standards or common technology platforms. The Open Handset Alliance (formerly Google Android) engages in developing an open source mobile platform; its over 30 members include Google, Broadcom, Intel, China Mobile, KDDI, and Samsung. Further examples of joint handset development platforms include the LiMo Foundation (founding members Motorola, NEC, NTT DoCoMo, Orange, Panasonic, Samsung and Vodafone) and the joint venture Symbian. Open source software development and the increasing co-development of application interfaces and services are also leading to collaboration and externally focused ICT R&D. The Eclipse Foundation is an open source platform supported by IBM which creates development environments, *e.g.* for enterprise software. Yahoo! partners with the Apache Software Foundation on the development of Hadoop, an open source project for distributed computing and data-intensive applications, which is being used for commercial purposes by Amazon Web Services, as well as for research into distributed computing by Yahoo! in collaboration with Computational Research Laboratories (India), IBM and Google.

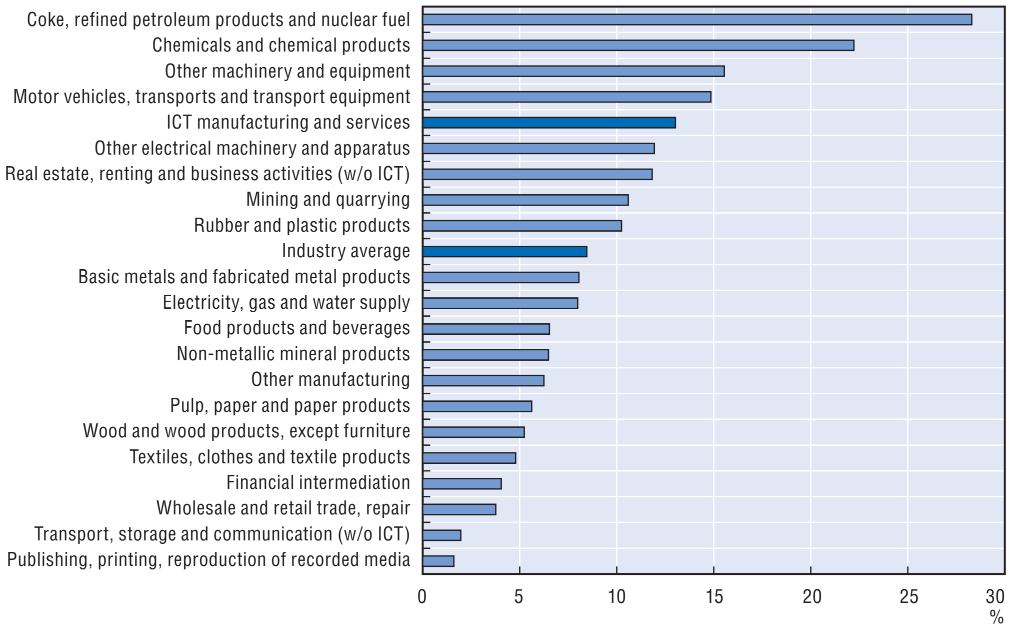
In sum, ICT companies increasingly use in-house R&D and their knowledge base (including their intellectual property portfolios) to build increasingly complex global innovation networks, to shape global standards, to develop platform strategies and to access globalising markets for knowledge workers (Ernst, 2008; Dedrick and Kraemer, 2008, ITIF, 2008).

In spite of these many examples, there is little comparable data on expenditures and on the impact of R&D collaboration and alliances. While industry alliance databases show increasing numbers of ICT alliances, they are often incomplete or not available for recent years.[29] Available data show that corporate funding of collaboration is low, especially when compared to participating companies' internal R&D expenditures. Official data on collaboration on R&D for the United States in 2005 show that USD 745 million was spent by industry for collaborative R&D projects in computer and electronic products, less than 2% of the field's total R&D expenditures (National Science Board, 2008).[30] Moreover, R&D outsourcing made up less than 3% of total computer and electronics R&D, compared to much higher shares of contracted-out R&D for pharmaceutical companies (13%), for example.[31]

The extent of innovative ICT firms' co-operation can be analysed from innovation surveys, which cover co-operation on innovation activities beyond R&D (*e.g.* joint marketing), but exclude pure contracting out.[32] On this broad definition, the ICT sector is one of the most collaborative sectors after the energy and chemical industries. Among innovative ICT firms in four EU countries, about 34% engage in some type of collaboration for innovation (against 24% of all firms), and 13% of ICT firms co-operate with universities and public research organisations (against 8.5% of all firms) (Figure 3.17).

Figure 3.17. **Co-operation of innovative firms with universities or higher education institutions per industry sector, four EU countries (France, Germany, Spain and the United Kingdom), 2002-04**

Percentages



StatLink http://dx.doi.org/10.1787/474448721826

Source: Fourth Community Innovation Survey (CIS4), OECD calculations.

Overall these data suggest that ICT firms and institutions have a large array of co-operative activities, particularly of an exploratory nature, but that the competitive dynamics of the industry mean that most development and innovation close to market is still often tightly held within firms. In sum, ICT R&D collaborations have historically been important and continue to evolve in number and different forms. Yet despite the long tradition and growing importance of externally focussed R&D initiatives in the ICT sector, this phenomenon should not be overestimated. In strategic areas ICT firms still focus firmly on internal development of technology while strongly relying on public-funded R&D. The organisation of joint R&D projects continues to raise potential difficulties relating to the sharing of research results and the protection of strategic company information. Future research and better data will have to shed more light on this complex topic.

Globalisation of ICT R&D

Along with the pharmaceutical, biotechnology, chemical, health and automotive sectors, the ICT industry has considerable foreign R&D investment (UNCTAD, 2005). ICT firms and public research organisations have increasingly internationalised their activities and are establishing R&D laboratories in or links with foreign locations, including in non-OECD countries. The ICT sector thus follows the trend of globalising R&D activities as multinational enterprises increasingly aim to exploit globally available knowledge and skills (MERIT, 2000; OECD, 2008a, 2008c).

At the same time, ICT R&D activities seem less internationalised than those of some other sectors (OECD, 2008c; UNCTAD, 2007). Most ICT firms still conduct most of their R&D in their home country. In 2005 only around 12% of business ICT R&D in the OECD was under foreign control, and most international R&D relationships were among affiliated companies rather than between domestic and foreign-owned ICT firms or laboratories. Moreover, the R&D intensity of affiliates abroad is generally far lower than R&D intensity in the home country. The need for secrecy, strong network effects, the search for spillovers and the high costs of dispersed R&D centres favour concentrating R&D activities in a few places. Globalised business ICT R&D networks are limited in number and often involve leading firms such as Cisco, HP, IBM, Nokia, Motorola, Toshiba, NEC, Microsoft and Google, which are likely to have between five and ten global ICT research centres. However, available data probably do not capture global innovation networks involving smaller firms (Ernst, 2008).

Outside the home country, ICT-related R&D investments are generally within the OECD area, with Japanese and European ICT firms mostly establishing R&D centres in the United States, and US ICT firms mainly establishing centres in Europe but increasingly in Asia (see Box 3.5). Japan and Korea attract comparatively little foreign ICT R&D.

Box 3.5. **R&D activities of US affiliates**

US-based non-bank multinational enterprises have more than doubled the value of their overseas R&D activities through their foreign affiliates since the mid-1990s, to USD 28.3 billion in 2005 or around 15% of total R&D expenditures of US MNEs (home and abroad) (BEA, 2007, and Table 3.6). In 2005, seven countries – the United Kingdom, Germany, Canada, France, Japan, and more recently Singapore and China – accounted for two-thirds of total R&D performed by US foreign affiliates. The share of R&D in Computers and electronic products is about 20% of total US MNE R&D abroad – a share which has fallen slightly – but the share of ICT services has increased to around 5% of total overseas R&D.

Table 3.6. **R&D performed abroad by majority-owned foreign affiliates of US parent companies, 2002-05**

Current USD millions

Industry/sector	2002	2005
All industries	21 063	28 316
Manufacturing	18 736	24 036
Computers and electronic products	4 975	5 376
Non-manufacturing		
Information services and data processing services	24	657
Computer systems design and related services	447	n.a.

StatLink http://dx.doi.org/10.1787/477425810053

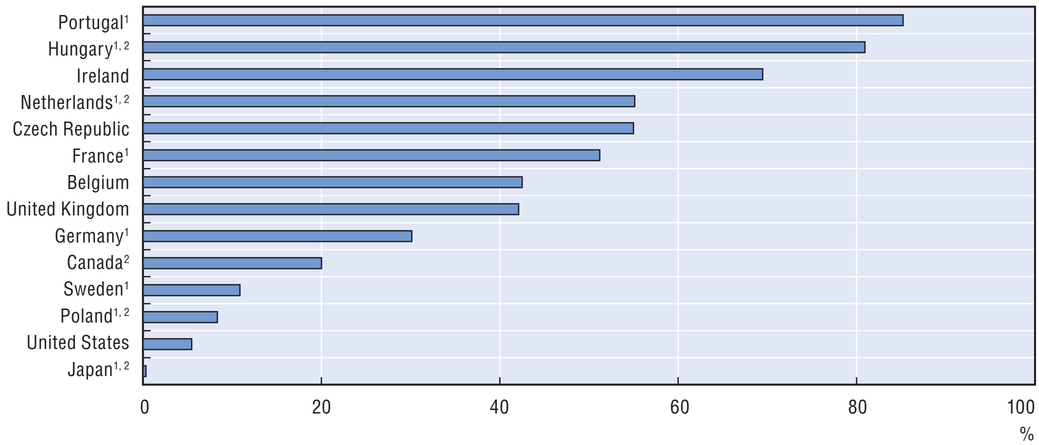
n.a.: not available; data are suppressed for reasons of confidentiality.

Source: National Science Board, 2008; Bureau of Economic Analysis, 2007.

Portugal, Hungary and Ireland have very high shares of ICT R&D under foreign control (over 70%) (Figure 3.18). The United Kingdom and France are among the large European countries in which foreign-controlled R&D exceeds 40%. All of these countries have even higher shares of foreign affiliates in ICT production (*e.g.* the foreign affiliates' share of computer equipment manufacturing turnover exceeded 90% in the Czech Republic and Hungary and is between 50 and 70% in France and the United Kingdom; see Chapter 2). In spite of considerable foreign investment, the overall share of R&D expenditures under foreign control in the ICT sector in the United States remains low.

Figure 3.18. **Share of R&D expenditure under foreign control in the ICT sector, 2005**

Percentages



StatLink http://dx.doi.org/10.1787/474557038777

1. Manufacturing ICT only.
2. 2004.

Source: OECD, *AFA database*, March 2008.

Nonetheless, internationalisation of ICT R&D also increasingly involves establishing ICT R&D centres in emerging economies. The sector is one of the first to have transformed these into fully fledged elements of globalised research networks. This internationalisation is strongly clustered and a few non-OECD locations are increasingly involved: China (Shanghai, Beijing) (OECD, 2006a), Israel (Haifa), India (Bangalore and Delhi), the Russian Federation (Moscow, St. Petersburg), and to a lesser extent Chinese Taipei, Malaysia and Singapore. New locations are also emerging as sources of innovation.

Affiliates under foreign control continue to devote a smaller share of turnover to R&D than national firms. However, in contrast to a few years ago, when foreign R&D, particularly in developing countries, mainly reflected an investment requirement or adapted for local markets, some foreign research activities now complement headquarter research activities. For example, Hewlett Packard's datamining in the Russian Federation, IBM's research on speech technologies in India and embedded systems in China, and Intel/Yahoo!'s software or search technologies in Israel all draw on the local talent pool, domestic firms and research organisations. In addition, ICT firms from emerging markets (*e.g.* Huawei, Tata) increasingly have their own globalised innovation networks.

ICT-related R&D in other industries

ICT-related R&D is increasingly crucial to technological advances and innovation in non-ICT sectors and products.[33] These include space, defence, infrastructure (*e.g.* power grids), automobiles, automation, robots, logistics, aviation, healthcare, environment monitoring, and toys.[34] However, little is known about the extent and impact of ICT-related R&D in these sectors, and these are hard to quantify because ICT R&D conducted in non-ICT industries often cannot be identified separately and its spillovers are hard to measure.

To shed light on this issue, this section first examines official data on ICT R&D of non-ICT firms which result in ICT products (mostly special tabulations from R&D surveys).[35] However, this approach does not measure the ICT research in non-ICT sectors that is an integral, but hidden, part of non-ICT products (*e.g.* embedded systems or software).[36] These data also do not deal with the use of ICTs in R&D in non-ICT industries, *e.g.* in the conception, development or production of products (*e.g.* software to conceptualise an airplane), although they are increasingly used for such purposes.

Non-ICT industry R&D leading to ICT products

Overall analysis of product-field data shows that a large share of the R&D in non-ICT industries, *i.e.* about one-quarter of economy-wide total ICT R&D, leads to ICT products. Moreover, in some non-ICT sectors, expenditures on R&D that result in ICT products are a large share of total R&D expenditures.[37]

Data for European countries show that in the Czech Republic, around 25% of ICT R&D in 2006 was performed in non-ICT industries, mainly real estate, renting and business activities (8%), construction (6%), manufacturing (5%), and financial intermediation (4%). In Denmark, close to 20% of business ICT R&D in 2005 was conducted in non-ICT industries, mainly in machinery, electrical equipment and medical instruments as well as financial intermediation and engineering and technical testing. This ICT R&D was predominantly devoted to product development rather than basic or applied research (Bloch and Graversen, 2007).

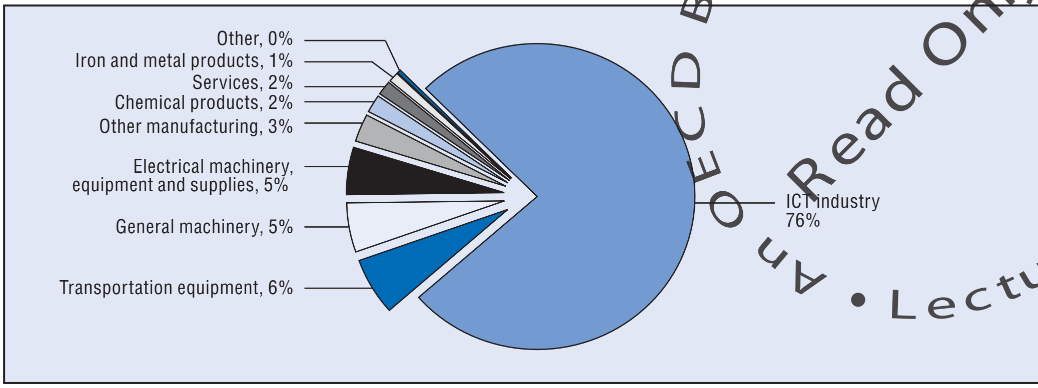
In Norway, around 25% of ICT R&D in 2006 was performed outside the ICT sector (Statistics Norway, 2008). The Norwegian financial and insurance sector accounts for half of these ICT R&D expenditures. The rest is distributed across all other manufacturing and service industries with some noteworthy shares in engineering and technical testing (3.5%) and manufacturing of machinery and equipment (2%). In many non-ICT, often traditional industries, the ICT R&D budget represents a large share of total R&D: 88% of the total R&D budget of publishing, printing and reproduction of recorded media, 65 to 95% in financial and insurance services, 28% in construction and 21% in wood manufacturing. In Finland, on the other hand, almost all ICT R&D expenditures are still in the ICT industry itself.

In the Asia-Pacific region, the trends are similar. In Japan, in 2006 USD 5.5 billion was spent on ICT-related R&D activities outside the ICT industry, or 24% of economy-wide ICT R&D spending (Figure 3.19). The biggest share was in transport equipment, which is dominated by the country's carmakers and suppliers, and in electrical and general machinery manufacturing. In Australia, non-ICT-industries were responsible for over 60% of all ICT R&D expenditure in 2005-06 (up from 55% two years earlier). Finance and insurance represented 34%, largely owing to in-house R&D of large Australian banks.

Software development plays a particularly important role in ICT R&D expenditures of non-ICT industries, notably in finance and publishing, but also in manufacturing

Figure 3.19. **Japanese ICT R&D expenditures, in ICT and non-ICT sectors, 2006**

Percentages



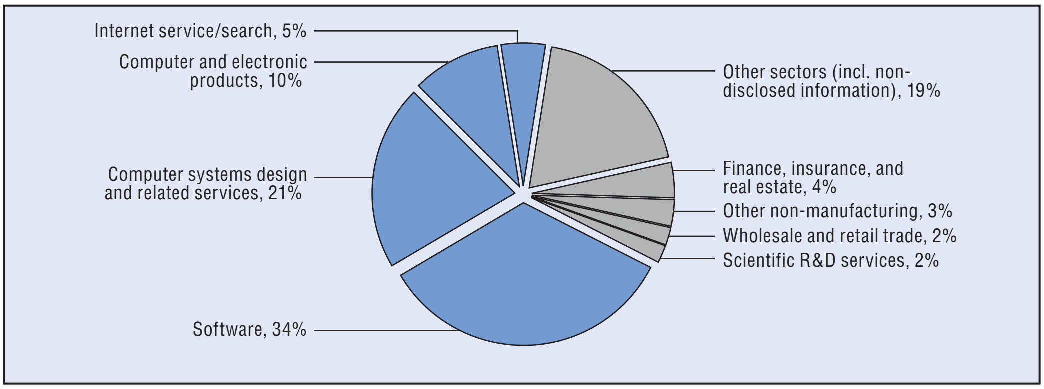
StatLink http://dx.doi.org/10.1787/474561275655

Source: Japanese Statistics Bureau, 2007.

(*e.g.* machinery). In Australia, software R&D accounts for most ICT-related R&D in the Australian manufacturing, wholesale and retail trade sectors. The National Bank of Australia, for example, spent AUD 253 million (6% of revenue) on internal development in 2006. Software development constitutes more than half of ICT R&D in the Czech Republic's financial intermediation, wholesale and retail trade, and motor vehicle repair sectors.[38] In the United States in 2005 about 30% of software was developed by non-ICT industries – chemical, finance and insurance, automotive and real estate sectors, other manufacturing activities, and service activities such as newspapers and architecture (Figure 3.20) (see Jankowski, 2001). In Germany, non-ICT industries employ an increasing number of software engineers; sometimes more than the IT industry itself (BITKOM, 2007).

Figure 3.20. **Software development in industrial R&D, United States, 2005**

Percentage of total software development



StatLink http://dx.doi.org/10.1787/474626703743

Source: National Science Foundation (2007).

Embedded systems and software in non-ICT industries

A growing amount of ICT-related research results in outputs which are an integral part of non-ICT products (embedded systems or software) to improve their performance and efficiency. This is usually not measured or is underestimated in the product-field data.

Industry associations and private consultancy reports put the 2008 market value for embedded systems at around EUR 138 billion and for embedded software at EUR 1.5 billion (BITKOM, 2007); this is equivalent to around 2.5% of total worldwide ICT spending (see Chapter 1). The market for embedded systems is growing rapidly (FAST, 2005). 60% of global semiconductor revenues, for example, came from uses outside the traditional computer market in 2007 (see Chapter 1).[39] Corporate R&D strategies as well as many R&D policies and programmes prioritise the development of embedded systems (see Figure 3.1 and Table 3.5).[40]

A substantial share of the research for these embedded systems is conducted by the ICT industry itself and is captured by ICT industry R&D expenditures. In particular computing and telecommunications have been bigger producers and users of embedded systems than the automotive, medical and other sectors (FAST, 2005). In the United States, for example, ICT firms other than software firms still account for most R&D expenditures for software development despite the growing share in non-ICT industries (National Science Board, 2008; Figure 3.20).[41] In China, the leading producers of embedded software are also communication equipment firms such as ZTE or the consumer electronics firm Haier.

However, R&D on embedded systems is increasingly used outside the ICT sector even if generated in the sector. Semiconductor R&D in particular is catering to the growing commercial interests of the non-ICT industry. Manufacturers such as Intel, Samsung, Texas Instruments, Toshiba, Renesas, Freescale and STMicroelectronics have increasing revenues from these activities.

Non-ICT firms in fields such as electrical engineering have also specialised in ICT R&D (Bosch and Continental develop products for the automotive industry, see Box 3.6). In official statistics, this would probably be captured as R&D in manufacturing of electrical equipment (main activity) or by R&D for automotive products (product field) but not as ICT-related R&D. This therefore complicates the analysis of the development of embedded systems. Furthermore, the process of gearing ICT research results to non-ICT products and the development of embedded systems is seldom simple and often requires substantial R&D by the non-ICT firms to adapt and integrate the technologies (Mortensen and Bloch, 2006).[42]

Box 3.6. **Embedded systems in cars**

The automobile sector is under pressure to improve its energy efficiency, to reduce its environmental footprint and to increase passenger and pedestrian security. ICT research is playing a major role to improve the competitiveness of automobile companies and to address these challenges. A modern, high-end car features about 80 embedded systems which are organised in various domain-specific networks. It has been suggested that a car's electronics cost more than the steel used to build it, and that high-end cars can have more than 100 central processing units (BITKOM, 2007). The same sources forecast that the software code volumes necessary for a car will soon rival the software code of computer operating systems.

Embedded systems and software are mostly used for security, multimedia and the interface between the driver and the automobile. Standard components are electronic fuel injection or anti-lock brakes. Advanced driver assistance systems include brake assist systems, lane departure warning systems, Adaptive Cruise Control (ACC), blind spot detection, driver

Box 3.6. Embedded systems in cars *(cont.)*

drowsiness monitoring and warning, emergency calls, Electronic Stability Control (ESC), night vision, obstacle and collision warning and voice recognition. Finally, meeting emission standards is only possible with new electronics and embedded systems. Safety measures go beyond in-car electronics: new traffic safety systems make use of communication between cars, modern networks and the road infrastructure (Kompetenznetze Deutschland, 2007).

This focus on ICT R&D is reflected in increasing ICT expenditures by and for the automotive sector. For example, German automotive companies have far higher R&D intensities than the international averages, partly because of the increasing ICT-related R&D (Federal Ministry of Education and Research, Germany, 2007). Germany has also seen automotive original equipment suppliers specialise in the provision of ICT-related R&D. Continental Corporation, for instance, with revenues of EUR 16.6 billion in 2007 and almost 152 000 employees, evolved from a tyre manufacturer to a leading supplier of brake technology, vehicle dynamics control, electronics and sensor systems. Other leading microelectronics and automotive suppliers such as Bosch contribute to ICT and microelectronics research.

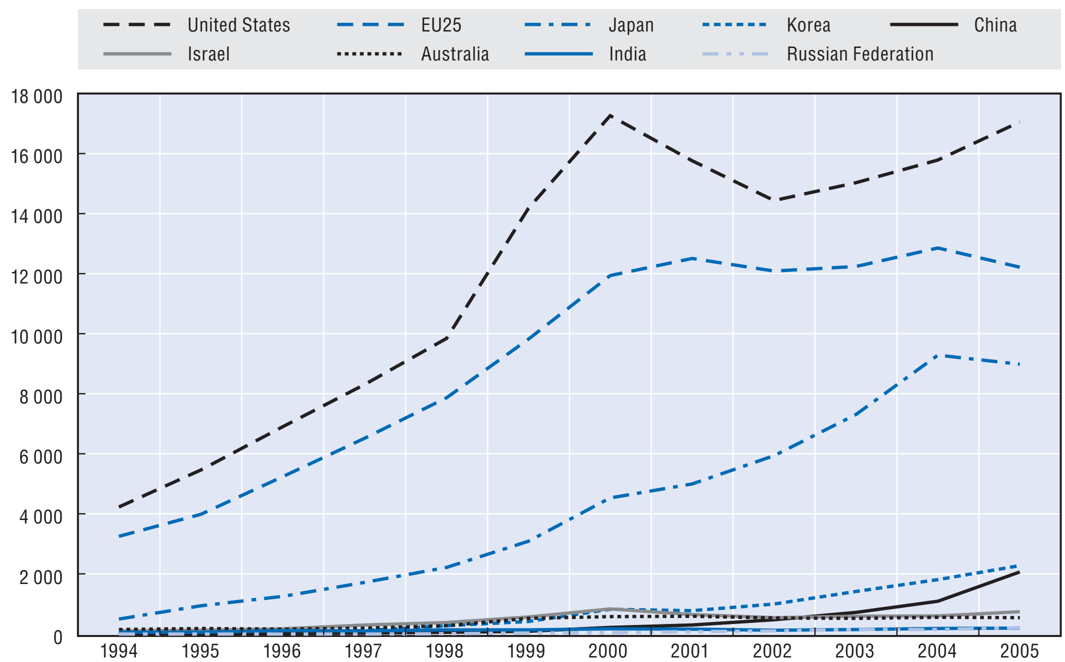
Sources: German Association for Electrical, Electronic and Information Technologies; German Association of the Automotive Industry (VDA), *www.vda.de/en/aktuell/statistik/jahreszahlen/allgemeines/index.html*; BITKOM, 2007; and Centre for Automotive Safety Research at the University of Adelaide. OECD (2008d) provides more details on the importance of broadband networks to modern transport and road management systems.

ICT-related patents and R&D expenditures

Patent data can be used as an indicator of R&D output although they are a trailing rather than a leading indicator.[43] The number of ICT-related patents grew very strongly from the mid-1990s to 2005 when over 50 000 international ICT-related patent applications were filed

Figure 3.21. **ICT-related patents filed under the PCT, by country, 1994-2005**

Number of patents



StatLink http://dx.doi.org/10.1787/474628656187

Source: OECD, *Patent database*, March 2008.

under the Patent Co-operation Treaty (PCT) with an average increase of 5% a year (CAGR) over 2000-05 (see Annex Box 3.A1.2 and OECD, 2007c for definitions). From 2000 to 2004, ICTs were the third fastest-growing technical field among PCT international applications (+28%), behind medical (+32.2%) and audiovisual technology (+28.3%) (WIPO, 2008).

The United States, Europe and Japan continue to lead in terms of total PCT applications (Figure 3.21). The number of ICT-related patent applications grew strongly in Korea and in China, with 2 308 and 2 099 international patents, respectively, in 2005; Chinese ICT patents more than doubled between 2004 and 2005. Resident ICT patent filings in the home country have grown particularly strongly in Korea and China. The main drivers are Samsung Electronics, (Korea), LG Electronics (Korea), Huawei Technologies (China), Electronics and Telecommunications Research Institute (Korea), ZTE Corporation (China) and NHN Corporation (Korea).

ICT-related patents represent on average 36.5% of total PCT filings and the share of ICT patents in total patents has been rising in almost all countries since the late 1990s (Figure 3.22). The shares are higher in some countries (Figure 3.23) owing to the focus on ICT inventions in Finland (59% of all national PCT filings), Singapore (56%), the Netherlands (48%), Korea (44%) and Japan (41%). The proportion of ICT patents in total Chinese filings tripled in a decade, from 17.3% in 1996-98 to 50.3% in 2002-05. India, the Russian Federation, South Africa, Brazil, Chile and other OECD enhanced engagement or accession countries are lower, with Israel as the exception. The United States (35% of all ICT-related patents), Japan (18%) and Germany (8%) lead in ICT-related patenting under the PCT and together make up well over half of ICT patent filings. Korea stands sixth, just before China, which is ahead of many other OECD economies.

Patent data also reveal that ICT patents are more internationalised than patents of other sectors: 17.5% of all ICT patents granted between 2001 and 2003 involve cross-border ownership (OECD, 2007c). Non-OECD countries such as China, India, Brazil and the Russian Federation still show a high level of foreign ownership in ICT-related patents. Patent data also confirm the increasing role of non ICT-industries in ICT R&D and innovation. In Europe, for example, the automotive sector accounted for 4% of total software patents (Hall *et al.*, 2006).

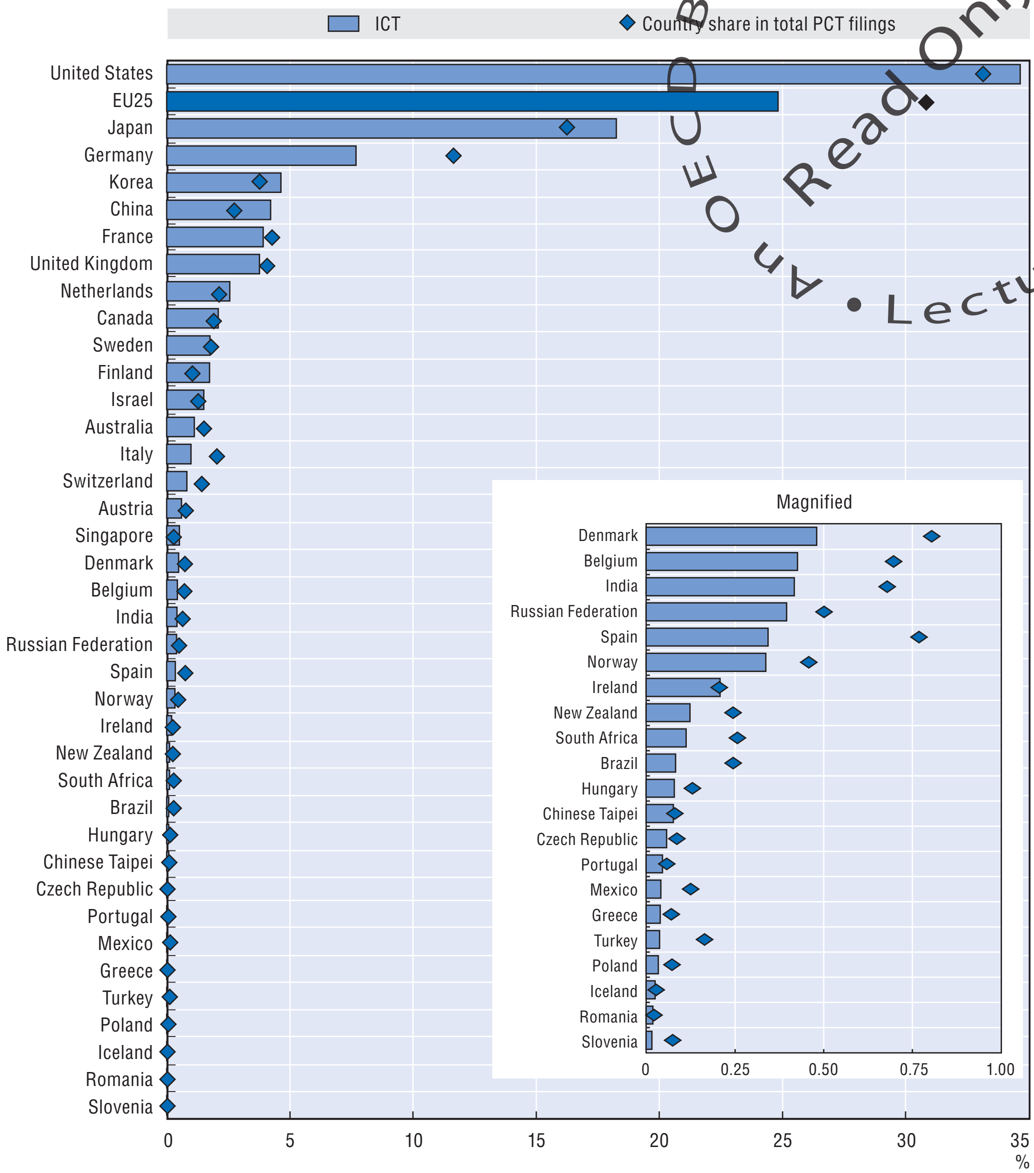
ICT firms as patent applicants

ICT firms occupy the top positions with respect to patents granted or applications for patents. Patent grants result from applications a few years earlier and are more a retrospective than prospective indicator. As shown in Table 3.7, 18 ICT firms are among the first 20 firms with patents granted by the United States Patent and Trademark Office (USPTO).[44] The top 20 are stable over time, but Samsung (now second, closing the gap with IBM), LG Electronics and Microsoft have made a significant jump in US patent applications. ICT service and Internet firms such as Google and Yahoo! do not have large numbers of patents.

Patent applications are potentially a better way to analyse trends in ICT inventions than patent grants as they reflect more recent activity (Table 3.8). The majority of the top 20 patent applicants in Europe, Japan and under the PCT are ICT firms: 13 out of 20 in Europe, 14 out of 20 in Japan, and 16 out of 20 under the PCT.[45] No ICT firm from outside the OECD region or from OECD accession/enhanced engagement countries is in the top 20 firms granted patents in the United States or among the top 20 applicants at the European Patent Office (EPO) or the Japan Patent Office (JPO). The picture is different for

Figure 3.22. **Share of countries in ICT-related patents filed under the PCT,[1] 2005**

Percentages



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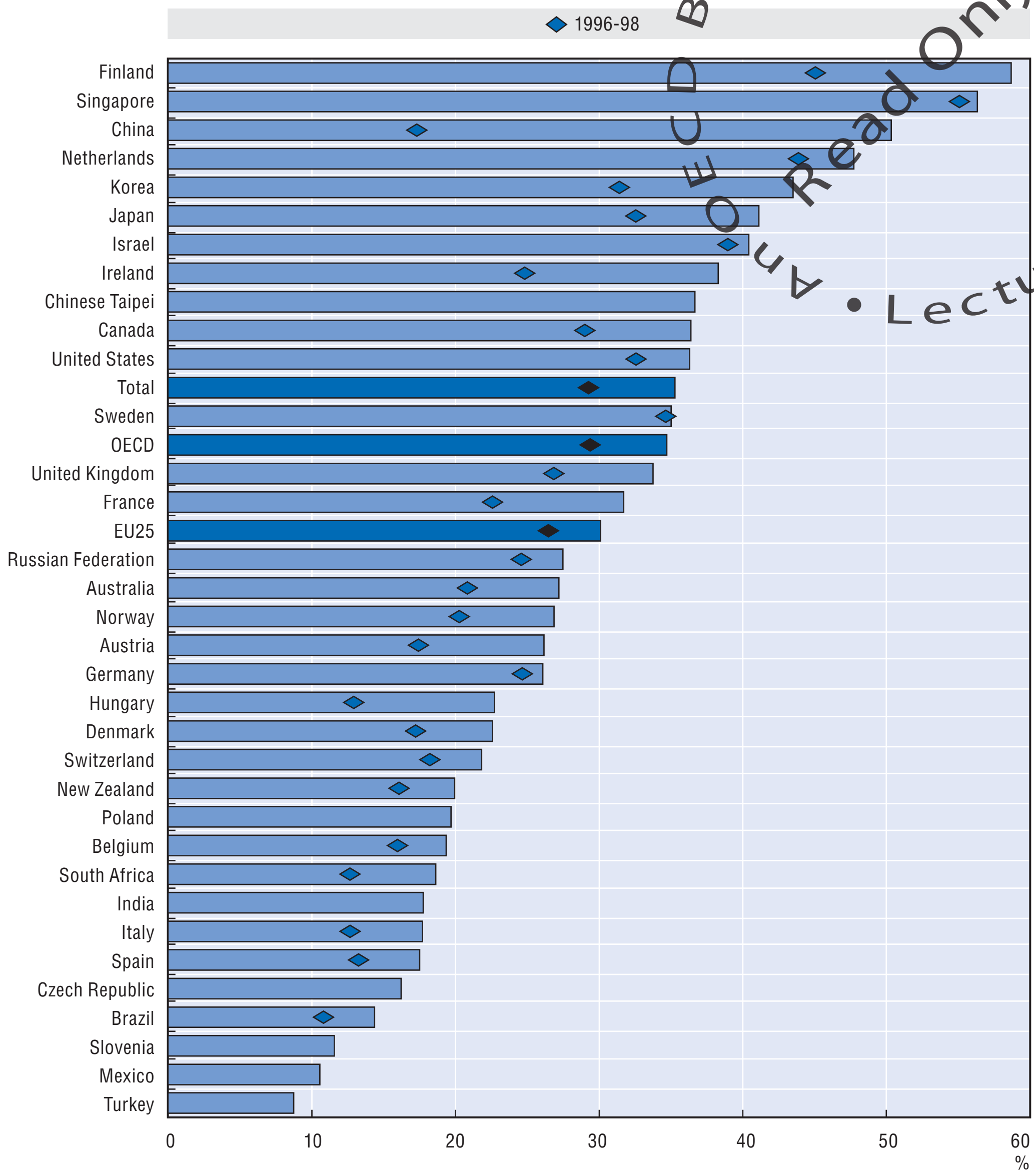
1. Patent applications filed under the PCT, at international phase, designating the European Patent Office.

Source: OECD, *Patent database*, March 2008.

applications under the PCT. Whereas Huawei occupies slot number 93 at the EPO (1 365 applications in 2007, according to Eurostat, 2007), it is in fourth position for PCT patent applications.

Patent applications rose by 41% from 2006 to 2007 at the Chinese patent office (SIPO), owing in large part to ICT applications (mainly for communication equipment).[46] In 2007, Huawei (1 544 applications) and ZTE ranked first and second. Four out of ten patent applications came from foreign entities, and firms from Chinese Taipei are among the top ten applicants. Samsung was the leader in foreign patent applications in China. Matsushita Electric, Philips and IBM were also among the leaders.

Figure 3.23. **ICT-related patents as a percentage of national total,[1] PCT filings,[2] 2003-05**



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1. Only countries with more than 250 PCT filings during 2003-05 are included in the graph.
2. Patent applications filed under the Patent Co-operation Treaty, at international phase, designating the European Patent Office.

Note: Patent counts are based on the priority date, the inventor's country of residence and fractional counting.

Source: OECD, *Patent database*, March 2008.

Figures 3.24 and 3.25 plot the ICT R&D expenditure (2002-04) of leading ICT firms against their lagged patenting activity in 2006 – patents granted by the USPTO and patent applications to the EPO, JPO and PCT. While ICT firms tend to engage in R&D and related ICT patenting, there is not necessarily a clear correlation at the firm level. Some firms with high R&D expenditures were granted or applied for few ICT patents. USPTO patents granted are low relative to the R&D expenditures of some large ICT firms such as Microsoft, Siemens, Nokia, NTT and Ericsson. At the EPO, the firms that patent relatively less than

Table 3.7. **Top 20 ICT patenting firms among patents granted (all industries) by the USPTO number of patents, 2007**

United States, 2007
1. IBM Corporation, United States, 3 125
2. Samsung Electronics, Korea, 2 723
3. Canon Inc., Japan, 1 983
4. Matsushita Electric Industrial, Japan, 1 910
5. Intel Corp., United States, 1 864
6. Microsoft Corp., United States, 1 637
7. Toshiba Corporation, Japan, 1 519
8. Micron Technology, United States, 1 476
9. Hewlett Packard, United States, 1 466
10. Sony Corp., Japan, 1 454
11. Hitachi, Ltd, Japan, 1 381
12. Fujitsu Limited, Japan, 1 293
13. Seiko Epson, Japan, 1 205
15. Infineon Tech AG, Germany, 847
17. Texas Instruments, United States, 749
18. Ricoh, Japan, 727
19. Siemens, Germany, 698
20. LG Electronics, Korea, 682

Note: The USPTO does not publish patent applications but patents granted. Figures show the total number of patents granted to these firms and not only ICT-related patents as defined in Annex Box 3.A1.2.
Source: USPTO (2008).

Table 3.8. **Position of ICT firms among the top 20 patent applicants (all industries) at the European Patent Office, Japan Patent Office, and the PCT, 2007 or latest available year**

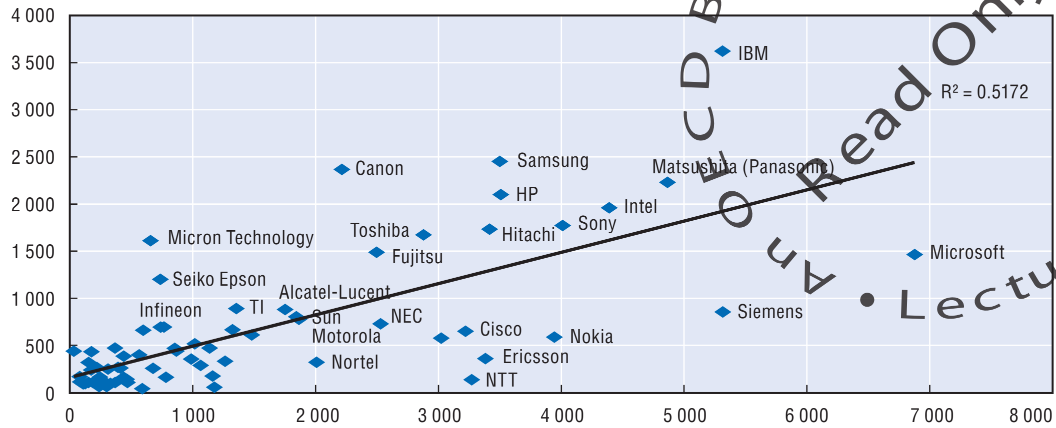
Europe, 2007	Japan, 2006	PCT, 2007
1. Phillips, Netherlands, 3 222	1. Matsushita, Japan, 13 842	1. Matsushita, Japan, 2 100
2. Samsung, Korea, 2 478	3. Canon, Japan, 8 317	2. Phillips, Netherlands, 2 041
3. Siemens, Germany, 1 850	4. Toshiba, Japan, 8 104	3. Siemens, Germany, 1 644
5. Matsushita, Japan, 1 395	5. Seiko Epson, Japan, 8 000	4. Huawei Technologies, China, 1 365
7. LG Electronics, Korea, 1 080	6. Sharp, Japan, 5 992	7. Qualcomm Inc, United States, 974
8. Sony, Japan, 929	7. Ricoh, Japan, 5 953	8. Microsoft Corp, United States, 845
9. Nokia, Finland, 873	9. Sony, Japan, 5 419	9. Motorola, United States, 824
10. Fujitsu, Japan, 819	10. Fujitsu, Japan, 4 923	10. Nokia Corp, Finland, 822
13. Hitachi, Japan, 755	11. Mitsubishi Electric, Japan, 4 697	13. LG Electronics, Korea, 719
15. NXP, Netherlands, 670	12. Hitachi, Japan, 4 485	14. Fujitsu, Japan, 708
16. Qualcomm, United States, 669	14. Fuji Xerox, Japan, 4 012	15. Sharp, Japan, 702
19. IBM, United States, 631	15. NEC, Japan, 3 318	16. NEC Corporation, Japan, 626
20. 3M, United States, 584	16. Sanyo Electric, Japan, 3 099	17. Intel, United States, 623
	20. Samsung Electronics, Korea, 2 536	18. Pioneer, United States, 611
		19. IBM, United States, 606
		20. Samsung, Korea, 598

Note: Figures show the total number of patents applied for by firms and not only ICT-related patents as defined in Annex Box 3.A1.2.
Source: EPO, 2008; Japan Patent Office; *WIPO patent database* (PCT applications).

other ICT firms are Microsoft, IBM, Intel, HP and Cisco. This also reflects the geographic location of the patent office and firm strategies, but some firms (*e.g.* Microsoft) systematically take out relatively few patents in relation to R&D expenditure. Japanese and

Figure 3.24. **ICT-related patents granted at the USPTO *versus* R&D expenditures**

Patents granted in 2006 (y axis); average R&D expenditure 2002-04 in USD millions (x axis)

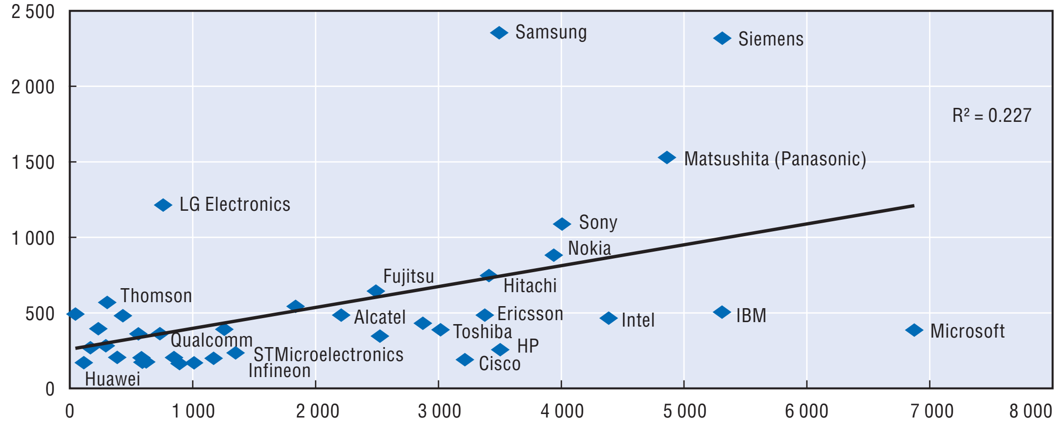


StatLink http://dx.doi.org/10.1787/474816575282

Source: USPTO and *OECD Information Technology Outlook database.*

Figure 3.25. **ICT-related patent applications at the EPO *versus* R&D expenditures**

Patent applications in 2006 (y axis); Average R&D expenditure 2002-04 in USD millions (x axis)



StatLink http://dx.doi.org/10.1787/474826775765

Note: Philips is not included.

Source: EPO and *OECD Information Technology Outlook database.*

Korean ICT firms seem instead to be very active in patenting in non-Asian patent offices when compared with R&D expenditures, and Chinese ICT firms are following their lead.

Strong growth in ICT sector patenting is first and foremost a result of high R&D expenditures and the innovative nature of the ICT sector. It also reflects the trend towards more patenting, new ICT sub-sectors, patenting by non-OECD ICT firms, and the rise of new forms of patenting (*e.g.* of software or business methods in certain OECD countries). Additional drivers are strategies to take out multitudes of patents (so-called patent thickets) or to bring technologies to market; interest in licensing technologies (including by firms specialising in patenting); the desire to ward off patent disputes; and the building of a domestic technology base to avoid paying royalties.

The ICT sector has also played a leading role in post-R&D alliances, product innovation and other innovation related to intellectual property. ICT firms have long been, and are increasingly, engaged in strategies involving, for example, technology cross-licensing (including to competitors), the creation of patent pools (*e.g.* the MPEG-2 patent pool), patent clearinghouses, the granting of patents to wide communities of users (*e.g.* IBM). These commercial exchanges of intellectual property allow for combining patented technologies from various sources into new products, for potentially avoiding patent disputes, and for facilitating product innovation at lower costs.

However, the overall impact of increased patenting and of new intellectual property alliances on innovation and the patent system remains unclear. Patent data need to be complemented by research that seeks to establish better patent quality indicators and links with the measurement of innovation.

Conclusion

The ICT industry leads in R&D expenditures, employment and patents, and the software and semiconductor sectors are particularly R&D-intensive. The share of ICT R&D conducted in non-ICT industries is also high (about one-quarter of total ICT R&D), and in some non-ICT sectors, ICT R&D spending (especially software-related) accounts for a large share of total R&D. The United States and Japan still have a large lead in terms of ICT firms' R&D expenditures and of ICT firms that spend the most. Korea has caught up impressively in this area. Although some other OECD and non-OECD countries also have relatively high levels of ICT R&D spending, ICT R&D expenditures from non-OECD ICT firms (especially from China and India, but also other emerging economies) are still comparatively low. However, new ICT firms from non-OECD countries are emerging rapidly, are increasingly R&D-intensive, and are rapidly forging new partnerships with OECD ICT firms and research organisations.

The organisation of R&D in the ICT sector continues to evolve, in particular around new kinds of collaboration (involving emerging ICT sub-sectors or common standards and technology platforms). The sector's research activities are increasingly international, although ICT firms commonly form global R&D networks with a limited number of global R&D centres located in only a few locations. Moreover, the reliance on long-term ICT-related public R&D and public-private collaboration continues to be important for the ICT sector (see Chapter 7). There has been a striking increase in the number of ICT patents in the OECD region (in particular from Korea) but also from non-OECD ICT firms (*e.g.* some Chinese firms).

Countries and firms have laid out ambitious ICT research priorities, which matter not only for innovation in the sector but increasingly for non-ICT sectors and for tackling societal challenges. OECD and non-OECD countries need to reassess the balance between public and private ICT R&D and the appropriate mix of short and long-term incentives and support for ICT research and innovation in the context of internationalisation and location of ICT firms, their R&D activities and high skill requirements.

Notes

1. See for instance DCITA (2007) on ICT R&D spillovers.
2. For other compilations of ICT-related research challenges, see Dachs and Zahradnik (2005); Jordan (2008); National Academy of Engineering, Grand Challenges for Engineering, *www.engineeringchallenges.org*; UK Computing Research Committee, Grand Challenges in Computer Research, *www.ukcrc.org.uk/grand_challenges*.

3. Early US High Performance Computing and Communications programmes (the predecessor of the Networking and Information Technology Research and Development programme, NITRD) only indicated ICT security as a sub-part of research into network infrastructures as did the EU's Fourth Framework Programme (FP4). The recent NITRD and the FP7 name ICT security as high-level research challenges; see also National Research Council (2007).
4. See Methodology and Definitions Annex for the definition of the ICT sector used for R&D expenditures.
5. Definitions for R&D figures follow the *Frascati Manual*: OECD (2002b).
6. The data are for 77 non-OECD countries and territories.
7. Industrial research and development is defined as R&D activities carried out in the business enterprise sector, regardless of the origin of funding.
8. More than one-third of total business R&D is carried out in the services sector in: Australia (47%), Norway (42%), Canada (39%), Ireland (39%), the Czech Republic (38%), the United States (36%) and Denmark (34%). In Korea, Germany and Japan less than 10% of business R&D is in the services sector, but this may also partly reflect the limited coverage of services in their R&D surveys.
9. For Canada, see Industry Canada (2007); for Japan, see MIC (2007).
10. Austria, Australia, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, Portugal, Spain, the United Kingdom and the United States.
11. There is a break in series in the US data from 2003 to 2005 and this may largely explain the apparent decline in US ICT sector expenditures between 2003 and 2005.
12. This mirrors findings of a positive relationship between the size of a country and its propensity to invest in R&D (Guellec, 1999).
13. Canada because of major reductions in R&D spending by the communications equipment manufacturing industries; Australia because of declining activities of Telstra's Research Laboratories, closure of ICT related Cooperative Research Centres and withdrawals of a number of major multinational firms from R&D activities in Australia (*e.g.* Ericsson, Motorola and Nortel) (Houghton, 2007).
14. Because of the break in series in US data between 2003 and 2005 the US data are not directly comparable over time.
15. Austria, Australia, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Mexico, the Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Switzerland, the United Kingdom and the United States.
16. The comparison is between two different samples of firms: the top 100 firms by R&D expenditures in 2001 and the top 100 firms by R&D expenditures in 2006.
17. In accordance with European legislation and SEC rules, Siemens changed accounting principles from GAAP to IFRS starting Q1 2007 and does not provide a reconciliation of R&D expenditures. Therefore, Siemens' R&D expenditures are only available until 2006 according to GAAP and only from 2005 according to IFRS. In 2006, R&D expenditures reported under GAAP were EUR 5 billion, but under IFRS only EUR 3 billion, a difference of 40%.
18. See van Pottelsberghe (2008) on the links between publicly and privately funded R&D.
19. Cambridge and Route 128 in Massachusetts; the Silicon Hills of Austin, Texas; Champaign County in Illinois; Silicon Valley in California.
20. Since 2000, GBAORD grew by 8% annually across the OECD, from USD 197 billion in 2000 to USD 293 billion in 2006 (in current PPP USD) (OECD, 2008a).
21. US spending for defence R&D is double the OECD average of 0.3% of GDP. Russia's defence R&D budget was 0.4% of GDP in 2003. Intensities should be seen in the context of the United States' large GDP (see OECD, 2008a; OECD, *Main Science and Technology Indicators* [MSTI] *database* 2007/2).
22. Estimates were produced by GFII (2007); projects of the European Commission to produce further estimates are under way.
23. All three enjoy high priority due to their location at the highest policy-making level (United States: Executive Office of the President, Japan: PM's Cabinet Office, EU: European Commission, adopted by the European Parliament and European Council).

24. *Sources:* National Coordination Office for Networking and Information Technology Research and Development, United States, *www.nitrd.gov*; Council for Science and Technology Policy, Japan, *www8.cao.go.jp/cstp/siryo/haihu73/siryo2.pdf* and Ministry of Education, Culture, Sports, Science and Technology, Japan, *www.mext.go.jp/english/kagaku/index.htm*; Community R&D Information Service, *http://cordis.europa.eu/fp7*; Federal Ministry of Education and Research, Germany, *www.bmbf.de/en/9069.php*; Networks of Centres of Excellence Program, Canada, *www.nce.gc.ca*; TEKES, Finland, *www.tekes.fi/eng/programmes/all*; Government of India Planning Commission, *http://planningcommission.nic.in/plans/planrel/11thf.htm*; Government of the People's Republic of China, *www.gov.cn/jrzg/2006-02/09/content_183787.htm* and National Natural Science Foundation of China, *www.nsfc.gov.cn/english/06gp/index.html*.
25. Open innovation comprises *i)* sourcing and integrating external knowledge of customers, suppliers, universities, research organisations, competitors; *ii)* bringing ideas to market, selling/licensing intellectual property and multiplying technology; and *iii)* working in alliances with complementarities (Chesbrough, 2003; Enkel and Gassmann, 2004; Chesbrough *et al.*, 2006; OECD, 2008b).
26. Examples of partnerships with universities include: Oracle and CERN (European Organisation for Nuclear Research) for grid computing technologies; Microsoft, Nokia, Hitachi and Toshiba with research centres at the University of Cambridge; Fujitsu with the Universities of Tokyo and Cambridge on quantum technologies.
27. The objective of the ITRS is to ensure advances in the performance of integrated circuits and to remove roadblocks to the continuation of Moore's Law. This assessment, called roadmapping, is a co-operative effort of global industry manufacturers and suppliers, government organisations, consortia, and universities. See *www.itrs.net*.
28. For more information on particular collaborations, see RAD Lab, *http://radlab.cs.berkeley.edu*; IBM and Google partnership, *www.ibm.com/ibm/ideasfromibm/us/google*; RESERVOIR, *ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/ssai/project-reservoir_en.pdf*; Microsoft, "Microsoft and Intel Launch Parallel Computing Research Centers to Accelerate Benefits to Consumers, Businesses", Press Release, 18 March 2008, *www.microsoft.com/presspass/press/2008/mar08/03-18UPCRCPR.mspx*; "Baidu, Huawei to form joint lab", *China Business News*, 17/12/2007.
29. See *e.g.* Hagedoorn (2001). Two information sources are the Co-operative Agreements and Technology Indicators database of the Maastricht Economic Research Institute on Innovation and Technology (CATI-MERIT) last updated in 2003 and the Thomas Database from which it is hard to separate R&D alliances from other alliances and obtain time-series data. See also National Science Board (2008).
30. The data do not cover possible international R&D collaborations or ICT services.
31. See also "NAICS and the ICT Sector (An analysis)", 1998, prepared by the United States Bureau of the Census, OECD, Paris (internal OECD working document).
32. The European Union's Fourth Community Innovation Survey (CIS4) measures four types of innovation as defined in the *Oslo Manual*: product, process, organisational, and marketing (OECD, 2005b). *Product innovations* involve significant changes in the capabilities of goods or services. Both entirely new goods and services and significant improvements to existing products are included. *Process innovations* represent significant changes in production and delivery methods. *Organisational innovations* refer to the implementation of new organisational methods. These can be changes in business practices, in workplace organisation or in the firm's external relations. *Marketing innovations* involve the implementation of new marketing methods. These can include changes in product design and packaging, in product promotion and placement, and in methods for pricing goods and services. In the CIS4, innovation co-operation measures the active partnership of the observed enterprise with other enterprises or non-commercial institutions such as universities or public research institutes. Co-operation can take place with more than one partner.
33. This section does not include ICTs in research, *e.g.* virtual modelling in the design of aircraft, except in cases where the ICT becomes part of the final product.
34. Often-cited anecdotal evidence indicates that over 80-90% of all integrated circuits and computing hardware are not in PCs but are embedded in other products (Artemis, 2006; BITKOM, 2007).
35. Data and specific tabulations for this chapter are based on: for Australia, the Australian Bureau of Statistics (ABS), see also DBCDE (2006); for the Czech Republic, the annual business R&D survey conducted by the Czech Statistical Office (CSO, 2008), with special tabulations provided to the OECD; for Denmark, Bloch and Graversen (2007); for Finland, provided by Statistics Finland; for

Germany, results of a business R&D survey published in Stifterverband (2007), special tabulations were provided by the Stifterverband für die Deutsche Wissenschaft; for Japan, Japanese Statistics Bureau (2003, 2005, 2007); for Norway, Statistics Norway (2008). Cross-country comparison should be treated with care due to different classifications, definitions, and survey designs.

36. In regular surveys following the "principal activity" approach, research by the automotive industry would be classified as automotive R&D. In contrast, when using the product-field approach in R&D surveys, firms are asked to indicate the character of the end product of their R&D efforts (independently from their main activity). Under the product-field approach, a car company conducting R&D leading to an ICT product would thus classify the research expenditures as ICT R&D. ICT research results (*e.g.* special chips) which can be identified as an integral part of another product (*e.g.* a car braking system) are classified as R&D in that sector (*e.g.* automotive R&D).

37. Not considered is ICT research which leads to non-ICT products which can also be identified in product-field data.

38. Data provided from the annual R&D survey conducted by the Czech Statistical Office (CSO, 2008).

39. See also the Embedded Software Industry Survey (2007), conducted by the Japanese Ministry of Economy, Trade and Industry (METI), *www.meti.go.jp/policy/it_policy/technology/houkoku.html* and *www.meti.go.jp/policy/it_policy/technology/ ET2007presentation.htm*; and P. Tsarchopoulos, 2008, "Message from the project officer", in *HIPEAC info*, No. 13, January, *www.hipeac.net/system/files/nl13.pdf*.

40. See also PCAST, 2007 (for the United States); and the EU's ARTEMIS (Advanced Research and Technology for Embedded Intelligence and Systems) programme, funded by public-private investment of EUR 5.4 billion between 2007 and 2013, with the aim of achieving "world leadership in intelligent electronic systems" by 2016; see *www.artemis-office.org*.

41. The majority of US and European software patents were obtained by the electronics, telecommunications equipment and machinery industries (Bessen and Hunt, 2007; Hall and MacGarvie, 2006). In Europe, the sector "electronic instruments and telecommunications equipment" alone accounted for 61.9% of software patents, followed by "telecommunications" with 8.2%.

42. See EurActiv.com, "Car industry EU's top R&D investor", 23 October 2006, *www.euractiv.com/en/science/car-industry-eu-top-rd-investor/article-159033* and F. Simonot-Lion and Y. Trinquet (2003), "New Solutions for In-Vehicle Embedded System Development", *ERCIM News*, No. 52, *www.ercim.org/publication/Ercim_News/enw52/simonot-lion.html*.

43. Patents are an indicator of invention rather than innovation since not all patents are commercialised and some types of technology are not patentable.

44. The USPTO does not publish patent applications.

45. Patent applications. However, national patent systems and application procedures are not entirely harmonised and therefore differ. For example, EPO and JPO numbers refer to patent applications *filed* in a given year, whereas PCT statistics cover patent applications *published* that year (18-month time lag). Moreover, the large number of JPO patent applications is largely due to procedural differences (see OECD, 2009).

46. See Chinese Government's Official Web Portal (2006), "SIPO reports fast growth of patent applications", 31 August, *www.gov.cn/english/2006-08/31/content_374694.htm*; and SIPO press releases: "Dramatic Increase of PCT Application in China in 2007", 19 February, *www.sipo.gov.cn/sipo_English/news/official/200802/t20080219_233605.htm* and "China Sees Sharp Increase in Domestic Patent Applications", 30 January, *www.sipo.gov.cn/sipo_English/news/official/200801/t20080130_232476.htm.*

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ANNEX 3.A1

Box 3.A1.1. **When is software development R&D?**

Guidelines on the treatment of software were included in the *OECD Frascati Manual* in 1993. For a software development project to be classified as R&D, its completion must be dependent on the development of a scientific and/or technological advance, and the aim of the project must be resolution of a scientific and/or technological uncertainty on a systematic basis. R&D is, thus, only one of the stages in bringing a new software product to the market and some of the following are considered R&D (not exhaustive):

1. R&D producing new theorems and algorithms in the field of theoretical computer science.
2. Development of IT at the level of operating systems, programming languages, data management, communications software and software development tools.
3. Development of Internet technology.
4. R&D on software tools or technologies in specialised areas of computing (*e.g.* artificial intelligence). Software-related activities of a routine nature are not considered R&D.*

   National and firm-level data do not always follow this complex separation of software activities which are considered R&D and those which are considered "routine": This complicates the task of producing reliable and internationally comparable software R&D figures.

* This relates to work on system-specific or programme-specific advances publicly available prior to the commencement of the work. Elimination of technical problems is excluded, as are support activities, converting and/or translating computer languages, adding user functionality to applications, debugging, adaptation of existing software, preparation of user documentation which does not involve scientific and/or technological advances, and market research.

Source: OECD *Frascati Manual* (2002b); OECD (1996).

Box 3.A1.2. **Definition of ICT patents**

Within a patent document, several sections can be analysed in order to connect the patent to the relevant technology: the International Patent Classification system (IPC) and the national patent classification system; the title of the invention; the abstract describing the invention and the list of claims. One or several classification codes are attributed during the patent examination process. However, for emerging technologies, a specific category or class might not yet be incorporated in the patent classification systems, which makes it difficult to identify patents related to these technologies afterwards. Therefore, to select patents related to specific technological domains, one can either look at the IPC classes and subclasses, and/or search for appropriate keywords within the text fields of the patent document. Such a method might exclude, or include, patents that are, or are not, relevant for a specific domain, but it makes it possible nonetheless to provide a relatively good picture of innovative activity in the technology field.

The 8th edition of IPC is used to identify patents in the ICT or biotechnology sectors. This definition remains provisional, as such fields evolve rapidly.

Patents in the ICT sector can be split into four fields, based on selected IPC classes:

Telecommunications

[G01S,G08C,G09C,H01P,H01Q,H01S3/(025,043,063,067,085,0933,0941,103,133,18,19,25), H1S5,H03B,H03C,H03D, H03H, H03M, H04B, H04J, H04K, H04L, H04M, H04Q]

Consumer electronics

[G11B,H03F,H03G,H03J,H04H,H04N,H04R,H04S]

Computers, office machinery

[B07C,B41J,B41K,G02F,G03G,G05F,G06,G07,G09G,G10L,G11C,H03K,H03L]

Other ICT

[G01B,G01C,G01D,G01F,G01G,G01H,G01J,G01K,G01L,G01M,G01N,G01P,G01R,G01V,G01W,G02B6, G05B, G08G, G09B, H01B11, H01J (11/,13/,15/,17/,19/,21/,23/,25/,27/,29/,31/,33/,40/,41/,43/,45/), H01L]

Source: OECD (2007c). For further details on the IPC classes (IPC, 8th edition, 2006): *www.wipo.int/classifications/ipc/ipc8*.

ISBN 978-92-64-05553-7
OECD Information Technology Outlook 2008

Chapter 4

Broadband and ICT Access and Use by Households and Individuals

Use of the Internet and broadband is spreading rapidly, and 1.5 billion people now have Interent access. Their socio-economic characteristics influence how they use the Internet, and there is evidence that new kinds of "digital use divides" *based on these socio-economic differences are appearing as the original digital access divides narrow. These new divides will need policy attention if they are to be overcome.*

Introduction[1]

The Internet and broadband are part of the everyday life of 1.5 billion people,[2] and the surge in broadband[3] access is providing new paths for innovative Internet use. Over the past decade, information and communication technology (ICT) policy has progressively shifted its focus from ICT readiness to the impacts of use and the more complex aspects of the "information society".

This chapter focuses on how the diffusion of ICTs, the Internet and broadband to households and individuals has developed and how the use of ICTs has changed. It first describes diffusion of, and access to, personal computers, the Internet and broadband in the light of different socio-economic factors. Next, it analyses the impacts of the Internet and broadband on how people allocate their time. Finally, it looks at the different rates of ICT diffusion across various populations, the resultant digital access divides (haves *versus* have-nots), the subsequent use divides (OECD, 2004), and how the use of ICTs is evolving with the uptake of broadband.

Access and use of broadband and selected ICTs: Recent developments

Speed of diffusion

The diffusion of ICTs depends on a range of economic, social and human factors, and often requires skills that are not necessarily needed for other goods and services. For this reason, home personal computers (PCs) initially diffused slowly, requiring at least a decade before they were widely adopted (Annex Table 4.A2.1). In contrast, the mobile phone was adopted very rapidly, as its use is straightforward and requires very few skills in addition to those needed for fixed telephones. Home Internet access, which relied on the PC installed base, diffused much more rapidly than PCs but more slowly than mobile telephones (Sciadas, 2002). Since the beginning of this century, broadband has spread rapidly and is catching up with the PC installed base. It has generally diffused more rapidly than narrowband Internet (Table 4.1; OECD, 2008a, 2008b; Annex Table 4.A2.2 and 4.A2.3; see also the OECD Broadband Portal at *www.oecd.org/sti/ict/broadband*).

Some countries are clearly ahead in terms of household diffusion. In Korea, more than nine out of ten households had home broadband access[4] at the end of 2005 (MIC-NIDA, 2006); in 2006 the share was above 50% in Canada, the Netherlands, the United Kingdom and the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), and near 50% in Belgium. In France, by mid-2006, more than nine out of ten home Internet connections were broadband and by mid-2007 the share was 95% (CREDOC, 2007).

The diffusion of high-speed Internet access has thus been very rapid. Early high-speed Internet users had the usual socio-economic characteristics of early technology adopters (younger, more educated, richer) but broadband then spread rapidly throughout the population. In Finland, for instance, two-thirds of home broadband connections in 2003 were in one-person households, but by 2006, differences in households had been considerably reduced: more than 93% of all Internet connections in one-person households

Table 4.1. **Speed of diffusion of selected ICT goods/services in selected OECD countries**

	Estimated number of years to move from…							
	Canada	Denmark	Finland	France	Japan	Netherlands	Norway	United Kingdom
… 20 to 50% of households								
TV	2	. .	. .	. .	. .	. .	. .	. .
Colour TV	. .	. .	7	4	3	4	. .	. .
PC	7	6	5	7	5	8	7[1]	7
VCR	3	. .	6	5	5	6		. .
Mobile phone	4	3	2	2	. .	. .		3
Mobile phone[1]	. .	. .	3	3	4	2	. .	. .
Internet at home[2]	3.75	3.5	5.3	5.5[1]	. .	2.5	2[1]	4.2
Broadband at home	4	2.2	2	3[1]	. .	2.2	1.75[1]	. .
… 20 to 40% of households								
Internet at home	2.25	1.7	2.9	4[1]	. .	1.5	1.5[1]	2
Broadband at home	2.6	1.6	1.6	2[1]	. .	1.7	1.25[1]	1.6

StatLink http://dx.doi.org/10.1787/477454081846

1. Percentage of individuals.
2. Including both narrow and broadband.

Source: OECD estimates, based on data from the *OECD Telecom database*, Statistics Canada, Cabinet Office (Japan), Statistics Finland, Statistics Netherlands, INSEE and CREDOC (France), and the Office of National Statistics (United Kingdom).

were broadband, but more than 88% also were in total households. In France, diffusion of broadband among Internet users in 2005 was so common that there were no significant differences between broadband Internet users and total users (see below).

Recent changes in the diffusion of PCs, the Internet and broadband

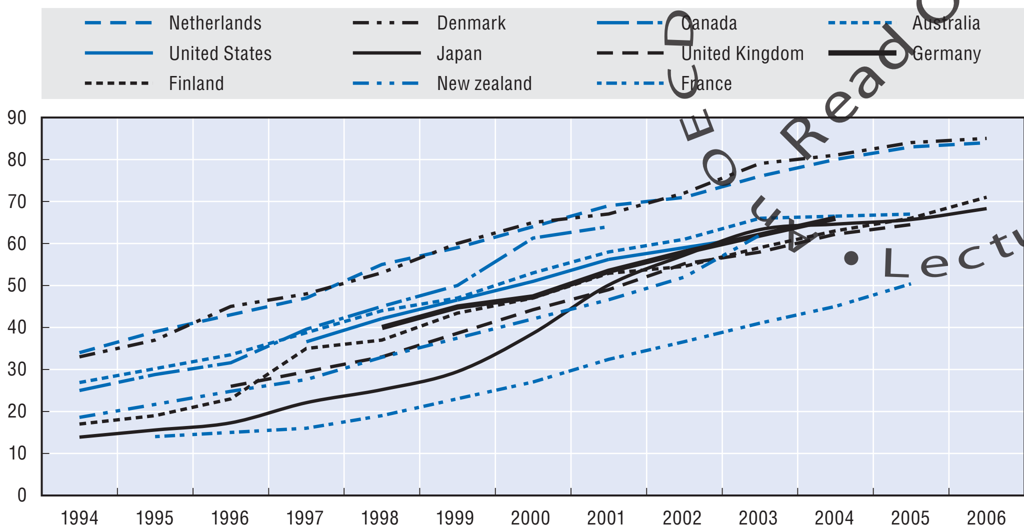
Following the readiness, intensity and impact phases of diffusion (OECD, 2000, 2005), PC readiness and diffusion have been achieved, with measurable impacts. In countries such as the Netherlands, Denmark and Finland diffusion of PCs to households is near 80%, after which diffusion slows significantly; in Japan, for example, even below that level, some households will probably never have a PC (Annex Figure 4.A1.1).

The pace of diffusion of household PCs is similar across OECD countries, with a similar pattern in Denmark, Finland, the Netherlands, New Zealand and the United Kingdom over more than a decade (Figure 4.1). However, significant disparities among countries remain. In France the prior uptake of the Minitel had a dampening effect; only in 2006 did France reach levels achieved in 1999 by Denmark and the Netherlands, and in 2001 by Australia, Germany and the United States.

Usage rates are higher than the presence of equipment in homes. In Finland in spring 2006, for example, the households PC equipment rate was 71%, but eight out of ten persons had used a computer in the previous three months compared to only three out of four in spring 2005 (Statistics Finland, 2006a). In 2006 use was nearly 100% among those aged 15 to 39 and 40% among those aged 60 to 74. Similarly, in 2006 in the EU15 53% of individuals had a PC at home, but more than 58% on average used a PC in some place at least once a week, almost every day or every day. In the same year in the United States, the share of adults using a computer at least occasionally was slightly higher than the share of individuals equipped with a computer, although in 2002, the share of adults using a computer was slightly lower than the share equipped (Pew, 2006). Overall household penetration rates thus underestimate people's contact with PCs.

Figure 4.1. **Households with access to a home computer in selected OECD countries, 1994-2006**

Percentage of households



StatLink http://dx.doi.org/10.1787/474837804028

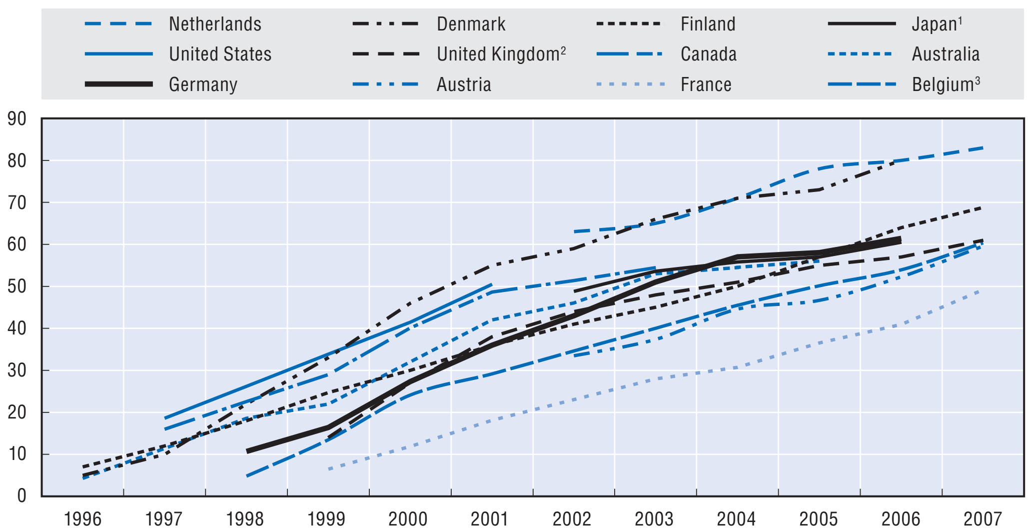
Source: OECD, based on ICT database and national sources. For further details, see Annex Table 4.A2.1.

Internet penetration at home

The Internet has spread much more rapidly than PCs. In Denmark and the Netherlands 80% of households have Internet access and more than half in most other countries for which data are available (Figure 4.2). The diffusion curve is strikingly similar

Figure 4.2. **Household access to the Internet in selected OECD countries, 1996-2007**

In percentage of households



StatLink http://dx.doi.org/10.1787/474860252526

1. Households that own equipment that can access the Internet.
2. April-June quarter until 2002.
3. 1997/98 instead of 1998.

Source: OECD, based on data from National Statistical Offices, the US Bureau of the Census, and Statistics Bureau of the Ministry of Internal Affairs and Communications of Japan, Survey of Household Economy. See also Annex Table 4.A2.2.

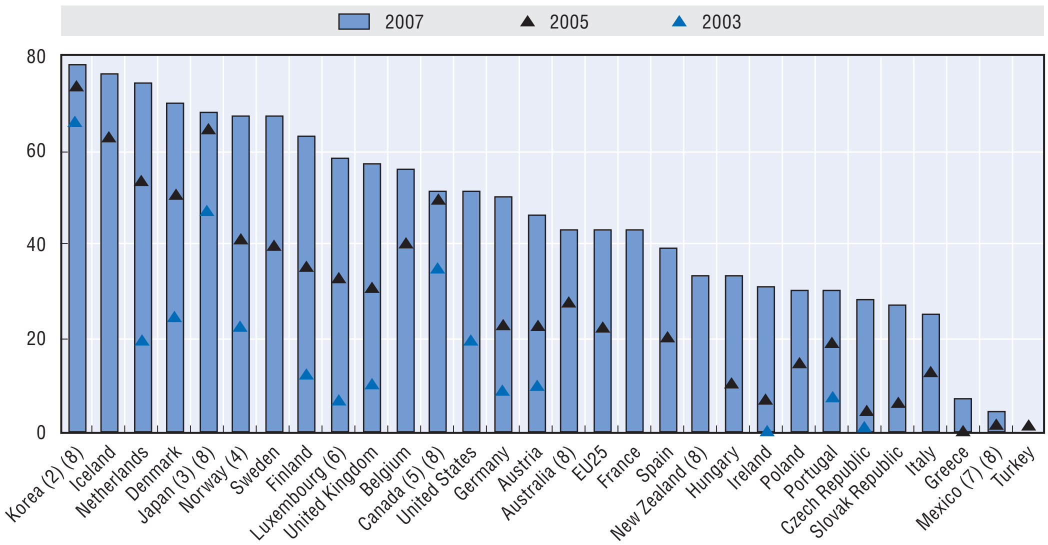
across countries even if diffusion is heterogeneous. Home is where people access the Internet most, and home use probably mirrors most accurately use of the Internet (Annex Table 4.A2.4).[5]

Broadband penetration at home

Household broadband use surged from around 2000 (OECD, 2008b). Price declines and speed increases have made high-speed household Internet availability and connection increasingly common even if uptake has differed among OECD countries (Figure 4.3; OECD, 2007a; US Department of Commerce, 2004). Furthermore, broadband availability has expanded far beyond the OECD area. The number of countries with commercial broadband available at speeds of 256 kbit/s or more rose from 81 in 2002 to 166 in 2006 and by 2006 most countries had at least some services available over 1 Mbit/s (ITU, 2006; the OECD Broadband Portal at *www.oecd.org/sti/ict/broadband*).

Figure 4.3. **Households with broadband access in OECD countries, 2003-07**[1]

In percentage of households



StatLink http://dx.doi.org/10.1787/474870203772

1. Generally, data from the EU Community Survey on household use of ICT, which covers EU countries plus Iceland, Norway and Turkey, relate to the first quarter of the reference year. For the Czech Republic, data relate to the fourth quarter of the reference year.
2. For 2003, data included broadband access modes such as xDSL, cable and other fixed and wireless broadband via computers.
3. Only broadband access via a computer.
4. For 2003, data include LAN (wireless or cable).
5. Statistics for 2003 and every other year thereafter include the territories (Northwest Territories, Yukon Territory and Nunavut). For the even years, statistics include the 10 provinces only.
6. For 2004, data include wireless access.
7. Households with Internet access via cable, ADSL or fixed wireless.
8. No 2007 data available, 2006 data used instead, 2006-07 data for Australia.

Source: OECD ICT database; Eurostat Community Survey on ICT usage in households and by individuals; Australian Bureau of Statistics; Japan MIC, Communications Usage Trend Survey; Korean National Information Society Agency. See also Annex Table 4.A2.3.

Effects of socio-economic characteristics on Internet and broadband access and use

Socio-economic characteristics (educational attainment, income, age, gender, place of access) have significant impacts on access to and use of PCs and the Internet. The impact of these characteristics around 2002 was described in detail in OECD (2004, Chapter 4).

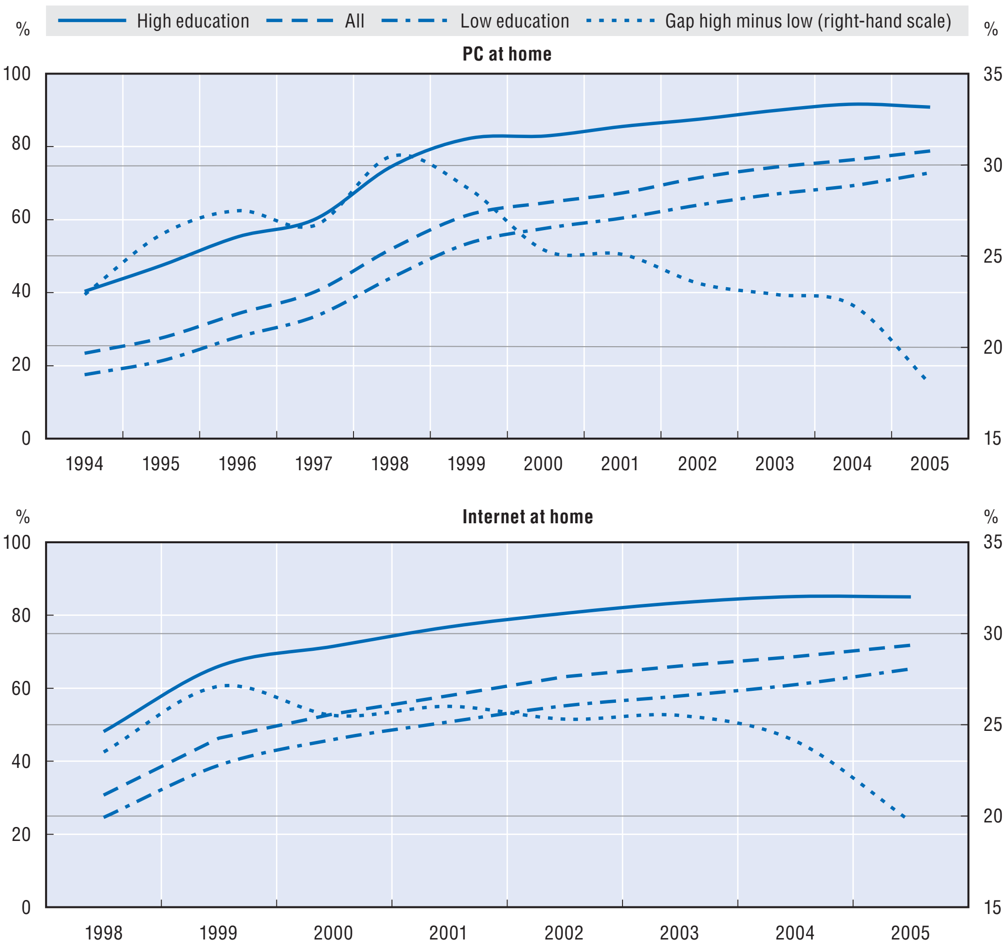
Differences in access have tended to persist although continuing penetration of PCs and the Internet has reduced them. However, usage patterns are changing as a result of greater access to PCs and the Internet and the spread of broadband. The following sections describe recent developments in access and use in terms of socio-economic characteristics and usage patterns and look again at the digital access divide.

Education

With rapid uptake of the Internet and the even more rapid switch to broadband, the impact of socio-economic differences appears to be declining in some countries. In Sweden for example both PC and Internet diffusion are increasing steadily and the gap between more and less highly educated groups is diminishing (Figure 4.4). The same is true of Internet access in Denmark. However, in Canada, Korea and the United States, the gaps have not closed significantly (Annex Figure 4.A1.2), and in 2007 Internet access by education level still showed significant gaps in some OECD countries (Figure 4.5).

Figure 4.4. **Diffusion of PC and Internet in Sweden by level of education, 1994-2005**

Percentage of the population[1]



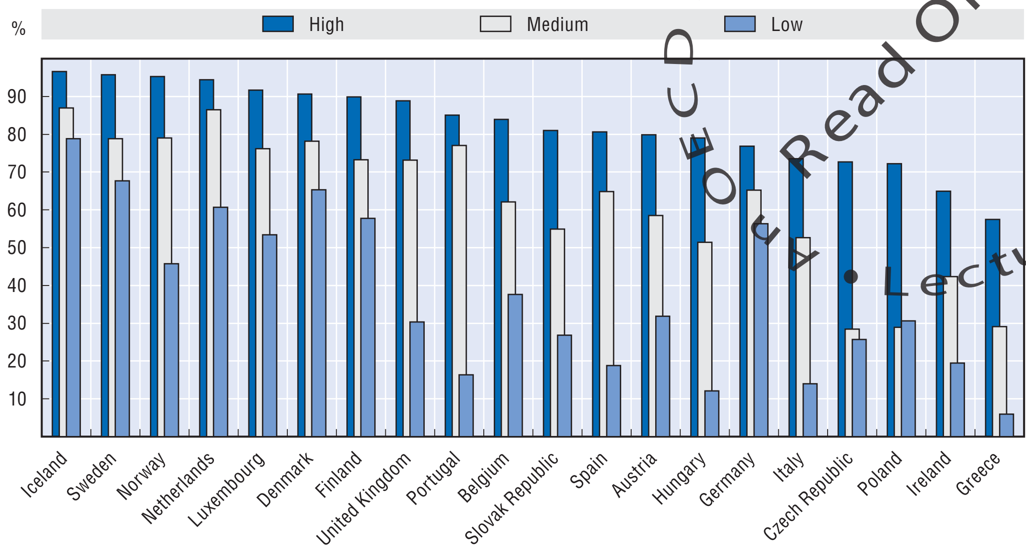
StatLink http://dx.doi.org/10.1787/475007006436

1. Persons aged 16 to 84.

Source: OECD, based on data from Statistics Sweden (2007).

Figure 4.5. **Internet access[1] by high, medium and low education level[2] in selected OECD countries, 2007**

Percentage of individuals



StatLink http://dx.doi.org/10.1787/475038642812

1. Individuals having accessed the Internet in the last three months.
2. Low = ISCED 0 to 2; medium = ISCED 3 to 4; high = ISCED 5 to 6/7.

Source: OECD, based on data from Eurostat, *NewCronos database*.

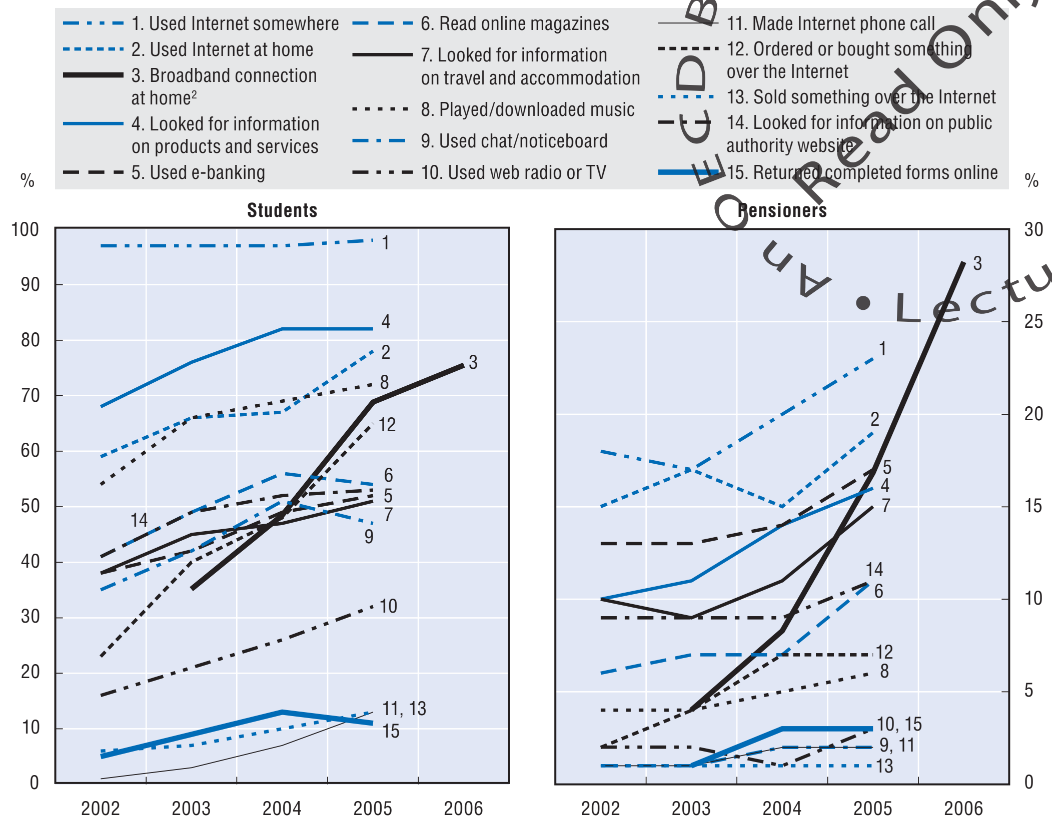
Age: generational differences

Earlier OECD analysis showed that the use of ICTs by older people is positively related to age of retirement from the workforce and educational attainment (OECD, 2004, Chapter 4). Once online, their patterns of use were similar to those of younger age groups, except for lower propensities to purchase and to use the Internet for entertainment. This suggested that older age groups that worked longer would not suffer a technological use divide, provided that they had the educational background to take advantage of new technologies. Recent analysis for Canada indicates that Internet use by tomorrow's older Canadians will reflect the higher rate of today's adults (McKeown *et al.*, 2007).

There are however enduring differences in terms of access speed. Internet users in older age groups subscribe more often than younger users to narrowband connections. The available evidence also indicates that different age groups engage in different kinds of online activities when using broadband. This has also been the case for the Internet.

ICT usage patterns among students, employed persons and pensioners in Finland show that while PC and Internet use is very widespread among the two first groups, only one in five pensioners used the Internet (Sirkiä *et al.*, 2004). The reason was not income but the fact that pensioners felt that the Internet did not provide services that met their everyday needs and that the services provided did not help resolve problems they found important. In spite of the overall rise in Internet users, differences in the use of ICTs by different generations seem to have increased (Figure 4.6).

Figure 4.6. **Broadband access and selected Internet activities[1] among students and pensioners in Finland, 2002-06**



StatLink http://dx.doi.org/10.1787/475061875461

1. Activities undertaken during the past three months on the Internet, whatever the place, except for "Returned completed forms online", for which no specific period was indicated.
2. Broadband connection at home is from Statistics Finland, *Consumer Survey*, and refers to the month of November of each year.

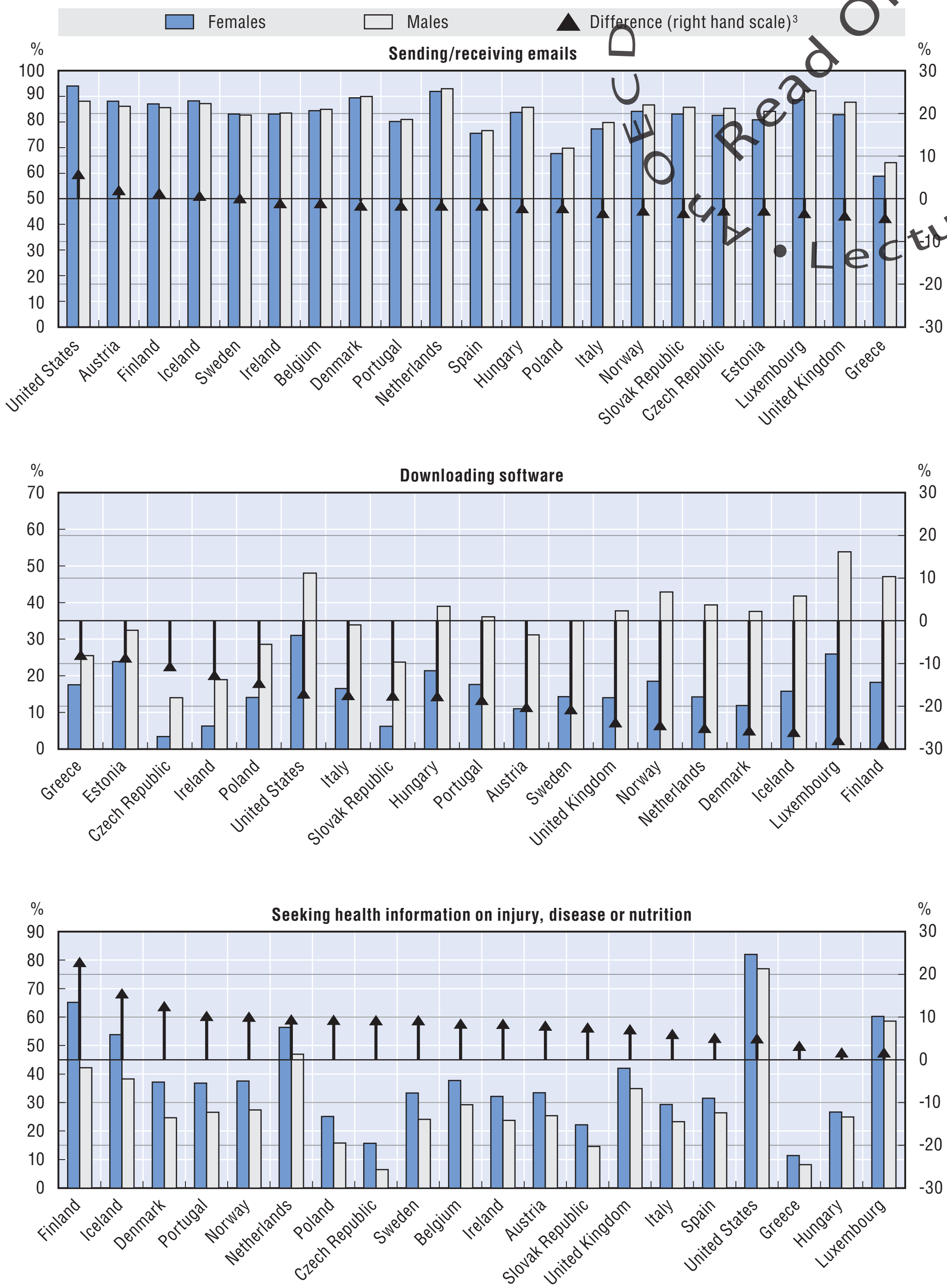
Source: Research Project *The Finns and the Future Information Society*, published by Statistics Finland (2006b).

Gender

ICT access continues to differ significantly by gender. Access by females tends to lag access by males, and while the gaps are narrowing they remain large in older age groups and for newer technologies. Furthermore, males and females access the Internet from different places. In many countries males are more likely to access the Internet from both home and work whereas females are more likely to access it from educational establishments, although the gaps are narrowing. There are also some significant differences in Internet use (Figure 4.7). For example, emailing was a very common activity for six Internet users out of ten, and the gender difference did not exceed 5 percentage points, whereas males downloaded more software and females were considerably more likely to engage in health-related activities or online shopping. Males were also more likely to play games and visit sports pages across all age groups (Annex Figures 4.A1.3, and 4.A1.4; Montagnier and Van Welsum, 2006).

Figure 4.7. **Gender differences for selected Internet activities in selected OECD countries, 2005**[1]

Percentage of individuals[2]



StatLink http://dx.doi.org/10.1787/475068148566

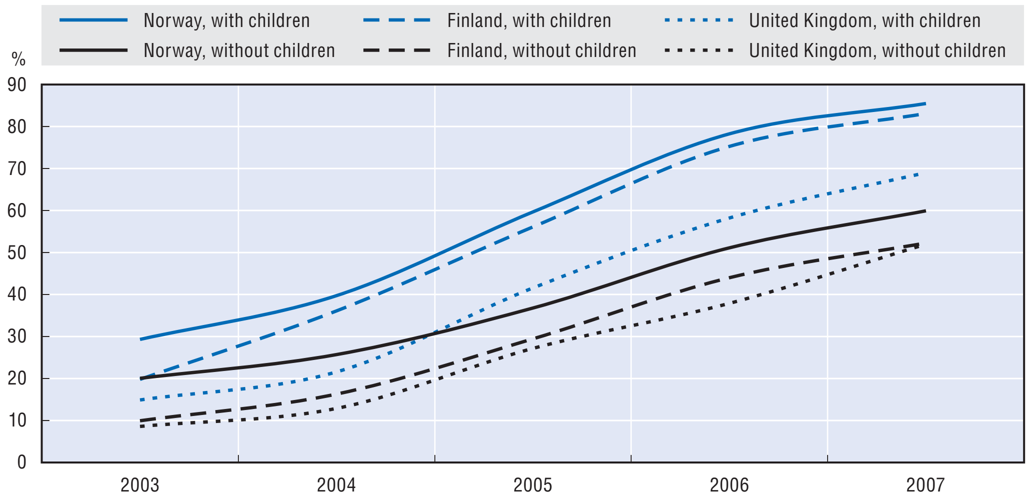
1. 2006 for the United States for "Seeking health information on injury, disease or nutrition".
2. Aged 16 to 74 or more having used the Internet in the last three months.
3. Difference measured as percentages of females minus percentages of males, in percentage points.

Source: OECD, based on data from Eurostat, *NewCronos database* (2006), Pew (2006).

Children in the family

Children have a clear positive impact on PC and Internet diffusion and broadband access among households (for details on PCs, see OECD, 2004). Broadband enables a far greater variety of online activities, some of which are undertaken by children. Age of household members is also a factor, as households with children tend to be younger. As the diffusion of PCs nears saturation, data from some countries shows that gaps are narrowing between families with and without children, but in terms of broadband diffusion families with children clearly lead those without (Figure 4.8).

Figure 4.8. **Broadband uptake among households with or without children in Finland, Norway and the United Kingdom, 2003-07**



StatLink http://dx.doi.org/10.1787/475175377143

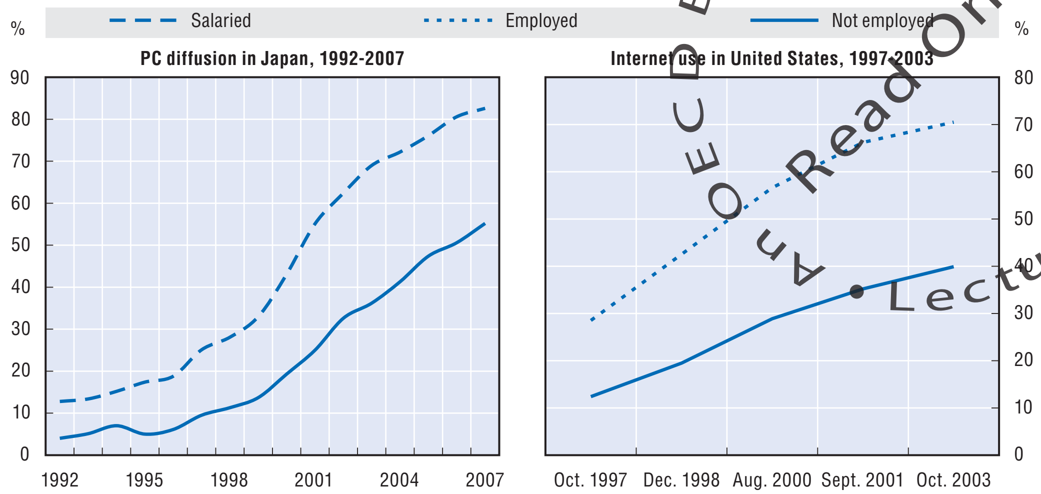
Source: OECD, based on data from Eurostat – *NewCronos database*.

Place of connection

In OECD countries the Internet is used most often at home. In Europe the Slovak Republic is the exception, where access is most often from work; work is not very far behind in other catch-up countries such as the Czech Republic, Greece, Portugal or Spain (Annex Table 4.A2.4). In all countries except Korea and the Netherlands, males are more likely to access the Internet from home than females. Overall, work or public places (cybercafés, etc.) replace home access where this is still limited owing to low network availability, cost of access, etc. Social norms governing interactions in public places also influence Internet usage pattern (Orbicom, 2005). In Korea, for example, people use the Internet at commercial public access facilities despite very high home use rates, although females do so less than males.

Work also contributes significantly to diffusion and use of ICTs. Among those aged 60 or more in Canada, unemployment has been negatively related to Internet use (Silver, 2001); the diffusion of PCs in Japanese and US households is clearly related to employment (Figure 4.9); and in Luxembourg Internet use at work significantly influences being connected at home (Poussing, 2006). In Finland, computer use became widespread in

Figure 4.9. **PC and Internet diffusion and use in the United States and Japan, by employment status**



StatLink http://dx.doi.org/10.1787/475224048580

Source: US Department of Commerce (2004) and Economic Planning Agency (Japan).

working life in the late 1980s. In 1984, 17% of wage and salary earners used ICT, 44% in 1990, 66% in 1997, and 75% in 2003 (Statistics Finland, 2006b).

Mobility

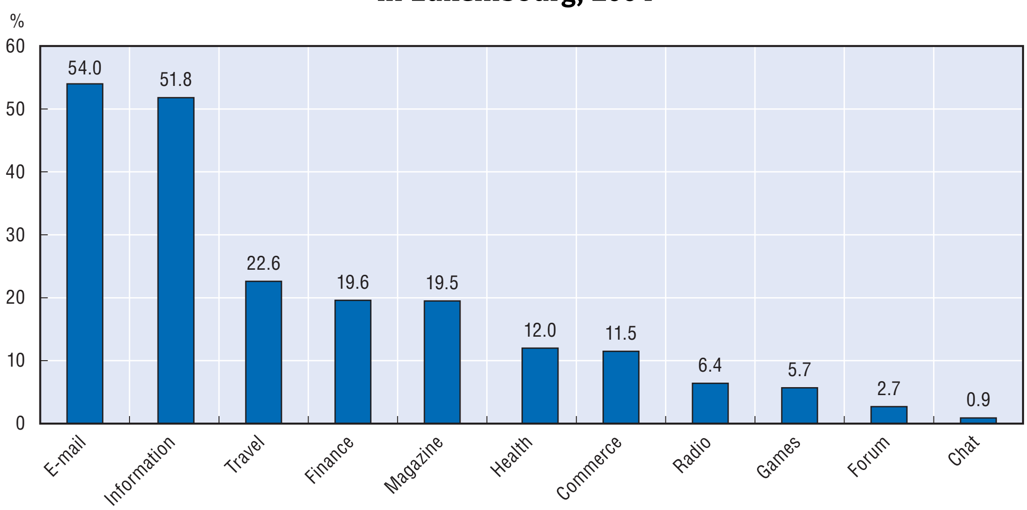
Mobile Internet access is increasing, but the propensity to use mobile Internet access varies greatly by country. Mobile phones are not necessarily the only way to access the Internet from a mobile device, but they are one indicator of mobile access. In Korea, more than in many other countries, people often use mobile access to connect to the Internet. In September 2002, one-third of mobile users (aged 12 or more) had accessed the Internet via a wireless connection more than once within the previous six months, and by September 2005, 43% had done so; in 2005, 99.6% of mobile access was via a mobile phone in preferences to devices such as Notebooks, PDAs or smart phones (MIC-NIDA, 2005). In the United Kingdom, the share of adults accessing the Internet via mobile phones remained constant at 8% between January 2001 and April 2003, but increased to 17% by October 2005 (Office of National Statistics of the United Kingdom, 2007). In France, in 2003, only 5% of mobile phone owners used them to access the Internet, but by mid-2007, this share reached 7% (CREDOC, 2007).

Accessing the Internet from home through mobile devices is one indicator of "mobility readiness". In 2005 in the Nordic countries, the share of all households accessing the Internet at home via a portable computer varied from 15% in Finland to 37% in Iceland. For hand-held computers and mobile phones, the shares were highest in Denmark at 4 and 12%, respectively, of all households. Shares were significantly higher in households with two adults and children (see Table 2.4 in Nordic Council of Ministers, 2005). In many countries WiFi is increasingly the home broadband service for multiple access points, and portable computers are often used as a first or second access point in multiple user families. In June 2007 in France, 17% of the population was broadly defined as mobile Internet users (connecting in public areas such as libraries, cybercafés, WiFi hotspots, etc., outside the home and workplace), but only 6% accessed the Internet via a mobile phone, and 5% via a laptop using WiFi. "Mobility" is relatively more developed in younger groups (under 39 years old), with high income and educational levels, with four or more persons in the household, and living in or near Paris (CREDOC, 2007).

Non-work related use at work

Using the computer or accessing the Internet from the workplace for reasons other than work is common and is likely to have implications for firm efficiency and productivity. In Canada in 2005, four out of ten Internet users had used the Internet at work for personal reasons in the last 12 months. Three out of four of those using the Internet while at work for personal reasons did so at least once a week, and 37% every day (Statistics Canada, Canadian Internet use survey, 2005). In Luxembourg in 2004 more than two-thirds of salaried employees used the Internet at work for personal reasons, and more than half were looking for non-business-related information (Poussing, 2006). Around one in five collected travel information, read newspapers or magazines or did financial operations; games, listening to the radio, accessing discussion forums or chatting were less frequent (Figure 4.10).

Figure 4.10. **Non-business-related use of the Internet at the workplace in Luxembourg, 2004**



StatLink http://dx.doi.org/10.1787/475267772507

Source: Poussing, 2006.

The effects of single variables

Socio-economic characteristics influence each other and a single variable will also reflect the influence of other variables. Using microdata and econometric techniques it is possible to isolate the effect of a given variable, controlling for the effects of all others. In France, for example, these analytical techniques show that age and education have the most significant impact on Internet access (Frydel, 2006). More than nine out of ten home Internet connections in France are broadband and there are no significant differences between broadband and Internet access for the same set of socio-economic variables.[6] Similar analysis of Internet use by Japanese households shows that age group had the greatest impact on access, followed by household income, while city size and gender had smaller impacts (Ministry of Internal Affairs and Communication of Japan, 2006). There is a negative influence for both the youngest and oldest age categories, and particularly for the group of those 60 years old or more (*i.e.* respondents in these age groups were less likely to use the Internet). Household income shows a clear threshold at around JPY 6 million a year.

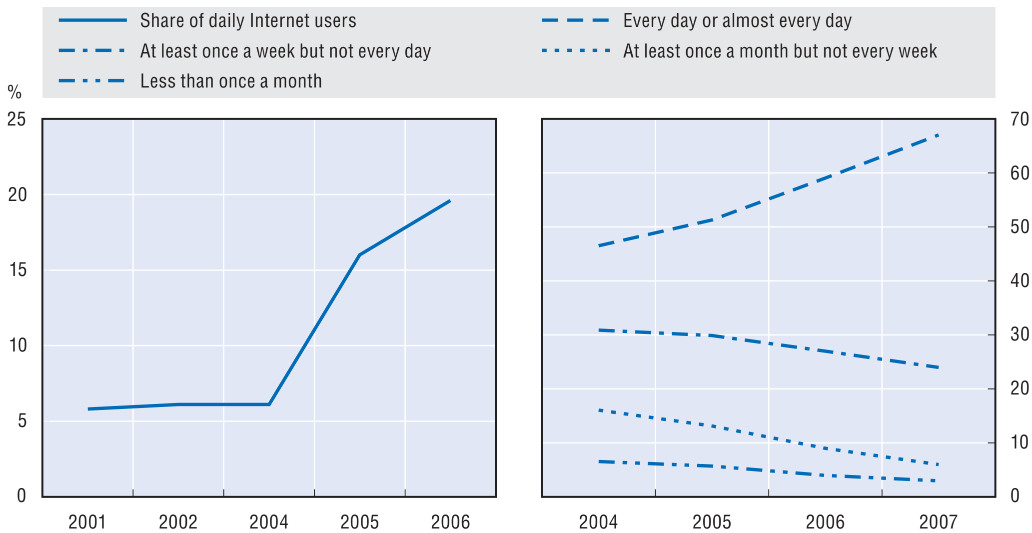
The impact of broadband on Internet activities

Household use and the subsequent impact of ICTs, particularly the Internet, are influenced by a complex mix of socio-economic factors and relations, which broadband amplifies or accelerates (OECD, 2008b). These impacts include the frequency and time/duration of use and its variety and diversity.

Impacts on frequency of use

Broadband increases the frequency of Internet use as well as the share of the online population conducting various activities. Daily access increased more via broadband than via narrowband in all 21 European countries surveyed in 2006 and again 2007. Having broadband clearly increases the frequency of Internet use, and there are shifts to higher use among users who previously accessed the Internet less frequently (at least once a week, but not every day, or at least once a month but not every week; Annex Tables 4.A2.6 and 4.A2.7). Access prices have a significant impact on connection and frequency of use, and broadband access prices are generally declining while average speed is increasing (OECD, 2008b).

Figure 4.11. **Frequency of use of the Internet in Mexico[1] and the United Kingdom[2]**



StatLink http://dx.doi.org/10.1787/475280166617

1. For 2001 and 2002, month of December; for 2004 and 2005, month of June; for 2006, month of April and preliminary results.
2. Great Britain only.

Source: Instituto Nacional de Estadística y Geografía (INEGI); OECD, based on data from the Office of National Statistics of the United Kingdom.

In France in 2006 seven out of ten persons with a broadband connection accessed the Internet daily but only three out of ten with a narrowband connection did so (CREDOC, 2007). In Finland most Internet connections are from home, and, with the diffusion of broadband, weekly frequency increases more at home than in other places (Statistics Finland, 2006b). In Mexico, the share of daily Internet users tripled between 2004 and 2006; although broadband diffusion among households is still relatively low, the share of Internet users accessing Internet via cable TV rose from 11 to 22% and diffusion of higher speed connections is undoubtedly amplifying the frequency of use. In the United Kingdom, frequency of access was relatively constant in 2000-02, with the exception of a decrease in very low frequency users (less than once a month) and an increase in daily users. From February 2003 to July 2007 the share of households with access to broadband Internet at home rose from 10 to 51%, and this amplified the trend towards more frequent use (Figure 4.11).

Expanding different online activities

Broadband expands the frequency of various online activities. People who have home access to broadband are much more inclined to undertake various online activities than those who do not, and the differences are large (Figure 4.12). In 2007 in Iceland 31% more broadband than narrowband users listen to the radio or watch TV via a PC; in the United States 12% more send or receive emails; and in the United States and Canada 22% more play/download games and music. These differences are an important indicator of the impact of broadband (Figure 4.12, and Annex Tables 4.A2.5 and 4.A2.8).

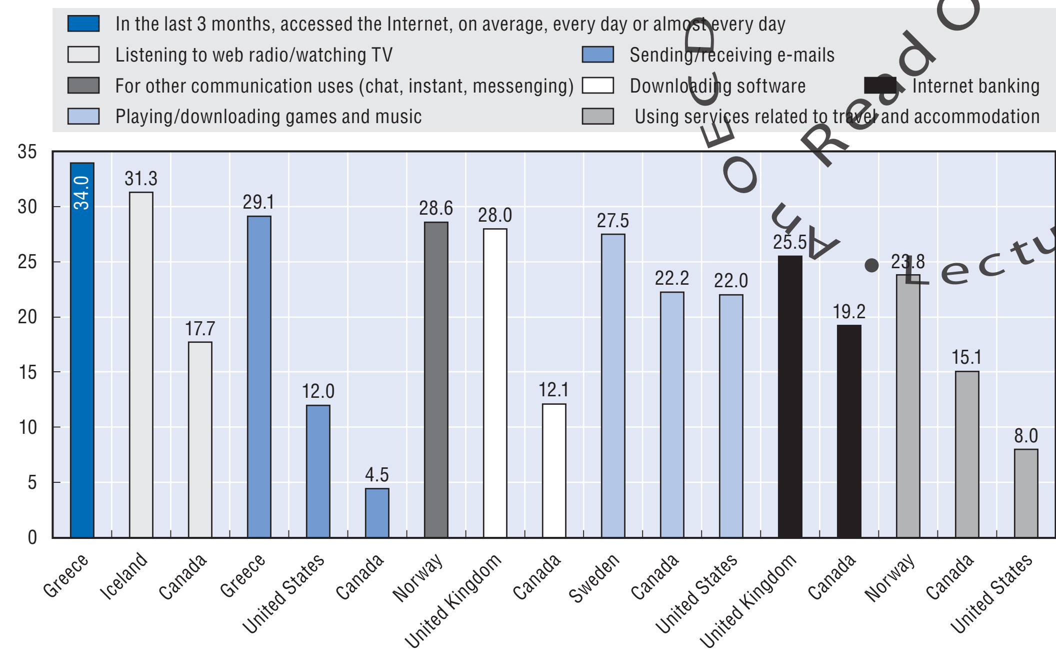
Impacts of broadband on the development of new Internet activities

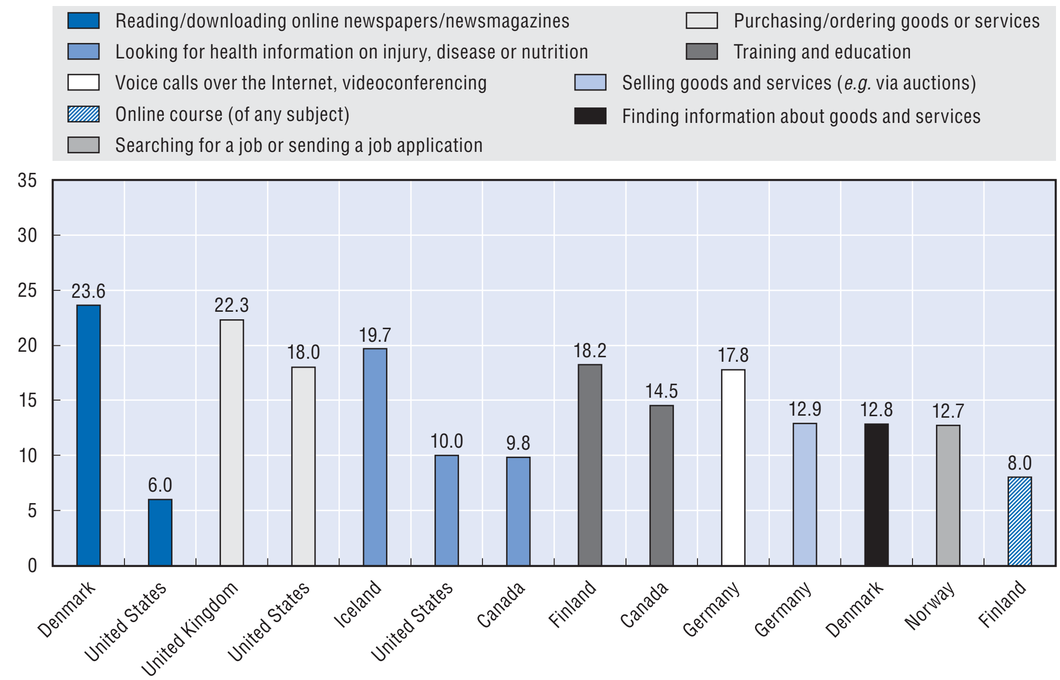
Various new activities have grown in parallel with broadband. The growth in new online activities is evident in all OECD countries (see Figure 4.18 for listening to Web radio/ watching TV; see OECD, 2007b, for the rise in user-created content; and OECD, 2008c, for developments in film and video; see Chapter 5). Playing or downloading music, games, images, telephoning or videoconferencing are all developing rapidly in parallel with the spread of broadband in the United Kingdom for example (Figure 4.13). While broadband plays a role, so do the development of new services, complements to other services (*e.g.* delivery), and ease of use. In a very short time, the Internet has become a major shopping place; in the United Kingdom for example buying or ordering tickets or goods and services has progressed rapidly, and selling goods and services has also grown rapidly as consumers bypass traditional intermediaries.

New activities are not undertaken equally by all users. A recent report shows that in the United States, the differences are considerable (Horrigan, 2007). The level of education plays a role through exposure to and use of broadband, wireless and other information technologies, which often begins in schools, and the level of education is important for the both intensity and type of online activity. In Sweden, for example, between 2003 and 2006, the gap between the highest and lowest education attainment level increased significantly for Internet banking, been stable for reading or downloading online newspapers/news magazines, and declined significantly for obtaining information from public authorities' websites or for sending completed forms (Annex Figure 4.A1.5).

Figure 4.12. **Impact of broadband on selected Internet activities, selected OECD countries, 2007**[1]

Difference between broadband and narrowband users, in percentage points[2, 3]



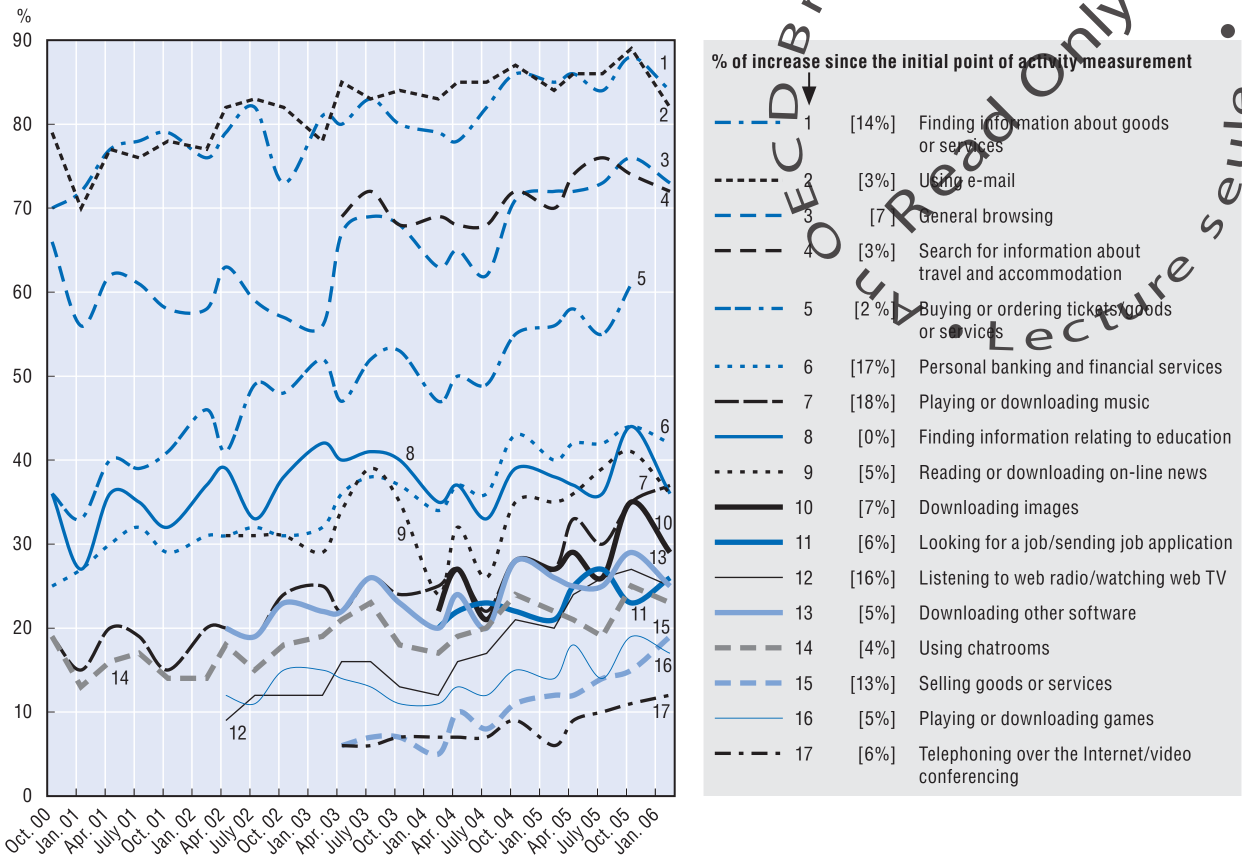


StatLink http://dx.doi.org/10.1787/475315134884

1. 2005 for Canada.
2. Differences, in percentage points, for a specific activity: for European countries, between individuals who live in a household with a broadband connection and those who live in a household with Internet access but with no broadband access.
3. Countries for which the difference is greater are selected. For a complete list of countries, see Annex Tables 4.A2.5 to 4.A2.8.

Source: OECD, based on data from National Statistical Offices, the Pew Internet and American Life Project, and the Eurostat *NewCronos database*. See Annex Tables 4.A2.5 to 4.A2.8.

Figure 4.13. **Internet activities of adults in the United Kingdom, 2000-06**



StatLink http://dx.doi.org/10.1787/475332534277

Source: Office of National Statistics.

Time use and the Internet

Both the time devoted to communication and the means of communication are changing, partly spurred by the Internet and broadband.

Time use is increasing

The Finns spend an average of around one hour a day with the PC and Internet. The time devoted to online activities is increasing for all age categories, driven by broadband applications and services, but use is considerably higher among the 15 to 39 than among the 60 to 74 age group, and students use PCs and the Internet more than employees and retired persons (Statistics Finland, 2006b). For specific online activities, in 2006 the 15 to 39 age group still spent on average over twice as much time using email, chat or the Internet as the 60 to 74 group, although the differences are lessening (Table 4.2). From 2001 to 2006, the average leisure time spent online from home increased considerably and one-third of those aged 15 to 74 spend more than five hours a week (Annex Figure 4.A1.6). Nevertheless, if "net addicts" are defined as those using PCs and the Internet more than five hours a day at home (*i.e.* more than five times the average), it was found that less than 2% can be so defined.

In Korea more time is also devoted to ICT use, especially the Internet, not only during leisure time. Between 2004 and mid-2006 the average time per week spent online increased

Table 4.2. **Average time spent using email, chat or Internet, per week, during leisure time, in Finland**

Age	2004	2005	2006	Variation 2004-2006 (%)
15-39	3 h 30 mn	5 h 40 mn	6 h	71
40-59	1 h 40 mn	2 h	3 h 10 mn	90
60-74	40 mn	1 h 40 mn	2 h 30 mn	275
All	2 h 30 mn	3 h 50 mn	4 h 30 mn	80
Ratio younger/older	19%	29%	42%	

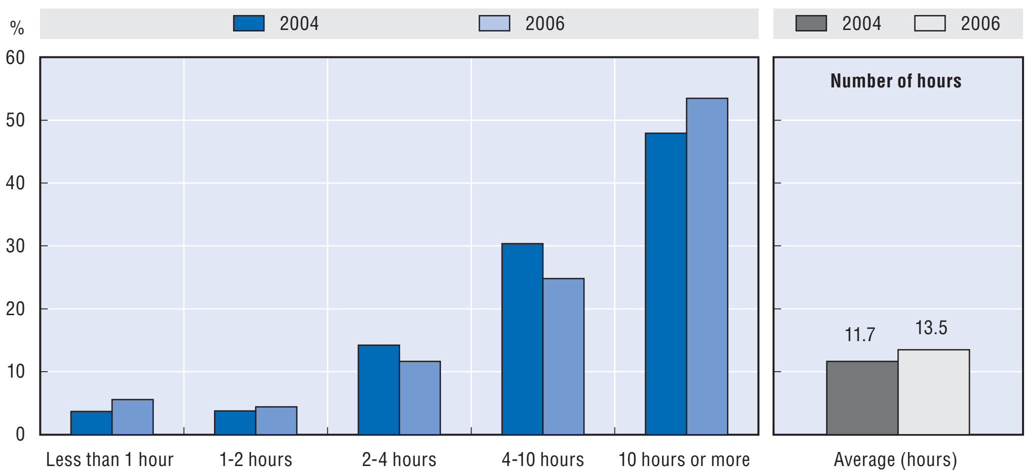
StatLink http://dx.doi.org/10.1787/477466150674

Source: Statistics Finland. See also Annex Figure 4.A1.6.

from 11.7 to 13.5 hours. But the increases are at the low- and high-user ends of the scale: low-intensity users (less than two hours) have stagnated or slightly increased, mid-intensive users (between two and ten hours) have decreased, and intensive or regular users (more than ten hours) have increased significantly (Figure 4.14).

Figure 4.14. **Weekly Internet access hours in Korea, 2004-06**[1]

Percentage of people



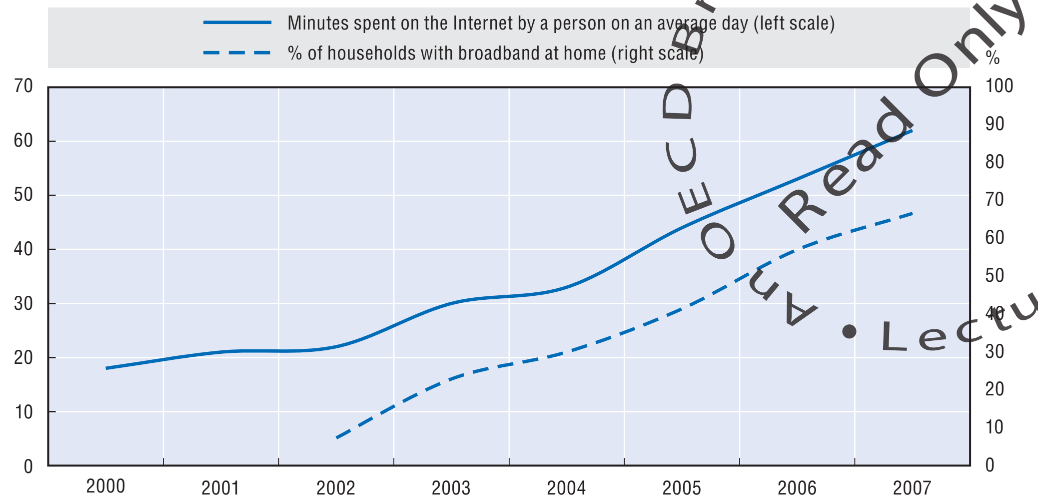
StatLink http://dx.doi.org/10.1787/475341643124

1. June 2006.

Source: OECD, based on data from NIDA.

The diffusion of broadband and the range of available uses have clearly affected the amount of time spent on the Internet. In Norway, time devoted to the Internet was multiplied more than threefold between 2000 and 2007 in parallel with the spread of broadband (Figure 4.15). Trends by age categories are similar for the Internet and PCs, and Internet access is highest among those with the highest educational attainment (Annex Figure 4.A1.2). However, longer use does not necessarily imply greater variety of uses despite the broader range available. In Finland also, the increase in regular use between 1996 and 2005 came from the rapid diffusion of broadband access and, in particular, from the replacement of slow connections with broadband connections (Statistics Finland, 2006c).

Figure 4.15. **Broadband diffusion and time spent on the Internet in Norway, 2000-07**



StatLink http://dx.doi.org/10.1787/475380784373

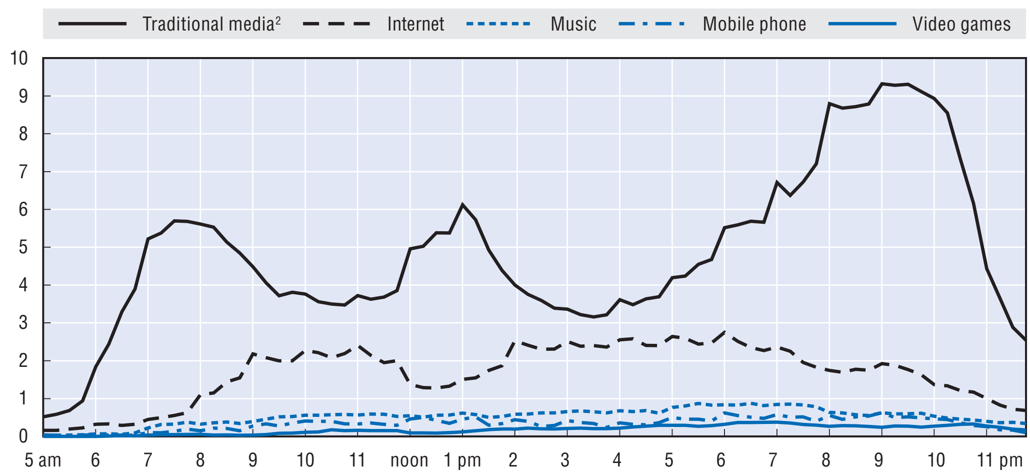
Source: OECD, based on data from Statistics Norway and Eurostat.

Private and work access are blurring

Significant use of the Internet occurs during work hours, when there is little contact with established media (TV, radio, press, cinema). Peak-time periods for established media, in particular TV news (morning, midday, evening) are also periods in which there is relatively less Internet contact (Figure 4.16). However, the line between private life and working time is blurring, particularly with the development of portable access devices (*e.g.* notebooks, mobile phones), which allow working life to impinge to a greater extent on private life and *vice versa*. Private tasks were undertaken by 48% of equipped workers

Figure 4.16. **Media consumption[1] by Internet users in France, 2006**

In millions



StatLink http://dx.doi.org/10.1787/475402541553

1. Penetration rate, in million of Internet users aged 13 or more, who had at least a contact with Internet or other media, during the day: Monday-Sunday, aggregates 2006, 5 a.m. to midnight.
2. Traditional media include television, radio, press and cinema.

Source: Media In Life, Médiamétrie, 2007.

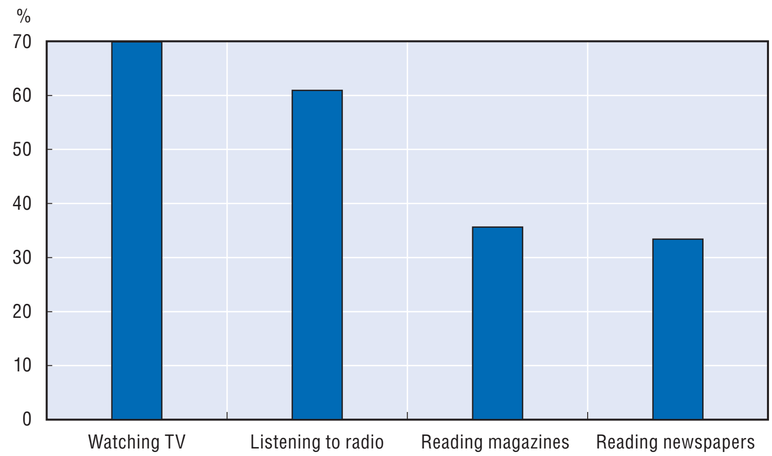
during their working time in France, compared with only 30% of those without a portable ICT tool. This trend to mix private and business life during working time was most pronounced for people equipped with a business portable computer (53%). A similar blurring between private and work-related activities in various time periods within an average working day has been observed in Luxembourg (Poussing, 2006).

Media consumption patterns are changing

The Internet makes it possible to pursue a large range of different activities online, sometimes in parallel, and broadband diffusion has increased these possibilities. A large share of American adult Internet users watch TV, listen to the radio or read magazines or newspapers online (Figure 4.17), although some of these activities may substitute each other; for example, the average time devoted daily to computer-related telephone calls, mail and email remained constant between 2003 and 2005 at around 19 minutes (US Bureau of Labor Statistics, 2006). Playing games and using computers for leisure activities decrease with age, except among those aged 55 or more, owing to differences in the use of time after retirement. Use on weekends is greater for those under 35 years of age, and, compared to use on week days, increases with the level of income and educational attainment.

Figure 4.17. **US adult Internet users who use other media while online, 2006**

Percentage of total adult Internet users[1]



StatLink http://dx.doi.org/10.1787/475418077776

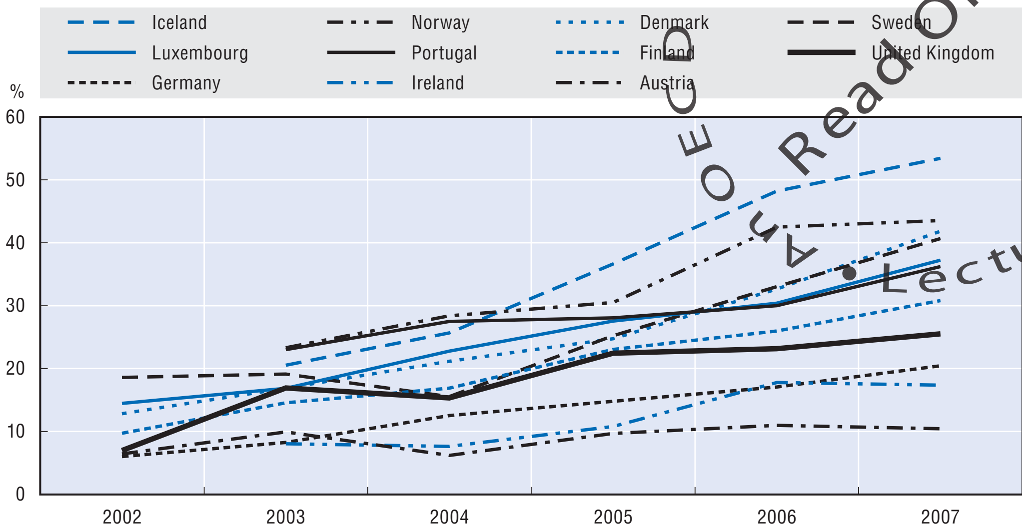
1. Based on 146.8 million adult Internet users, from BIGResearch's July 2006 survey.

Source: eMarketer, January 2007.

Listening to web radio and watching TV over the Internet have also increased dramatically (Figure 4.18), particularly among younger age groups. In France the youngest Internet users have almost double the number of contacts with the Internet and other media than overall users, with Internet contacts at a maximum in the evening, clearly linked to the daily education schedule (Médiamétrie, 2007).

Figure 4.18. **Internet users listening to Web radio/watching TV, selected OECD countries, 2002-07**

Percentage of Internet users aged 16 to 74



StatLink http://dx.doi.org/10.1787/475443274387

Source: OECD; based on data from Eurostat, 2008.

From the digital access divide to the digital use divide

The digital divide and the different rates of ICT uptake by households and individuals reflect economic and social structures and development, infrastructure deployment, skills, training and knowledge, and relative income, none of which is necessarily directly linked to ICTs (Sciadas, 2003). Although some measures of the digital divide may decrease over time, some will remain, reflecting more enduring socio-economic differences. In Finland for example, marginalisation due to ICT is not different from other types of marginalisation (Statistics Finland, 2003). In spite of declining measures of overall dispersion, the gap in penetration rates between the top and bottom groups has increased in many countries (Annex Table 4.A2.9).

Adoption of ICT goods as compared to other goods is initially much more clearly driven by higher income, education or occupation ("early adopters"). In France, in spite of narrowing differences in penetration for selected ICT goods (mobile phone, PC, the Internet) differences are much more persistent than for other electronic/electrical goods (microwave, television, fixed phone, or video tape recorder). PCs diffuse more slowly among the different groups than either the Internet or mobile phones (see Box 4.1).

A widening usage divide?

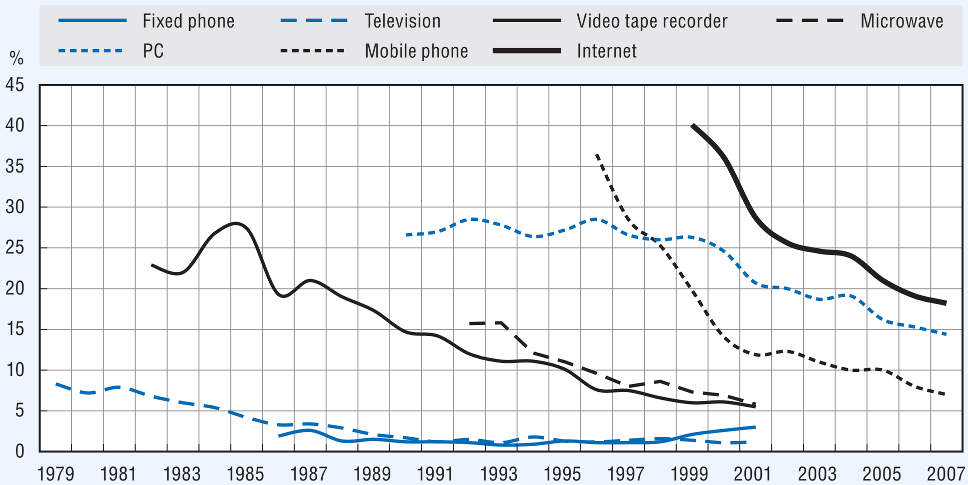
Internet activities mirror social activities and people's interests: who they are, their tastes, their activities and the social group to which they belong. Although the digital divide is decreasing and differences in access among various social groups are declining, a second digital use divide is based on inequalities of use and socio-economic factors. It can be observed indirectly through the variety of Internet use and the very diverse abilities of individuals to find information efficiently online (Hargittai, 2002, also available in Pénard and Suire, 2006). Moreover as broadband use increases in frequency, variety and diversity among frequent users two other effects are likely to increase the advantages of broadband

Box 4.1. **France: The diffusion of ICTs compared to other technologies**

Penetration rates for products differ, and for a given diffusion rate, the disparities are generally greater for the Internet or the PC than for the mobile phone, suggesting that some products are intrinsically more widespread and "democratic" than others. Compared with "old" goods, new ICTs have higher but more rapidly decreasing rates of disparity, except for PCs. This is especially true for mobile phones, but the Internet also has rapidly decreasing rates of disparity.

Figure 4.19. **Evolution of inequalities in possession of selected products in France**

Average value[1] of the Gini coefficient in percentage



StatLink http://dx.doi.org/10.1787/475572522364

1. Gini coefficient average calculated from values for each category (age, income, diploma, profession, and size of agglomeration).

Source: OECD, based on Bigot (2002, 2006) and CREDOC (2005, 2007). For a discussion of Gini coefficients see OECD (2004).

Diffusion of the PC has been slow and disparities remain. The Internet shows even larger initial disparities; however the impact of different social factors on disparities (location, occupation, education or income level) was reduced more rapidly, and the pace tends to parallel that of PCs. ICTs thus seem to have a specific diffusion pattern with the level of disparities, for a given penetration rate, systematically higher than for other products. Among ICTs, mobile phones and the Internet are diffusing rapidly and the Internet is second after mobiles among all technologies in diffusion speed.

Source: OECD, based on Bigot (2002, 2006) and CREDOC (2005, 2007); OECD (2004).

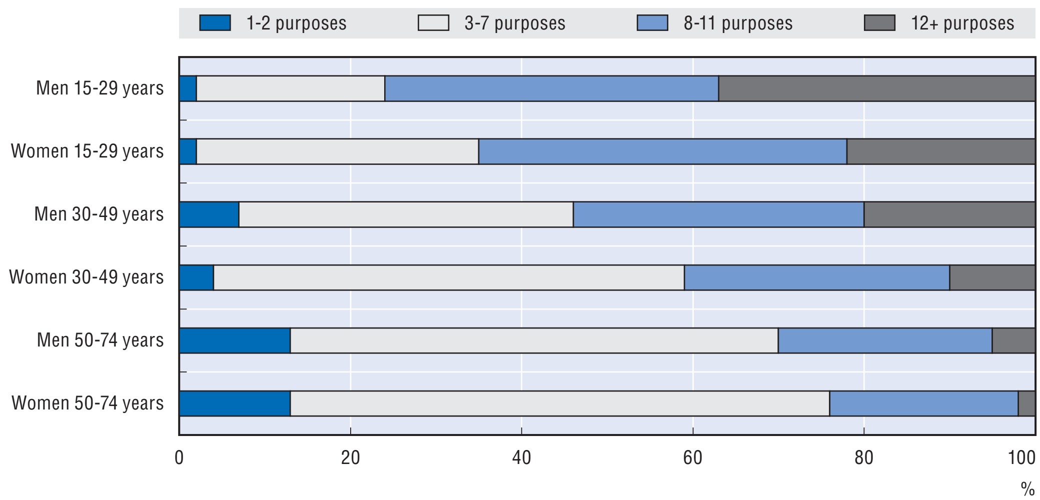
use for frequent and diversified users. The costs of undertaking transactions via the Internet are likely to be lower than off-line costs and to decline further, and there is likely to be a rapid expansion of diversified and accessible content available. Both of these effects are likely to increase the importance and impacts of the digital use divide linked with broadband use (see also OECD 2008b).

Diversity and variety of Internet use

Internet use is highly differentiated by age and to a lesser extent by gender. In Finland for example young people use the Internet in more varied ways than older people (Sirkiä *et al.*, 2005). In 2004, six out of ten users in the 15 to 29 age group listed eight uses, against one out of seven among those 50 to 74 years old. Less than 5% of Internet users aged 15 to 29 used it for only one or two purposes, compared with nearly 20% of those aged 50 or more. In 2006 these differences remained. Only 2% of the youngest age group used it for only one or two purposes compared to 10% among those aged 50 or more. More than two-thirds of the youngest group used the Internet for more than eight different purposes compared with less than 30% of persons aged 50 or more (Figure 4.20). Males tend to use the Internet in more ways than females.

Figure 4.20. **Number of purposes of use of the Internet in Finland, 2006**

Percentage of Internet users by age and gender



StatLink http://dx.doi.org/10.1787/475452405478

1. 21 activities are measured. For the list of activities, see Annex Table 4.A2.10.

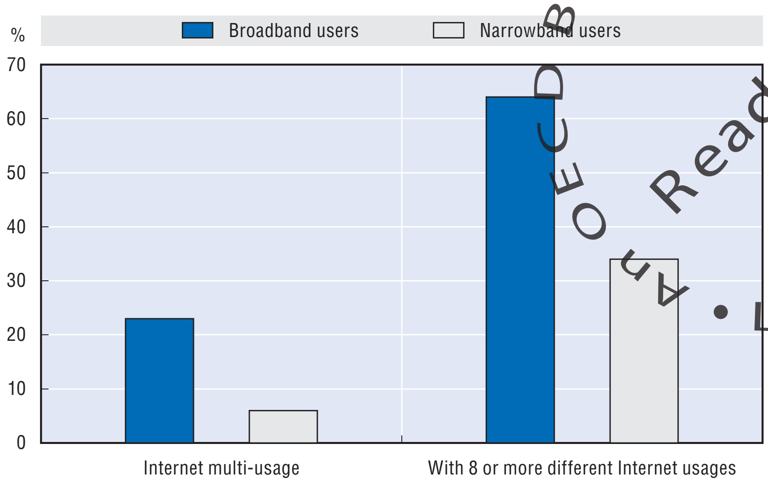
Source: Statistics Finland, "Suomalaiset tietoyhteiskunnassa 2006" ("Everyday Use of ICT in Finland 2006"), *Katsauksia* 2007/1. See also Annex Table 4.A2.10.

Broadband has a significant effect on the variety of uses from home. Broadband Internet users have much more varied uses than those with slower Internet connections (Figure 4.21), and the share of multi-users is four times higher among broadband users (for similar results in the United States, see US Department of Commerce, 2004). One-third of narrowband users had eight or more different uses, but this share was double among broadband users. It has also been underlined that residents of urban areas use the Internet for more purposes than those living in rural areas. Overall it seems that in terms of variety of use the Internet is not yet abolishing distance (Sirkiä *et al.*, 2005). More than geographical location, a broader group of socio-economic and social capital factors may explain the variety of Internet use.

Similar effects are observed in Canada for both age and broadband[7] (Figure 4.22). In 2005, persons aged 18 to 34 clearly used the Internet in a more varied way. More than 45% identified 12 or more different purposes, compared with only one-third of those aged 35 to 44 and even fewer in older age groups. In Canada only among those aged 65 or more

Figure 4.21. **Broadband effect on variety of home Internet use in Finland, 2004**

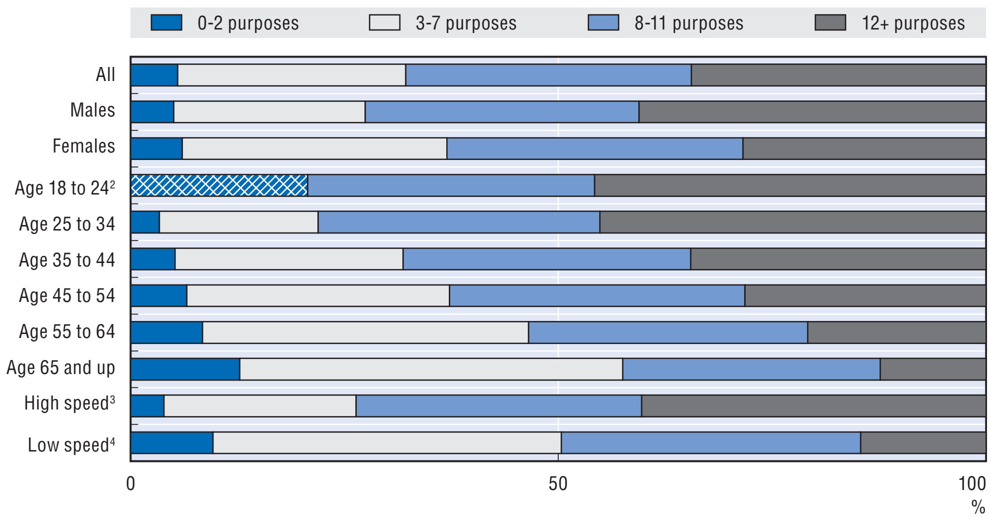
Percentage of the respective category



StatLink http://dx.doi.org/10.1787/475504450564

Source: OECD, based on data from Sirkiä *et al.*, 2005.

Figure 4.22. **Number of activities[1] participated in by home Internet users during the last 12 months, Canada, 2005**



StatLink http://dx.doi.org/10.1787/475534765111

1. 21 activities are measured, see Annex Table 4.A2.11.
2. Due to low reliability of the estimate for the 0-2 purposes category (the coefficient of variation exceeds 33.3%), this category has been combined with the category 3-7 purposes for the 18 to 24 age group.
3. "High speed" includes all respondents who identified that they access the Internet at home using cable or satellite, and all respondents accessing the Internet using a telephone connection or other connection (*e.g.* television, wireless [cellular phone or PDA], other) which they identified as a high-speed connection.
4. "Low speed" includes all respondents accessing the Internet at home through a telephone or other connection (*e.g.* television, wireless [cellular phone or PDA], other) which they identified as not a high-speed connection.

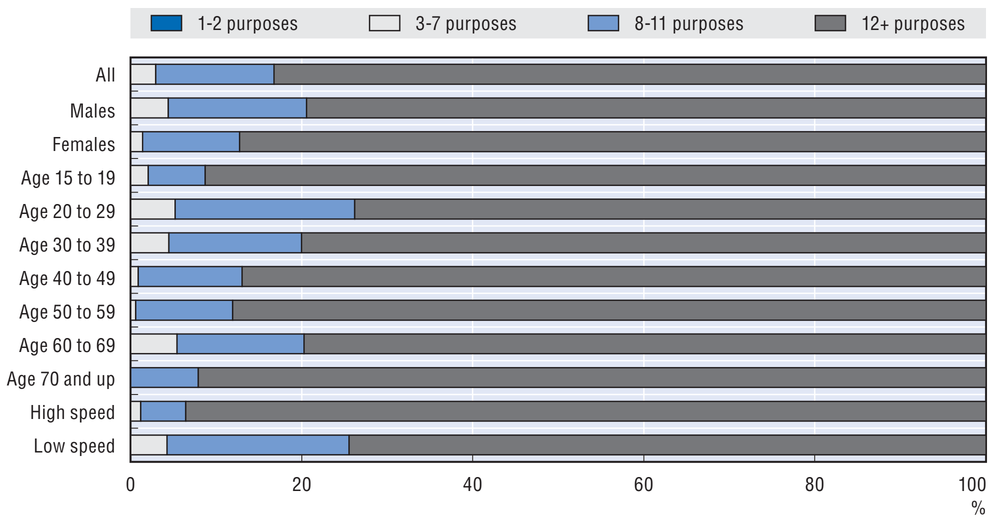
Source: Statistics Canada, *ad hoc* tabulation, based on data from the *Canadian Internet Use Survey 2005*, February 2007. See also Annex Table 4.A2.11.

does the majority (56%) use the Internet for fewer than eight purposes. Similarly, more than four out of ten broadband users use it for more than 12 purposes, compared with fewer than one out of six narrowband users, and only one out of four broadband users use it for fewer than eight purposes compared with more than one out of two narrowband users. Broadband is clearly a strong spur to increase the variety of Internet use.

In the Netherlands, it has similarly been shown that the frequency of Internet use is much higher for younger than for older people, and this also holds for the variety of use. Users with ten Internet activities were 32 years old on average against 49 years old on average for those with only one (CBS, 2007, and Annex Table 4.A2.12).

France appears to have a distribution somewhat different from other countries. More than eight out of ten Internet users (those having used Internet during the last month) had more than 12 different Internet activities. This may be due to the influence of relatively cheap home broadband penetration on the variety of activities. Compared with Canada, Finland and the Netherlands, variety of use appears to be high in the youngest Internet users and then increase with age, although numbers in the older age groups are relatively small and these users may largely be "early adopters" with socio-economic characteristics that make them more advanced users (education, income). Broadband clearly multiplies the variety of uses (Figure 4.23).

Figure 4.23. **Number of activities[1] participated in by Internet users during the last month, France, 2005**



StatLink http://dx.doi.org/10.1787/475553431576

1. 22 activities measured.

Source: INSEE, *ad hoc* tabulations, based on data from the survey *Enquête Technologies de l'information et de la communication*, October 2005. See also Annex Table 4.A2.13.

Regarding age differences, use by older groups will increase as they are progressively equipped, particularly as diffusion of ICTs is close to saturation in some countries (*e.g.* Denmark, Finland, Korea, the Netherlands). The share of advanced users among retired people should grow, not only due to a mechanical increase in Internet-using people who reach retirement age, but also because increasing numbers of routine activities (such as social contacts, administrative tasks, etc.) take place via the Internet. Social contact and interaction between older and younger age groups also increasingly take place via the Internet and this will further spur use by older groups as broadband uptake spreads.

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Education, knowledge and social capital

Some aspects of "social capital" are important explanatory factors in Internet use and the knowledge divide. A comparative study of six countries (Bermuda, Canada, Italy, Norway, Switzerland and the United States) has shown that as literacy skills increase, there are substantial increases in the diversity and intensity of Internet use and the use of computers for task-oriented purposes (Veenhof *et al.*, 2005). These patterns generally held for all countries. Having measured the likelihood of being an intense computer user, the analysis confirmed that education was strongly associated with computer use, controlling for other variables. Furthermore, differences by educational level were larger for intensity and diversity of Internet use than for perceived usefulness and attitudes towards computers.

A 2005 analysis in France went beyond the usual socio-economic factors to focus on indirectly measured social capital through *social networks* and *cultural behaviour*, holding other factors constant (*i.e.* gender, age, educational attainment, occupation, income, and physical location) (CREDOC, 2005). It showed that a dense social network (regularly seeing family members, inviting friends to the house, participating in one or more associations) has no significant influence on the probability of being connected from home. On the other hand, the variety of cultural practices (*e.g.* going to the cinema, seeing a play, a concert, visiting a museum, regularly visiting a library, etc.) has a strong influence on computer equipment and Internet connection at home. People who do not have such activities are 3.3 times less likely to be Internet-connected at home than those who have five such activities. This suggests that there is a knowledge-related "distance" to the Internet. Another study of low-income French households showed that access inequalities were largely explained by education level: in households with low incomes, the higher the lowest diploma the more access was likely (Sautory, 2007).

The influence of socio-economic factors on ICT and Internet use will affect how the knowledge society develops. Socio-economic characteristics reinforce some practices among younger age groups, owing to their different needs for peer-to-peer communication and knowledge development (see "New Millennium Learners", OECD, 2006b). A survey of French high school students on how socio-economic differences affect the use of instant messaging shows that the lower the socio-economic status, the higher the frequency of use (Table 4.3), suggesting that the socio-economic group largely drives particular forms of communication.

Table 4.3. **Differences among high school pupils by socio-economic group in the use of instant messaging for chatting, France, 2005**

	Total	Higher SES	Medium SES	Lower SES
Never	41	51	39	30
Sometimes	29.5	31	27	31
Frequently	18	8	22	27

StatLink http://dx.doi.org/10.1787/477503620831

Notes: SES = socio-economic status.
Source: Pasquier (2005), as provided in OECD, 2006b.

The tool itself, in this case instant messaging, reflects and amplifies a practice that depends on socio-economic status. Similarly, it was found that the substitution between mobile and fixed phones is particularly strong among households with low income and education attainment (Sautory, 2007). For this particular use the higher the socio-economic status the lower the use of the tool. The relationship between socio-economic status and the intensity and variety of ICT usage, *i.e.* cultural experience and knowledge acquisition through the Internet, is thus not necessarily uniform across applications. Differences in existing patterns of use are *magnified* but not caused by ICTs.

Moreover, ICT devices and equipment are constantly changing. Until recently, much ICT and Internet content was text-based (Stewart, 2000, cited in Veenhof *et al.*, 2005). Broadband is encouraging audio-visual content, but text or words remain crucial. For example new video search engines can use vocal recognition systems to find video or TV programmes in which specific words are used. The Web site *blinkx.com*, allows full-text search on TV or radio programmes. Such developments will be reflected in new use patterns by different socio-economic groups, as in the case of instant messaging.

Conclusion

High-speed broadband is changing people’s use of the Internet. The Internet is part of everyday life for 1.5 billion people and is driving major changes in people's lives. This chapter analysed the use of the Internet, showing that socio-economic characteristics have a direct bearing on how people use the possibilities it offers. It focused on the diffusion and use of ICTs, particularly the Internet and broadband, among households and individuals. Personal computers, the Internet and broadband have reached relatively high diffusion levels across and within OECD countries but differences among countries remain significant. Selected socio-economic variables were used to track pervasiveness and variety of use and the impact of broadband on patterns and frequency of use.

With increasing frequency of Internet use there are changes in how time is allocated, and broadband has a significant effect in this respect. Different rates of PC and Internet diffusion across different populations have resulted in digital divides (haves *versus* have-nots), and a digital *use* divide is increasingly evident as the simple digital *access* divide declines (OECD, 2004, 2006a). This knowledge or second-level use divide persists beyond connectedness and is increasingly important as broadband access increases. Background and socio-economic status have a direct bearing on how people use information technology in general and broadband in particular.

Policy responses to reduce the emerging use divide need to be wider than a simple focus on ICT-related issues. The increasing digital use divide and the remaining digital access divide are linked to other social and economic divides as well as to location factors. Efficient and creative use of ICTs is one of the keys to innovation, organisational change, growth and employment, and the emerging use divide needs to be taken into account when devising policies to increase the benefits of broadband and ICTs. Most OECD countries have programmes to promote IT education and skill formation. All aim at improving quality and spreading skills more widely, but the approaches for achieving these common aims are diverse (see Chapter 7). When investing in the future, a key question is: What kind of education and training should be encouraged to close the digital use divide and ensure wider benefits for all.

Notes

1. A full set of tables and graphs for this chapter is available in OECD (2008a). Thanks are due to In-Hoe An (National Internet Development Agency, Ministry of Information and Communication, Korea), Régis Bigot (CREDOC, France), John Horrigan (PEW Research Center), Anders Hintze (Statistics Sweden), Martin Mana (Czech Statistical Office), Thomas Le Jeannic, Emmanuelle André and Samuel Dambrin (INSEE, France), Lea Parjo (Statistics Finland) and Ben Veenhof (Statistics Canada) who provided data used in this chapter.
2. Data for end 2007. See ITU, "Global ICT developments" at: *www.itu.int/ITU-D/ict/statistics/ict/index.html*. Note also that the report estimates 3.3 billion mobile subscribers and 1.3 billion fixed telephone lines end 2007.
3. The OECD definition of broadband is download speeds equal to or faster than 256 kbit/s. Many broadband services are considerably higher in most OECD countries. The term "high-speed Internet" is synonymous with broadband. In some surveys users self-identify whether they are using a high-speed connection.
4. Assuming that xDSL wired access at home is a good proxy for broadband access.
5. There are also considerable differences in take-up of different technologies. Cable modem is a popular access platform for home subscribers in countries where it is widely available and can provide competitive services, *e.g.* the United States.
6. INSEE, *ad hoc* tabulations, based on data from the survey *Enquête Technologies de l'information et de la communication*, October, 2005.
7. For Internet use in Canada in 2005, enduring digital access divides are linked with location factors (*e.g.* remote and rural locations) and socio-economic factors (*e.g.* lower income and lower levels of educational attainment), see McKeown, *et al.* (2007). Significant differences in Internet access between rural and urban locations were also found in earlier OECD work, see OECD (2002).

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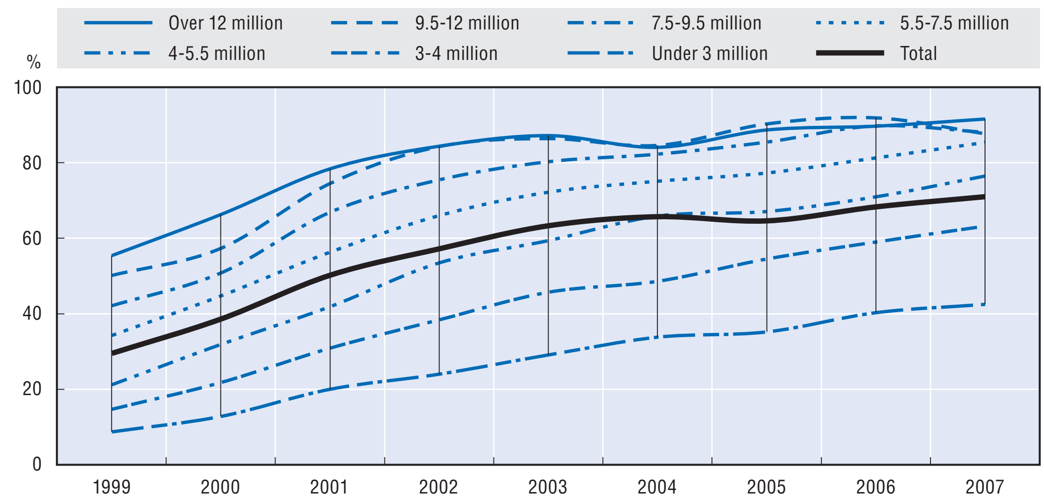
ANNEX 4.A1

Figure 4.A1.1. **Diffusion of PCs among households by income level[1] in Japan, 1992-2007[2]**

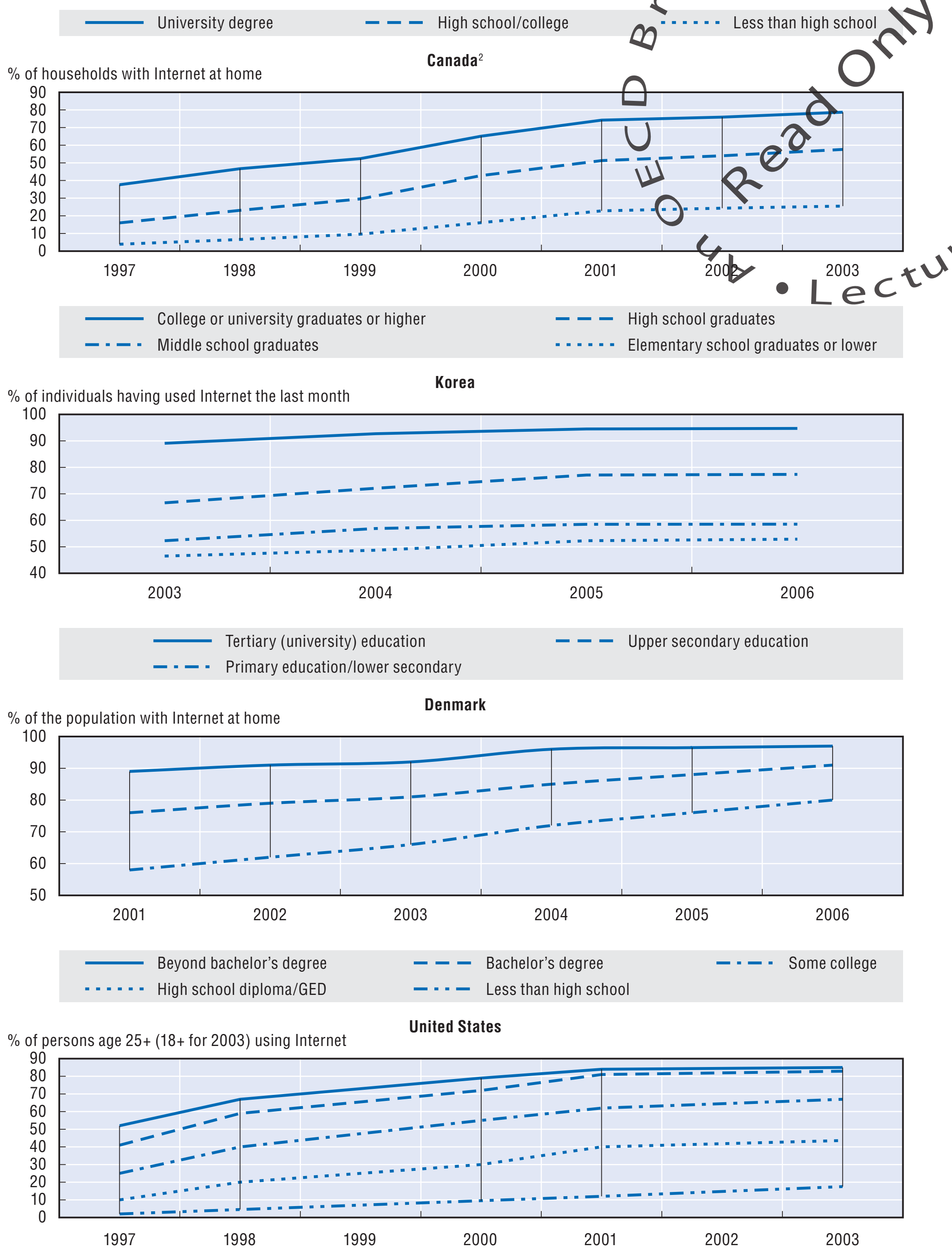


StatLink http://dx.doi.org/10.1787/475637434204

1. In millions of current JPY.
2. Fiscal year, ending in March.

Source: Cabinet Office, Japan.

Figure 4.A1.2. **Internet access or use by educational attainment in selected OECD countries**[1]



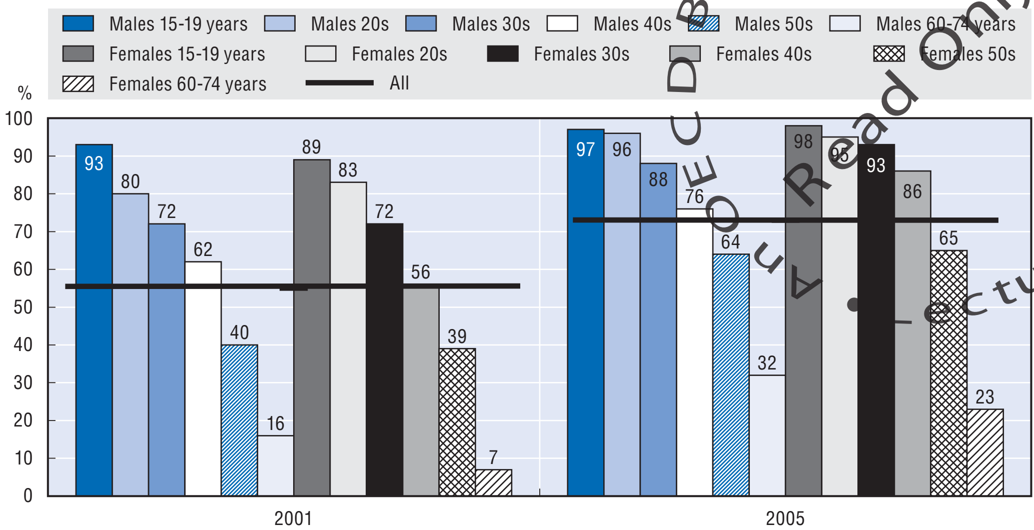
StatLink http://dx.doi.org/10.1787/475665053837

1. Levels of education, locations and populations (households or individuals) vary among the selected countries.
2. Levels of education of household head.

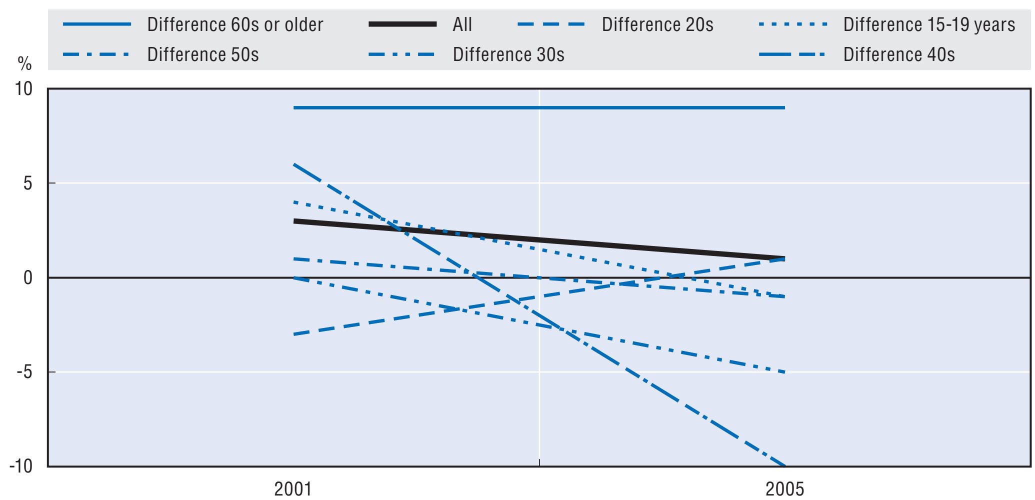
Source: OECD, based on data from national statistical offices, Ministry of Information and Communication–NIDA (Korea), and from US Department of Commerce.

Figure 4.A1.3. **Internet usage in Finland, 2001 and 2005**[1]

Percentage of individuals aged 15 to 74



and gender differences[2]



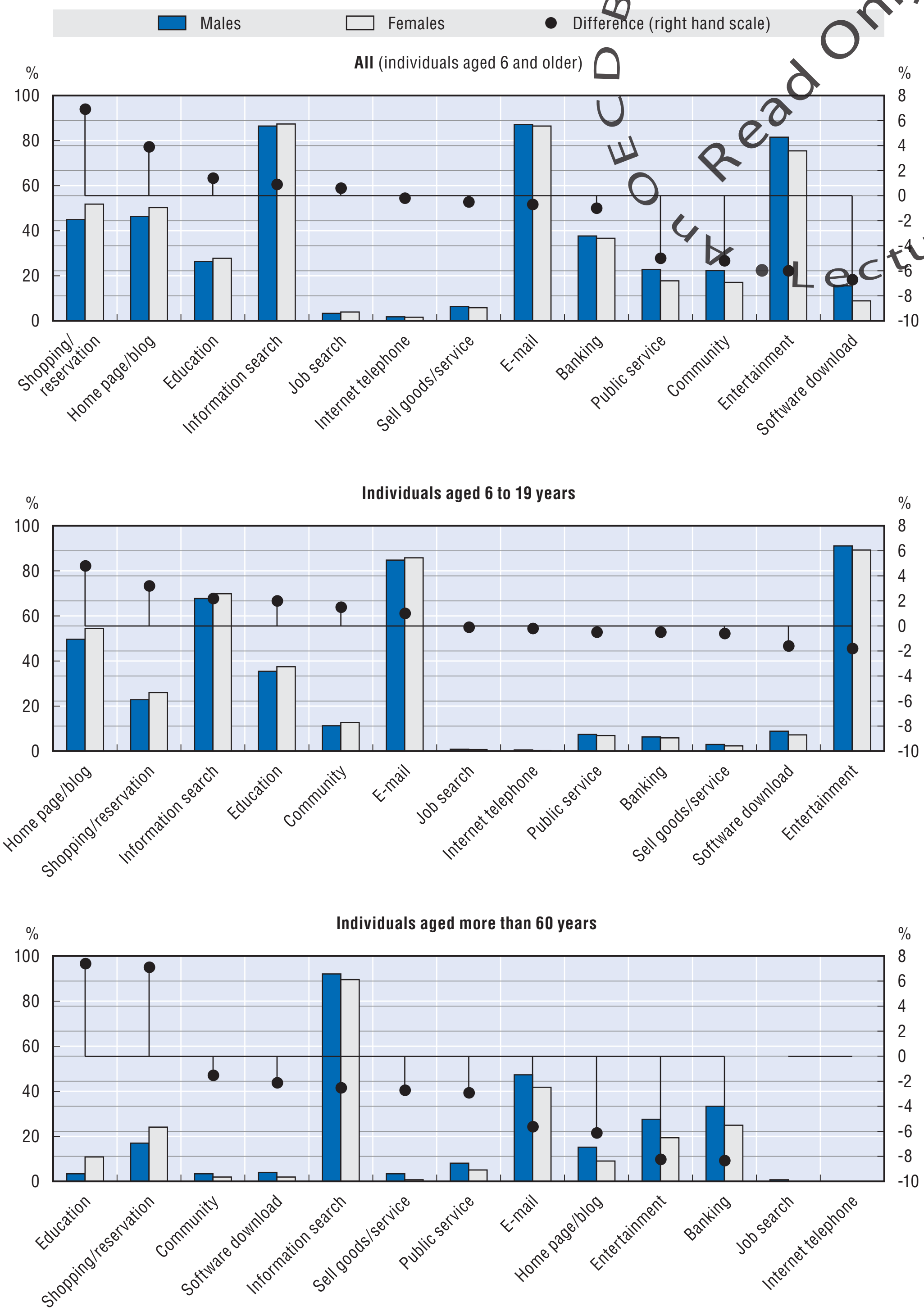
StatLink http://dx.doi.org/10.1787/475667382733

1. Spring of each year.
2. Expressed as Internet usage rate of males minus females.

Source: Statistics Finland (2006b).

Figure 4.A1.4. **Internet usage pattern by gender and age in Korea, 2005**

Percentages of individuals



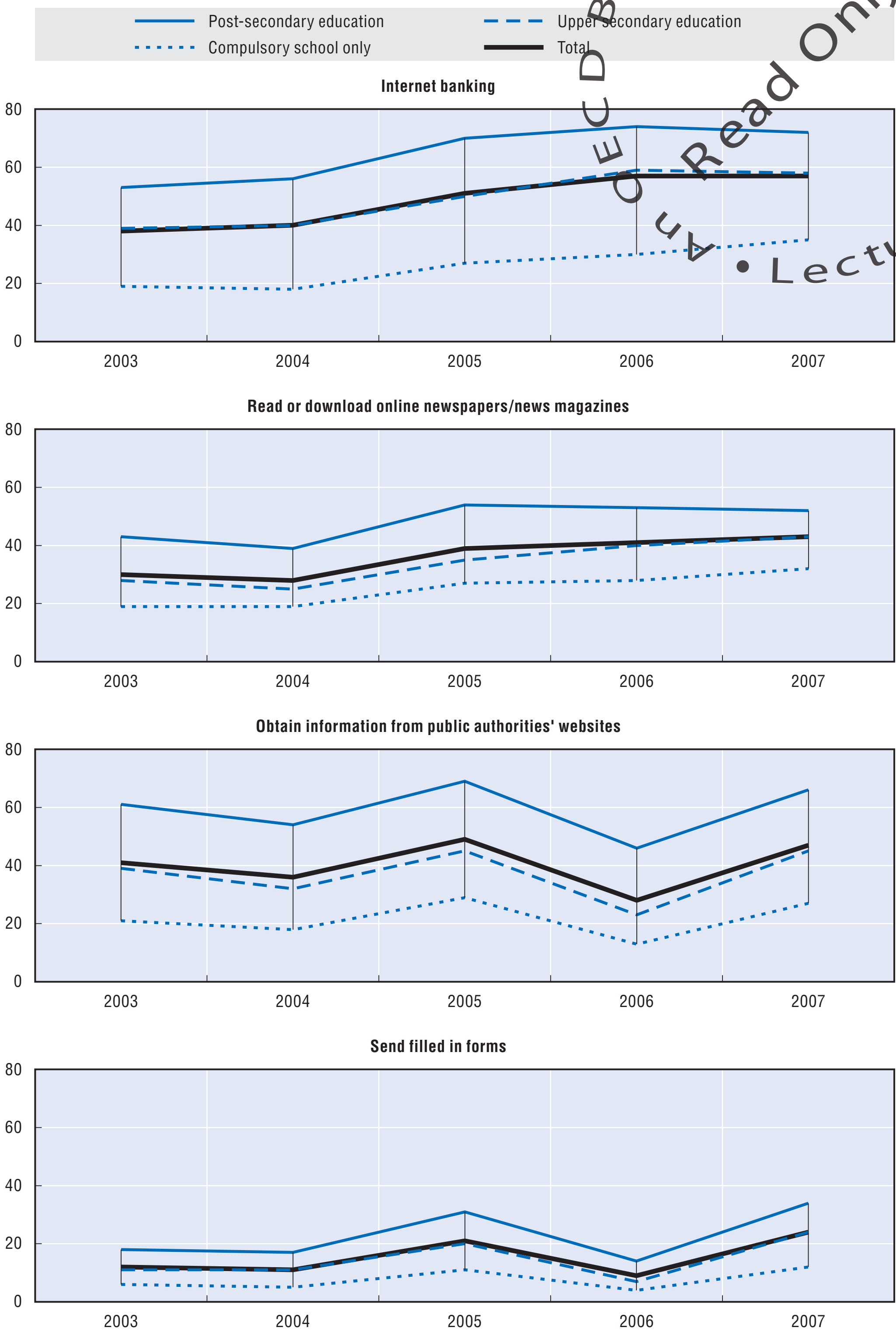
StatLink http://dx.doi.org/10.1787/475671874503

1. Difference measured as percentages of females minus percentages of males, in percentage points.

Source: Montagnier and Van Welsum (2006), based on data from the National Internet Development Agency of Korea, 2006. Available at: *http://isis.nic.or.kr/english/sub02/sub02_index.html?flag=2*.

Figure 4.A1.5. **Selected online activities by level of education in Sweden, 2003-07**

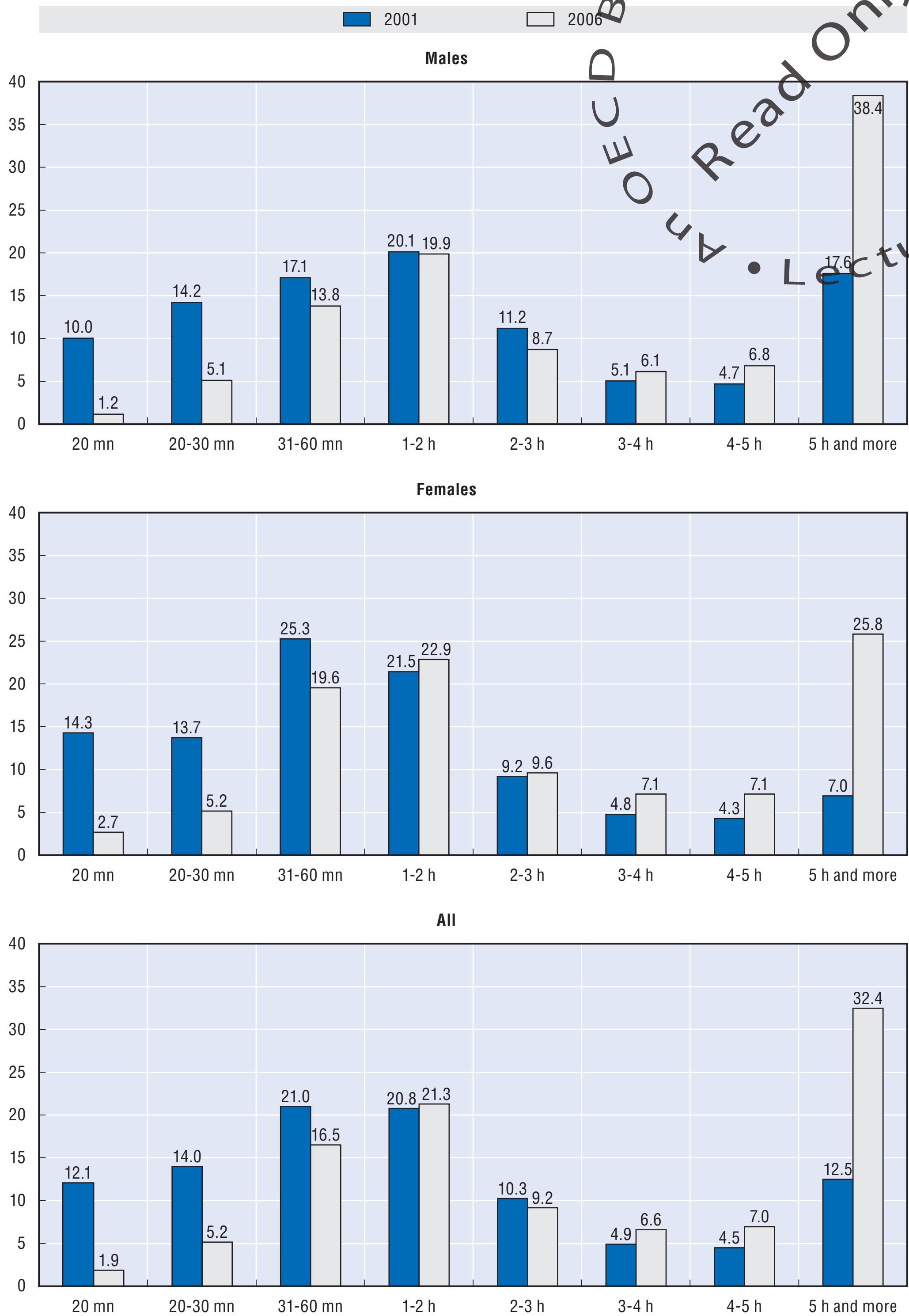
Percentage of people aged 16 to 74



StatLink http://dx.doi.org/10.1787/475710272447

Source: Statistics Sweden.

Figure 4.A1.6. **Minutes using the Internet at home in leisure time per week in Finland, 2001-06**[1]



StatLink http://dx.doi.org/10.1787/475726871216

1. November of each year. All people in November 2001 and people aged 15 to 74 in November 2006.

Source: OECD, based on data from Statistics Finland.

ANNEX 4.A2

Table 4.A2.1. **Households and individuals with access to a home computer in selected OECD countries, 1986-2007**

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Percentage of households																					
Australia									26.9		33.5		44.0	47.0	53.0	58.0	61.0	66.0		67.0		
Austria															34.0		49.2	50.8	58.6	63.1	66.8	70.7
Belgium[1]											28.1	35.6	34.9	45.3	47.3	48.7					57.5	67.2
Canada[2]	10.3				16.2	18.5	20.0	23.0	25.0	28.8	31.6	36.4	40.6	50.0	55.2	59.8	64.1	66.6	68.7	72.0		
Denmark					15.0			27.0	33.0	37.0	45.0	48.0	53.0	60.0	65.0	69.6	72.0	79.0	81.0	84.0	85.0	83.0
Finland					8.0				17.0	19.0	23.0	35.0	37.0	43.4	47.0	52.9	54.5	57.4	57.0	64.0	71.1	76
France[3]		7.0		8.2			11.0			14.3	15.0	16.0	19.0	23.0	27.0	32.4	36.6	41.0	45.0	50.4	54.0	
Germany												39.8	44.9	47.3	53.4	57.2	61.0	65.2	68.7	69.9	76.8	
Ireland													18.6		32.5			42.2	46.2	54.9	58.5	65.4
Italy															29.4					43.9	46.1	47.8
Japan[4]		11.7	9.7	11.6	10.6	11.5	12.2	11.9	13.9	15.6	17.3	22.1	25.2	29.5	38.6	50.1	57.2	63.3				
Japan[5]										16.3	22.3	28.8	32.6	37.7	50.5	58.0	71.7	78.2	77.5			
Korea[6]															71.0	76.9	78.6	77.9	77.8	78.9	79.6	
Mexico[7]											3.1		5.7		10.4	11.6	15.2		18.0	18.4	20.5	
Netherlands[8]		11.0	14.0	18.0	22.0	25.0	29.0	31.0	34.0	39.0	43.0	47.0	55.0	59.0	64.0	69.0						
Netherlands[9]																	76.0	76.0	80.0	83.0	84.0	86.0
New Zealand[3]	6.7	8.6	9.6	11.5	11.6	13.3	15.9	17.1	18.6	21.7	24.8	27.6	32.9	37.5	42.8	46.6	52.0	62.0			71.6	
Norway[10]																		68.0	72.0	74.0	75.0	82.0
Portugal[11]										11.0		14.0		21.0	29.4			38.3	41.3	42.5	45.4	
Spain[11]															30.4			47.1	52.1	54.6	56.9	
Sweden[11, 12]														56.7	59.9	69.2				79.7	82.5	
Switzerland[13]					14.5								51.1		57.7	62.2	65.4	68.9	70.6	76.5	77.4	
Turkey[14]															12.3							
United Kingdom[15]	16.0										26.0		33.0		47.0	52.9	57.9		62.0	65.0		
United States[16]				14.4	15.2				23.0			36.6	42.1		51.0	56.2		61.8				

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Table 4.A2.1. **Households and individuals with access to a home computer in selected OECD countries, 1986-2007** *(cont.)*

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Percentage of individuals[17]																					
Australia													38.0		46.0	53.0	55.3					
Italy																			39.2	39.9	41.4	
Netherlands[9]													60.0	66.0	70.0	74.0	81.0	82.0	85.0	87.0	88.0	
Norway		13.0							33.0	39.0	43.0	50.0	57.0	67.0	71.0	75.0	76.0	77.0	79.0	83.0		
Sweden									23.4	27.6	34.3	40.3	52.1	61.4	64.7	67.4	69.7					
Turkey[18]																				17.7		

StatLink http://dx.doi.org/10.1787/477522043137

1. INS, *Direction Générale Statistique et Information Économique – Enquête sur les budgets des ménages.*
2. Until 1996, May of each year. Household Facilities and Equipment Survey. 1997 and onwards, Survey of Household Spending.
3. June of each year, except October for 2005.
4. Fiscal year ending in March. Consumer Survey, Economic and Social Research Institute, Cabinet Office.
5. Fiscal year ending in March. Information and Communications Policy Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications. Communication Trends Survey.
6. From NIDA. December of each year, except June for 2003.
7. December for 2001 and 2002. June for 2004 and 2005. April preliminary data for 2005 and 2006.
8. From CBS, *Sociaal-economish panelonderzoek* (SEP).
9. CBS, POLS Survey up to 2004. ICT-*gebruik huishoudens en personen survey* for 2005-06.
10. Second quarter of each year from 2004 onwards.
11. From 2002 onwards, Eurostat *NewCronos database.*
12. Survey on living conditions until 2001.
13. OFS, Enquête sur les revenus et la consommation.
14. For 2000, households in urban areas only.
15. March 2001-April 2002 (financial year) instead of 2001. For 2004, 2004/05 and 2005, 2005/06, Expenditure and Food Survey, Office for National Statistics.
16. November of each year, except August for 2000 and September for 2001.
17. Age cut-off: Australia (18+), Netherlands (12+), Norway (9 to 79), Sweden (16 to 84). Norwegian media barometer for Norway.
18. Share of the population having used a PC in the last three months.

Source: OECD, ICCP, from National Statistical Offices, Eurostat *NewCronos database*, or other national official statistical sources.

Table 4.A2.2. **Households with access to the Internet[1] in selected OECD countries, 1996-2007**

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Percentage of households											
Australia[2]	4.4		16.0	22.0	32.0	42.0	46.0	53.0		56.0	64.2	
Austria					19.0		33.5	37.4	44.6	46.7	52.3	59.6
Belgium[3]			4.8	13.5	24.1	29.2			45.5	50.2	54.0	60.4
Canada		16.0	22.6	28.7	40.1	48.7	51.4	54.5				
Denmark	5.0	10.0	22.0	33.0	46.0	55.0	59.0	66.0	71.0	73.0	80.0	
Finland			12.0	24.7	30.0	36.0	41.0	45.0	50.0	57.0	64.0	68.8
France[4]				6.5	11.9	18.1	23.0	28.0	30.7	36.5	40.9	49.2
Germany								54.1	60.0	61.6	67.1	70.7
Ireland			5.0		20.5			33.5	38.2	45.1	48.7	57.0
Italy				7.7	18.8					34.5	35.6	38.8
Japan[5]					34.0	35.1	48.8	53.6	55.8	57.0	60.5	
Japan[6]	3.3	6.4	11.0	19.1	34.0	60.5	81.4					
Korea[7]						49.8	63.2	70.2	68.8	72.2	74.8	
Mexico[8]						6.2	7.4		8.7	9.0	10.1	
Netherlands[9]							63.0	65.0	71.0	78.0	80.0	83.0
New Zealand[10]						37.4					60.5	
Norway								55.0	60.0	64.0	69.0	78.0
Portugal				5.0	9.0	13.0		21.7	26.2	31.5	35.2	
Sweden[11]				42.3	48.2	53.3				72.5	77.4	
Switzerland[12]									61.0		70.5	
Turkey[13]					6.9							
United Kingdom[14]			9.0	14.0	27.0	38.0	44.0	48.0			57.0	61.0
Great Britain[15]							46.0	50.0	51.0	55.0	57.0	61.0
United States[16]			26.2		41.5	50.5		54.6				
	Percentage of individuals with access at home[17]											
Canada[18]										60.9		
Netherlands[19]			16.0	26.0	45.0	56.0	64.0					
Netherlands							68.0	71.0	76.0	82.0	85.0	
Norway		13.0	22.0	36.0	52.0	60.0	63.0	64.0	66.0	74.0	79.0	
Sweden			30.7	46.3	53.3	58.2	63.5	66.4	69.2			
Switzerland[20]						51.8	59.4	64.4	68.7	70.6	76.8	79.1

StatLink http://dx.doi.org/10.1787/477550853083

1. For Denmark, Ireland, the Netherlands and before 1999 for the United Kingdom, access to the Internet via a home computer; for the other countries access to the Internet through any device (*e.g.* computer, phone, TV, etc.). Age cut-offs vary across countries.
2. 2004-05 instead of 2005.
3. INS, *Direction Générale Statistique et Information Économique – Enquête sur les budgets des ménages*, until 2004. Eurostat *NewCronos database* for 2005 and 2006.
4. June of each year, except October for 2005. Before 2005, Internet access from PC. For 2005, Internet access from any device.
5. Survey of Household Economy. Device that can access the Internet.
6. MPHPT, *Communications Usage Trend Survey*. End of the calendar year. Ratio of households using the Internet. Access devices include PCs, mobile phones, PDAs, Internet-capable video game consoles, TVs, etc.
7. Internet access at home. From NIDA. December of each year, except June for 2003.
8. December for 2001 and 2002. June for 2004 and 2005. April preliminary data for 2005 and 2006.
9. CBS, POLS Survey up to 2004. *ICT-gebruik huishoudens en personen* survey for 2005-06.
10. July 2000-June 2001 for 2001. The information is based on households in private occupied dwellings with access to the Internet. Visitor-only dwellings, such as hotels, are excluded. For 2006, QuickStats National Highlights of the 2006 Census.
11. Survey on living conditions. Eurostat *NewCronos database* for 2005-06.
12. OFS, *Enquête sur les revenus et la consommation*.
13. Households in urban areas only.
14. April-June quarter.
15. National Statistics Omnibus Survey.
16. November of each year, except August for 2000.
17. Age cut-offs may vary across countries. For instance, 12 to 74 for the Netherlands and 16 to 84 in Sweden; from 14 years in Switzerland.
18. Canadian Internet use survey.
19. Autumn of each year. POLS Survey.
20. OFS, based on REMP/MA-Net, Net-Metrix-Base.

Source: OECD, ICCP, from National Statistical Offices, Eurostat *NewCronos database*, or other national official statistical sources.

Table 4.A2.3. **Households and individuals with broadband access to the Internet from home in selected OECD countries, 2000-07**

	2000	2001	2002	2003	2004	2005	2006	2007
					Households[1]			
Australia[2]					28.0		38.9	
Austria[3, 4]				10.3	15.9	23.1	33.1	46.1
Austria[11]				18.0	25.4	33.6	40.7	45.7
Belgium						40.6	48.0	56.4
Canada		20.5	27.2	35.0	43.0	50.0		
Denmark				25.1	35.8	51.2	63.3	69.5
Finland				12.4	21.3	36.1	52.9	60.2
France[5]						27.0		
France[3]						30.3		42.9
Germany				9.3	18.0	23.2	33.5	49.6
Iceland					45.4	63.5	72.1	76.1
Ireland				0.6	2.9	7.4	13.0	31.0
Italy[6]						11.6	14.4	22.6
Italy[3]						12.9	16.2	25.3
Japan[7]			29.6	47.8	62.0	65.0	67.9	
Korea	30.3	57.7	68.4	67.0	70.5	74.0	78.1	
Netherlands			15.0	22.0	34.0	54.0	66.0	74.0
Norway				22.9	30.0	41.4	57.1	66.7
Poland					8.3	15.6	21.6	29.6
Portugal				7.9	12.3	19.7	24.0	30.4
Sweden						40.2	51.0	66.6
United Kingdom[8]							40.0	51.0
United Kingdom[3]				10.7	15.8	31.5	43.9	56.7
					Individuals[1]			
Australia[2]					31.0			
Netherlands			17.0	26.0	39.0	59.0	71.0	
Switzerland[9]						39.5	44.8	53.5
United States[10]	3.0	8.7	13.6	19.0	27.0	36.0	45.0	54.0

StatLink http://dx.doi.org/10.1787/477558632525

1. Age cut-offs vary across countries.
2. 2004-05.
3. Eurostat. Age cut-offs 16 to 74.
4. Statistics Austria.
5. INSEE.
6. ISTAT.
7. Only broadband access via a computer.
8. National Statistics Omnibus Survey.
9. OFS, based on Publica Data-IGEM, KommTech Studie; 15 years old or more.
10. PEW Research Center.
11. Austrian Regulatory Authority for Broadcasting and Telecommunications; data excludes mobile broadband access; as opposed to other sources this data includes private and business customers.

Source: OECD, compiled from national statistical offices, Eurostat *NewCronos database*, and PEW Research Center.

Table 4.A2.4. **Places where the Internet has been used[1] by females and males,[2] 2005**

	At home		At work		At place of education[3]		Other people's house	
	Females	Males	Females	Males	Females	Males	Females	Males
Australia	50.0	53.0	28.0	31.0	9.0	8.0	20.0	18.0
Austria	73.6	75.2	41.4	47.7	9.4	8.3	1.9	3.8
Belgium	79.4	83.0	29.7	31.4	9.2	7.5	4.8	5.7
Canada	60.3	61.5	25.2	27.4	11.3	12.0	..	..
Czech Republic	59.9	62.9	43.2	43.8	23.2	19.7	6.5	7.0
Denmark	92.7	93.3	47.7	48.7	14.9	13.7	..	..
Finland	74.1	80.8	53.3	50.8	..	..	5.5	9.1
Germany	86.1	89.0	27.7	34.0	12.9	14.6	6.3	10.0
Greece	60.9	65.9	40.4	46.5	18.9	14.8	10.0	13.1
Hungary	52.8	59.0	43.9	46.5	18.9	19.8	15.5	15.3
Iceland	87.5	91.5	52.3	56.1	19.7	20.0	11.5	15.5
Ireland	66.8	71.1	44.4	47.2	10.9	9.7	6.3	9.2
Italy	68.9	74.1	44.8	49.1	13.5	9.9	9.3	12.1
Korea	98.0	97.5	13.5	32.5	8.9	8.6	7.7	7.2
Luxembourg	92.3	94.5	28.3	45.4	14.9	13.1	3.1	4.9
Netherlands	93.4	93.1	40.1	50.9	10.3	11.0	3.6	3.9
Norway	83.0	85.7	54.0	62.3	17.9	13.3	7.0	11.0
Poland	56.5	59.5	34.2	29.3	28.1	28.7	15.4	18.9
Portugal	58.4	63.2	47.0	49.3	28.6	20.7	13.8	15.5
Slovak Republic	34.0	45.4	56.2	51.8	23.7	20.3	22.1	24.5
Spain	60.7	65.9	44.2	47.2	19.9	17.5	23.3	24.1
Sweden	84.8	88.7	47.7	49.7	16.8	12.5	5.1	7.2
Switzerland[4]	87.3	86.7	33.9	49.0	7.0	8.5	10.0	11.5
United Kingdom	83.0	83.2	44.9	48.3	17.5	14.1	21.0	26.9

StatLink http://dx.doi.org/10.1787/477568185527

1. Used in the last month in Korea, last three months for EU countries, past six months in Switzerland, past 12 months for Australia and Canada.
2. Persons aged 16 to 74 for EU countries, age 6 and older for Korea, and 18 and older for Australia and Canada.
3. Technical and further education or tertiary institution for Australia, school for Canada and Korea.
4. OFS, based on REMP/MA-Net.

Source: OECD, based on data from the Australian Bureau of Statistics, Eurostat, Statistics Canada, and the Ministry of Information and Communication, National Internet Development Agency of Korea.

Table 4.A2.5. **Marginal effect of broadband on selected activities in Canada, 2005**

	High speed[1]	Low speed[2]	*Difference[3] for Internet users*
E-mail	93.0	88.6	4.5
Participating in chat groups or using a messenger	40.8	27.2	13.6
Searching for information on Canadian municipal, provincial or federal government	54.6	45.0	9.6
Communicating with Canadian municipal, provincial or federal government	23.8	19.5	4.3
Searching for medical or health related information	60.6	50.8	9.8
Education, training or school work	46.2	31.8	14.5
Travel information or making travel arrangements	66.7	51.6	15.1
Paying bills	59.4	41.3	18.1
Electronic banking	62.5	43.3	19.2
Researching investments	28.6	18.9	9.6
Playing games	41.5	27.9	13.6
Obtaining or saving music	41.1	18.9	22.2
Obtaining or saving software	34.8	22.6	12.1
Viewing the news or sports	65.8	47.8	18.1
Obtaining weather reports or road conditions	69.9	57.4	12.5
Listening to the radio over the Internet	29.9	12.2	17.7
Downloading or watching television	10.2	2.0[4]	8.1
Downloading or watching a movie	9.8	1.9[4]	7.8
Researching community events	45.6	32.4	13.2
General browsing (surfing)	86.1	78.0	8.1

StatLink http://dx.doi.org/10.1787/477568724283

1. "High speed" includes all respondents who identified that they access the Internet at home using cable or satellite, and all respondents accessing the Internet using a telephone connection or other connection (*e.g.* television, wireless [cellular phone or PDA], other) which they identified as a high-speed connection.
2. "Low speed" includes all respondents accessing the Internet at home through a telephone or other connection (*e.g.* television, wireless [cellular phone or PDA], other) which they identified as not a high-speed connection.
3. Difference, in percentage points, between home Internet users with high-speed connections and those with low-speed connections. Internet users at home are individuals who answered they used the Internet from home in the past 12 months.
4. Use with caution – coefficient of variation between 16.6 and 33.3%.

Source: Statistics Canada, Canadian Internet Use Survey 2005.

Table 4.A2.6. **Marginal effect of broadband[1] on selected activities in EU countries, 2007**

Activities	Sending/ receiving emails	Using services related to travel and accommodation	Telephoning over the Internet, videoconferencing	Finding information about goods and services	Listening to web radios/ watching TV	Playing/ downloading games and music	Downloading software	Reading/ downloading online newspapers/ newsmagazines	Seaking health information on injury, disease or nutrition	Using Internet to make phone calls	Selling goods and services (*e.g.* via auctions)	Internet banking
Austria	4.1	5.6	8.7	5.8	3.3	8.9	10.6	12.8	8.0	10.4	. .	5.8
Belgium	5.4	9.6	1.4	6.6	7.5	11.9	8.8	10.3	1.8	5.0	6.5	14.2
Czech Republic	6.7	5.6	6.2	3.9	2.5	–1.3	8.1	4.6	3.7	8.8	0.0	8.2
Denmark	5.7	12.5	9.2	12.8	19.5	14.2	25.3	23.6	13.0	19.8	11.3	16.5
Greece	29.1	16.5	14.7	8.5	27.9	20.6	22.8	23.3	11.9	24.5	. .	12.9
Spain	7.3	8.4	9.6	3.1	18.0	20.3	14.2	10.2	2.4	9.0	1.6	5.0
Finland	7.2	13.4	16.5	8.8	18.1	22.7	18.3	13.8	11.5	14.6	4.8	8.1
France	14.6	16.6	17.2	9.4	15.6	19.4	12.6	8.4	6.3	27.7	12.7	14.3
Hungary	3.5	14.2	14.5	8.1	14.7	8.5	19.3	12.6	2.3	14.8	1.7	10.7
Ireland	2.8	15.1	7.5	9.2	13.9	12.1	9.1	8.3	8.8	10.0	2.9	16.8
Iceland	11.1	19.1	14.8	6.7	31.3	19.2	15.1	–1.0	19.7	25.2	7.3	12.6
Italy	4.5	6.0	7.6	4.1	8.8	9.9	7.8	9.2	5.0	10.1	1.8	6.3
Luxembourg	7.6	2.3	13.9	6.9	19.4	15.9	23.1	11.9	9.5	19.3	4.7	22.3
Netherlands	3.4	8.9	6.0	9.8	24.0	18.5	14.0	14.9	12.5	8.5	6.0	15.0
Norway	15.7	23.8	10.9	9.4	24.2	26.1	21.0	12.9	16.1	20.5	8.3	11.3
Poland	6.7	5.6	5.3	5.9	8.0	6.0	7.0	11.6	7.0	8.1	3.6	10.1
Portugal	11.6	15.9	11.2	9.9	10.7	8.2	12.7	19.7	13.3	12.0	. .	18.8
Sweden	14.6	13.6	9.4	7.7	25.1	27.5	16.6	18.2	9.7	11.0	10.1	19.5
Slovak Republic	4.7	4.7	14.8	4.2	14.2	12.7	9.7	11.8	2.5	19.0	2.2	12.3
United Kingdom	8.6	7.5	13.7	5.3	29.6	19.7	28.0	11.7	7.5	14.2	8.1	25.5

StatLink http://dx.doi.org/10.1787/477625026330

1. Differences, in percentages, among individuals who have used the Internet in the last three months, for the specific activity, between individuals who live in a household with broadband access and those who live in a household with Internet access but no broadband access.

Source: OECD, based on data from Eurostat, *NewCronos database*.

Table 4.A2.6. **Marginal effect of broadband[1] on selected activities in EU countries, 2007** *(cont.)*

Activities	In the last 3 months, I accessed the Internet, on average, every day or almost every day	In the last 3 months, I accessed the Internet, on average, at least once a week (but not every day)	In the last 3 months, I accessed the Internet, on average, at least once a month (but not every week)	Yes, I have already used the Internet in the last 3 months, to send a filled-out form	In the last 3 months, I have received unsolicited e-mail that I would regard as junk mail or spam[2]	I have used Internet, in the last 3 months, to look for a job or send a job application	I have used Internet, in the last 3 months, for training and education	I have used Internet, in the last 3 months, for doing an online course (on any subject)	I have used Internet, in the last 3 months, for other communication uses (chat sites, messenger, etc.)	for ordering/buying goods or services, over the Internet, for private use, in the last 3 months
Austria	9.7	–7.1	–2.3	2.8	5.6	4.0	0.9	. .	4.9	6.0
Belgium	15.3	–12.0	–3.6	4.3	4.6	–1.8	3.2	–1.2	9.2	10.9
Czech Republic	12.5	–6.6	–5.8	2.1	. .	3.0	–1.6	–0.1	11.7	11.7
Denmark	18.5	–9.7	–7.6	11.8	15.3	3.1	17.1	3.0	13.9	16.2
Greece	34.0	–22.3	–9.0	12.1	23.7	2.1	6.5	3.5	10.8	19.0
Spain	19.0	–8.8	–7.5	–0.9	4.0	4.6	4.0	1.4	10.8	6.8
Finland	25.0	–15.6	–6.0	2.9	15.4	9.1	18.2	8.0	12.6	8.2
France	22.7	–14.0	–7.0	10.6	6.0	–0.8	12.0	3.5	23.7	12.8
Hungary	18.7	–14.3	–3.3	7.1	13.8	2.2	6.0	3.1	10.0	7.2
Ireland	24.0	–16.7	–7.0	3.5	9.3	6.3	6.9	0.5	9.6	14.0
Iceland	18.5	–17.6	–0.9	–1.3	6.6	7.4	17.6	2.9	21.7	14.8
Italy	5.9	–1.6	–3.0	1.0	6.4	1.0	5.2	0.4	6.1	3.4
Luxembourg	26.5	–17.0	–5.5	11.3	3.2	–3.8	3.7	–0.6	9.6	13.2
Netherlands	15.3	–12.4	–2.3	12.9	13.0	5.5	9.7	0.9	26.2	17.3
Norway	30.7	–20.8	–8.5	4.3	15.7	12.7	16.1	2.1	28.6	22.1
Poland	13.5	–9.6	–3.2	2.1	6.3	1.4	3.1	. .	2.6	6.5
Portugal	28.9	–12.8	–12.3	9.7	22.5	2.1	11.0	3.1	8.1	18.8
Sweden	29.7	–23.2	–5.9	13.0	11.7	8.2	13.1	–1.2	21.2	18.4
Slovak Republic	15.1	–10.1	–3.5	–2.9	12.8	2.0	–1.2	0.5	14.5	6.3
United Kingdom	26.0	–14.7	–9.1	9.7	12.5	7.4	12.1	7.2	15.9	22.3

StatLink http://dx.doi.org/10.1787/477625026330

1. Differences, in percentages, among individuals who have used the Internet in the last three months, for the specific activity, between individuals who live in a household with broadband access and those who live in a household with Internet access but no broadband access.

Source: OECD, based on data from Eurostat, *NewCronos database*.

Table 4.A2.7. **Selected Internet broadband activities[1] in EU countries, 2007**

Activities	Sending/ receiving emails	Using services related to travel and accommodation	Telephoning over the Internet, videoconferencing	Finding information about goods and services	Listening to web radios/ watching TV	Playing/ downloading games and music	Downloading software	Reading/ downloading online newspapers/ newsmagazines	Seaking health information on injury, disease or nutrition	Using Internet to make phone calls	Selling goods and services (*e.g.* via auctions)	Internet banking
Austria	86.4	45.6	21.6	74.9	12.0	28.2	29.8	40.3	45.1	24.5	. .	49.7
Belgium	92.5	54.0	16.6	84.2	21.2	36.6	24.1	26.8	39.1	16.5	13.1	56.2
Czech Republic	90.2	56.9	39.7	81.8	21.4	44.1	24.8	49.6	25.2	38.2	. .	30.0
Denmark	92.4	65.2	14.9	85.6	45.0	42.9	47.5	60.7	48.9	31.1	29.3	74.0
Greece	88.7	65.2	19.3	92.5	44.5	61.2	45.0	68.3	33.1	31.6	. .	22.1
Spain	86.9	69.9	18.7	83.7	37.7	54.8	47.0	50.8	45.6	15.8	7.0	37.1
Finland	92.8	75.2	25.8	88.9	34.2	47.4	43.1	66.1	62.3	29.8	18.0	86.4
France	86.5	55.8	17.2	91.4	31.7	38.7	26.8	31.2	50.8	44.2	12.7	60.8
Hungary	96.1	54.3	31.2	87.2	38.3	56.3	41.0	61.2	49.2	32.1	8.5	27.9
Ireland	86.8	78.1	16.1	83.4	24.0	28.7	22.9	21.5	27.9	16.2	8.0	52.6
Iceland	90.5	69.0	25.8	87.5	56.5	41.9	33.9	75.3	50.9	37.9	13.8	82.5
Italy	85.6	51.7	18.6	72.7	25.6	42.0	35.5	51.2	45.1	26.3	10.7	35.2
Luxembourg	94.9	73.4	33.5	89.5	42.1	46.8	53.7	57.3	64.2	36.1	16.8	65.1
Netherlands	95.7	58.4	25.3	91.9	44.8	55.8	36.4	49.2	55.7	29.5	25.0	79.9
Norway	91.2	68.2	16.3	90.1	47.2	44.2	44.0	80.8	45.8	27.3	10.7	86.5
Poland	80.3	30.7	28.3	67.8	35.1	42.9	33.0	40.2	33.8	30.8	13.4	36.1
Portugal	88.5	40.2	25.7	86.2	41.3	57.3	27.9	44.7	50.1	22.1	. .	37.2
Sweden	90.2	54.7	12.6	89.7	46.1	50.0	33.3	58.0	34.2	15.9	18.1	76.0
Slovak Republic	93.5	51.5	33.7	75.7	29.3	52.7	27.6	52.6	33.6	37.0	5.7	36.2
United Kingdom	89.6	67.3	13.7	89.3	29.6	38.7	28.0	33.7	29.7	14.2	19.9	51.8

StatLink http://dx.doi.org/10.1787/477638462037

1. Percentages of individuals who have used the Internet in the last three months and undertaken the selected activities, and who live in a household with broadband access.

Source: OECD, based on data from Eurostat, *NewCronos database*.

Table 4.A2.7. **Selected Internet broadband activities[1] in EU countries, 2007** *(cont.)*

Activities	In the last 3 months, I accessed the Internet, on average, every day or almost every day	In the last 3 months, I accessed the Internet, on average, at least once a week (but not every day)	In the last 3 months, I accessed the Internet, on average, at least once a month (but not every week)	Yes, I have already used the Internet in the last 3 months, to send a filled-out form	In the last 3 months, I have received unsolicited e-mail that I would regard as junk mail or spam[2]	I have used Internet, in the last 3 months, to look for a job or send a job application	I have used Internet, in the last 3 months, for training and education	I have used Internet, in the last 3 months, for doing an online course (on any subject)	I have used Internet, in the last 3 months, for other communication uses (chat sites, messenger, etc.)	For ordering/buying goods or services, over the Internet, for private use, in the last 3 months
Austria	72.1	21.8	4.6	21.6	63.5	13.3	33.7	. .	23.2	43.5
Belgium	77.2	19.5	2.6	13.1	63.6	11.3	34.8	3.1	36.0	23.5
Czech Republic	60.1	31.0	8.3	8.5	. .	17.6	30.9	2.2	54.4	6.4
Denmark	85.4	11.2	2.8	41.9	57.0	32.0	80.5	5.0	44.1	55.4
Greece	84.8	11.4	3.1	22.4	69.7	17.0	46.8	9.7	27.3	30.1
Spain	67.1	24.6	6.6	17.7	68.8	20.0	55.9	10.1	57.8	29.8
Finland	83.2	14.1	2.4	22.7	58.6	34.8	57.9	18.0	31.7	43.7
France	72.0	21.8	4.5	32.9	56.9	19.9	77.7	3.5	34.9	45.6
Hungary	85.5	13.4	1.0	31.1	62.5	26.3	50.4	5.6	57.8	17.4
Ireland	69.4	24.1	5.2	37.4	70.4	13.3	52.5	4.7	18.9	53.5
Iceland	85.1	11.4	2.4	21.4	76.7	17.9	55.1	10.3	57.1	38.0
Italy	86.6	4.2	6.5	12.3	53.7	19.7	59.9	4.8	36.1	20.0
Luxembourg	79.6	15.9	3.9	30.2	64.8	17.1	62.5	3.9	47.6	51.2
Netherlands	81.0	16.3	2.3	40.7	70.0	22.7	39.6	4.2	34.3	53.2
Norway	81.8	14.3	2.8	32.3	67.6	27.3	65.4	4.6	50.8	59.6
Poland	73.6	20.2	5.4	9.7	68.6	17.4	52.1	. .	63.1	30.3
Portugal	77.6	15.8	4.7	36.4	59.9	16.8	74.0	3.1	71.1	18.8
Sweden	79.0	17.2	3.0	33.5	60.0	24.3	44.2	3.1	38.9	52.3
Slovak Republic	72.4	23.7	3.8	13.5	63.3	21.1	14.4	1.0	60.3	23.3
United Kingdom	74.1	20.7	3.8	27.5	72.4	22.5	51.7	7.2	31.5	68.7

StatLink http://dx.doi.org/10.1787/477638462037

1. Percentages of individuals who have used the Internet in the last three months and undertaken the selected activities, and who live in a household with broadband access.

Source: OECD, based on data from Eurostat, *NewCronos database*.

Table 4.A2.8. **Marginal effect of broadband on selected Internet activities in the United States, 2007**[1]

	Difference[2] for Internet users	
	Who have ever done the corresponding activity	Who have yesterday done the corresponding activity
1. Go online for no particular reason, just for fun or to pass the time	12	14
2. Send instant messages to someone who is online at the same time	8	10
3. Download a podcast so you can listen to it or view it at a later time	3	1
4. Visit a local, state, or federal government website	6	8
5. Get sports scores and information	18	15
6. Participate in an online discussion, a listserv or other online group or forum	7	3
7. Use an online search engine to help you find information on the web	10	30
8. Rate a product, service, or person using an online rating system	8	2
9. Buy or make a reservation online for a travel service, such as airline tickets, hotel room, or rent-a-car	21	4
10. Get financial information online such as stock quotes or mortgage interest rates	8	5
11. Download music files to your computer so you can play them at any time you want	22	7
12. Pay to access or download digital content online, such as music, video, or newspaper articles	15	3
13. Download video files to your computer so you can play them at any time you want	12	4
14. Send or read e-mail	6	24
15. Get news online	18	21
16. Buy a product online such as books, music, toys, or clothing	17	4
17. Looked for health information online	8	7
18. Log onto the Internet using a wireless device	21	
19. Post comments to an online news group or website	12	
20. Create or work on your own online journal or blog	8	
21. Take material you find online – like songs, text, or images – and remix it into your own artistic creation	7	
22. Create or work on your own webpage	11	
23. Create or work on webpages or blogs for others including friends, group you belong to, or work	6	
24. Share something online that you created yourself, such as your own artwork, photos, stories or videos	8	
25. Create or use an avatar or online graphic representation of yourself, for example, in a virtual world such as Second Life	5	
26. Done at least one of the content activities (items 20 to 25)	23	

StatLink http://dx.doi.org/10.1787/477665285786

1. Survey of April 2006 for items 1 to 7, December 2006 for items 8 to 11, August 2006 for items 12 to 18, and December 2005 for the others.
2. Difference, in percentage points, between home broadband Internet users and home dial-up users.

Source: Pew Internet and American Life Project.

Table 4.A2.9. **PC and Internet penetration rates, differences between top and bottom income bands**[1]

	1994	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Quartiles												
Canada												
Internet	..	..	27	38	43	49	53	53	55	..	..	..
Finland												
Internet	..	..	20	33	41	52	54	49	60	59	47	53
France												
PC	..	18	20	22	28	28	33	32	35	..	34	..
Internet	..	..	..	..	11	20	27	29	35	..	37	..
Sweden												
PC	22	23	25	30	23	18	15	13	15	12	..	..
Internet	..	..	..	29	28	25	21	18	19	17	..	..
Quintiles												
Australia[2]												
PC											45	
Internet											50	
United Kingdom												
Internet	..	..	..	24	40	61	62	66	68	69	..	..
Deciles												
Canada[3]												
PC	32	48	..	..	..	65	..	..	..	..	..	..
Internet	..	18	41	47	55	63	..	..	..	..	..	..
Netherlands												
PC	..	..	..	29	38	38	50	..	..	..	..	..
Internet	..	..	..	24	37	41	59	..	..	..	..	..
Sweden												
PC	30	33	42	35	26	23	18	15	17	12	..	..
Internet	..	..	..	37	34	32	25	23	25	18	..	..
United Kingdom[4]												
Internet	..	..	..	29	42	66	70	73	75	71	76	..

StatLink http://dx.doi.org/10.1787/477688222365

1. Difference in the penetration rates between high- and low-income quartiles, quintiles or deciles.
2. 2004-05 instead of 2005.
3. 1990 instead of 1994.
4. 1998/99 instead of 1998, and similarly for other years.

Source: OECD, based on data from national statistical offices.

Table 4.A2.10. **Purposes of use of the Internet in Finland, spring 2004 and spring 2007**

Percentage of Internet users	2004	2007
Sending/receiving e-mail	88	90
Finding information about goods or services	84	86
Internet banking	71	84
Using services related to travel and accommodation	60	71
Reading or downloading online papers/news magazines	52	63
Seeking health-related information	. .	59
Obtaining information from public authorities websites	62	54
Looking for information about education, training or course offers	. .	45
Listening to the music on the net or downloading it onto the computer or other device	30	41
Formalised educational activities at school, university or other educational institution	29	38
Purchasing/ ordering goods or services (excl. shares/financial services)	37	. .
Other financial and insurance services (*e.g.* buying of shares or securities)	16	. .
Downloading programmes to the PC	. .	38
Downloading pictures onto the computer	37	. .
Downloading of games from the net onto the computer	11	. .
Instant messaging	. .	37
Looking for a job or sending a job application	31	33
Reading weblogs	. .	33
Listening to web radios or watching web television	17	31
Chatting or writing to discussion forums	25	29
Playing games on the net	23	25
Telephoning over the Internet	5	20
Selling goods or services (*e.g.* via auctions)	11	17
Completing post education courses	8	16
Downloading games to the PC	. .	9
Video conferencing	4	7

StatLink http://dx.doi.org/10.1787/477716514055

Source: Sirkiä *et al.*, 2005.

Table 4.A2.11. **Number of activities[1] participated in by home Internet users during the last 12 months, Canada, 2005**

	0-2 purposes	3-7 purposes	8-11 purposes	12+ purposes
All	**5.5**	**26.7**	**33.4**	**34.4**
Males	5.0	22.4	32.1	40.5
Females	6.0	31.0	34.6	28.4
Age 18 to 24	20.7[2]		33.6	45.7
Age 25 to 34	3.3	18.6	33.0	45.1
Age 35 to 44	5.2	26.7	33.6	34.5
Age 45 to 54	6.6	30.7	34.6	28.1
Age 55 to 64	8.4	38.2	32.6	20.8
Age 65 and up	12.8	44.8	30.1	12.4[3]
High speed[4]	3.9	22.5	33.4	40.2
Low speed[5]	9.6	40.8	35.0	14.6

StatLink http://dx.doi.org/10.1787/477735744015

1. 21 activities are measured.
2. Owing to low reliability of the estimate for the 0-2 purposes category (coefficient of variation exceeds 33.3%), this category has been combined with the category 3-7 purposes for the 18 to 24 age group.
3. Use with caution – coefficient of variation between 16.6 and 33.3%.
4. "High speed" includes all respondents who identified that they access the Internet at home using cable or satellite, and all respondents accessing the Internet using a telephone connection or other connection (*e.g.* television, wireless [cellular phone or PDA], other) that they identified as a high-speed connection.
5. "Low speed" includes all respondents accessing the Internet at home through a telephone or other connection (*e.g.* television, wireless [cellular phone or PDA], other) which they identified as not a high-speed connection.

Source: Statistics Canada, *ad hoc* tabulation, based on data from the *Canadian Internet Use Survey 2005*, February 2007.

Table 4.A2.12. **Diversity of Internet activities[1] in the Netherlands, 2006**

Number of Internet activities	Number of Internet users		Share of Internet users 2006	Average age of Internet users 2006
	2005	2006		
	Abs. (x 1 million)		*% cumulative*	*Years*
1	0.4	0.3	3	49
2	0.6	0.5	7	43
3	1.0	0.7	14	38
4	1.5	1.1	24	39
5	1.6	1.7	41	37
6	1.5	1.7	57	37
7	1.6	1.8	75	36
8	1.2	1.5	90	36
9	0.6	0.8	97	34
10	0.2	0.3	100	32
Total	10.3	10.4		38

StatLink http://dx.doi.org/10.1787/477745117861

1. Persons aged 12 to 74 years who used the Internet in the three months preceding the survey and carried out specific Internet activities.

Source: CBS-Statistics Netherlands, *ICT use by households and individuals, 2005-06*. As published in The *Digital Economy 2006*, CBS (2007), *www.cbs.nl/NR/rdonlyres/243639BE-67DA-43D2-933B-583E3C97631E/0/2006p38pub.pdf*.

Table 4.A2.13. **Number of different uses of the Internet in France, all types of connection combined, 2005**

	Number of individuals	Number of different uses of Internet			
		1 to 2	3 to 7	8 to 11	12 and over
All	**2 462**	**0**	**2.9**	**13.9**	**83.2**
Males	**1 202**	0	4.4	16.2	79.4
Females	**1 260**	0	1.4	11.4	87.2
Males					
15-19 years	**128**	0	4.4	6.0	89.6
20-29 years	**251**	0	7.7	25.2	67.1
30-39 years	**310**	0	7.0	19.4	73.6
40-49 ans	**230**	0	1.7	14.2	84.1
50-59 years	**185**	0	0.0	11.5	88.5
60-69 years	**69**	0	4.1	17.9	78.1
70 and over	**29**	0	0.0	8.5	91.5
Females					
15-19 years	**151**	0	0.0	6.7	93.3
20-29 years	**283**	0	2.6	16.8	80.6
30-39 years	**316**	0	1.7	11.1	87.2
40-49 ans	**228**	0	0.0	10.0	90.0
50-59 years	**201**	0	1.3	11.1	87.5
60-69 years	**65**	0	7.0	11.3	81.7
70 and over	**16**	0	0.0	6.5	93.5
All					
15-19 years	**279**	0	2.1	6.7	91.6
20-29 years	**534**	0	5.2	21.0	73.8
30-39 years	**626**	0	4.5	15.5	80.1
40-49 ans	**458**	0	0.9	12.2	86.9
50-59 years	**386**	0	0.6	11.3	88.1
60-69 years	**134**	0	5.4	14.8	79.8
70 and over	**45**	0	0.0	7.9	92.1
Farmers	**22**	0	0.0	8.5	91.5
Artisans, with own business	**84**	0	0.0	13.2	86.8
Managers	**405**	0	6.0	19.2	74.8
Intermediate professions	**591**	0	1.8	13.0	85.3
Non-manual workers	**511**	0	2.0	13.9	84.1
Manual workers	**214**	0	4.5	12.3	83.2
Pensioners	**194**	0	1.7	16.0	82.4
Other non-active	**441**	0	3.3	12.2	84.6
Employed	**1 629**	0	2.7	13.8	83.5
Unemployed	**169**	0	5.0	19.7	75.4
Retired	**175**	0	1.8	14.8	83.4
Student	**364**	0	3.6	12.0	84.5
Other	**125**	0	0.8	14.0	85.2
Higher education	**1 043**	0	4.1	18.7	77.2
General secondary school diploma	**258**	0	5.3	13.4	81.3
Technical secondary school diploma	**137**	0	1.1	17.7	81.3
Professional secondary school diploma	**81**	0	4.2	10.9	85.0
Vocational qualifying certificate (BEP, CAP, BEPC)	**805**	0	1.4	10.7	88.0
No degree	**138**	0	2.5	4.9	92.7
1st quartile	**415**	0	4.1	11.6	84.4
2nd quartile	**501**	0	1.1	12.2	86.7
3rd quartile	**682**	0	2.0	14.7	83.3
4th quartile	**864**	0	4.3	15.5	80.2

Table 4.A2.13. **Number of different uses of the Internet in France, all types of connection combined, 2005** *(cont.)*

	Number of individuals	Number of different uses of Internet			
		1 to 2	3 to 7	8 to 11	12 and over
Paris	**510**	0	3.7	17.6	78.7
Urban area, pop. > 100 000	**758**	0	4.1	14.7	81.2
Urban area, pop. 20 000-100 000	**295**	0	2.3	13.2	84.5
Urban area, pop. < 20 000	**377**	0	2.0	13.7	84.3
Rural community	**522**	0	1.6	9.5	88.8
Low speed	**476**	0	1.2	5.2	93.6
High speed	**1 357**	0	4.3	21.3	74.4

StatLink http://dx.doi.org/10.1787/477756767431

Read: 74.8% of managers with Internet access used the Internet for 12 or more different purposes in the past month.
Coverage: population aged 15 years or older having used the Internet in the last month.
Source: INSEE *ad hoc* tabulations, based on data from the survey *Enquête Technologies de l'information et de la communication*, October 2005.

ISBN 978-92-64-05553-7
OECD Information Technology Outlook 2008

Chapter 5

Digital Content in Transition

Digital content is an important driver of the ICT industry, spurred by the rapid increase of OECD broadband subscribers, mobile broadband technologies and development of the participative Web. Digital content markets have annual growth well over 20% in the industry sectors analysed in this chapter (advertising, games, music, and film) and increasing shares of total revenues, but with significant differences among them. As new revenue streams and business models develop, functions and control along the value chain are shifting among established and new participants to dominate different parts of it. Cross-industry collaboration and new business partnerships are developing and new entrants and online business models are emerging. Despite fast growth the goal of digital content "anywhere, anytime and on any device" is still hampered by structural factors.

Introduction

Broadband applications and digital content are expected to provide new impetus for the digital economy, following and complementing the infrastructure push that has provided widespread network access. This chapter focuses on user-created content, a set of creative industries (online computer and video games, film and video and music) and online advertising. It builds on studies on the digital content sector (OECD, 2005a, 2005b, 2006a, 2007, 2008a, 2008b), and the results of the "OECD-Canada Technology Foresight Forum on the Participative Web: Strategies and Policies for the Future".[1]

Following an overview, sector analyses describe the main market developments, impacts on value chains and online business models, challenges and outlook, and barriers to digital broadband content development. The analysis is part of a broader project on the impact of broadband and digital content on industry structure, growth and employment and the associated policy implications (see Chapter 7 and OECD, 2006b).[2]

Broadband content markets and value chains: Cross-sector comparisons

The availability of broadband has encouraged the development of new Internet activities and demand for content and applications (see Chapter 4). A greater willingness to pay for Internet content and greater confidence in Internet applications have played a large role on the demand side. Broadband use has also become more participative as users upload content, increasing demand for upstream bandwidth.

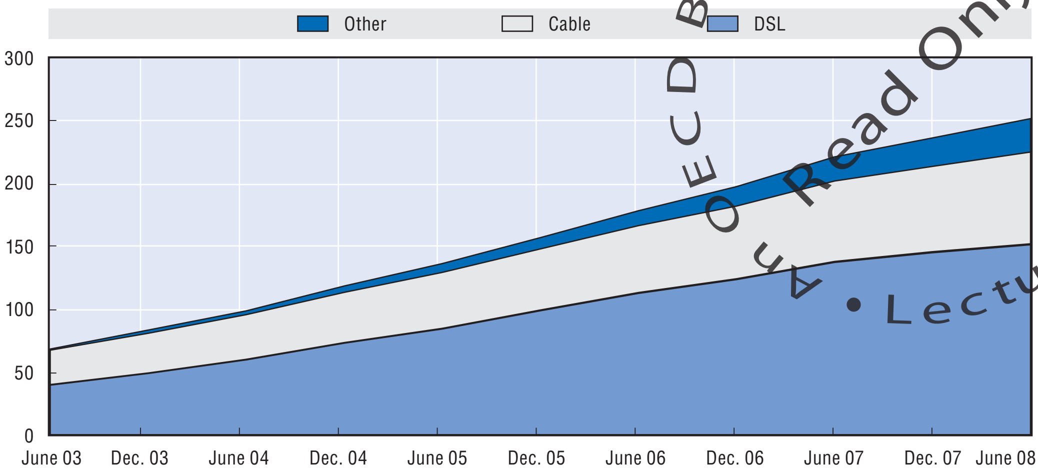
On the supply side, technological developments such as more widespread broadband and wireless access, the emergence of other technologies (*e.g.* content protection technologies, portable media players and tools which allow shifting content from the PC to the TV), lower entry barriers (*e.g.* for content distribution), and a corresponding rise in new business models have facilitated the emergence of innovative broadband content and applications. Consequently, the role of broadband as a communication and content distribution platform has evolved significantly. Since 2003, broadband subscribers in the OECD area increased from 68 million in June 2003 to 251 million in June 2008 (Figure 5.1). Connections are faster and less expensive with an average speed of advertised connections at almost 14 Mbit/s in 2008.

More data-intensive applications are being developed, *e.g.* streaming high-definition video, new peer-to-peer applications, virtual reality environments, and health, environmental or educational broadband applications. Global consumer Internet traffic is set to double between 2007 and 2009 and to increase by another 77% until 2011. Broadband applications based on peer-to-peer technology remain the main source of traffic, but Internet video applications are rapidly gaining shares and are overtaking traffic generated by Web browsing, emailing, and file downloads (Figure 5.2). Online games are showing increased popularity and rely on ever-more efficient data transfer technologies.

However, the evolution towards broadband applications and use is far from its full potential. Many new broadband content applications, especially converged services such

Figure 5.1. **Broadband growth, OECD total, 2003-08**

Million subscribers

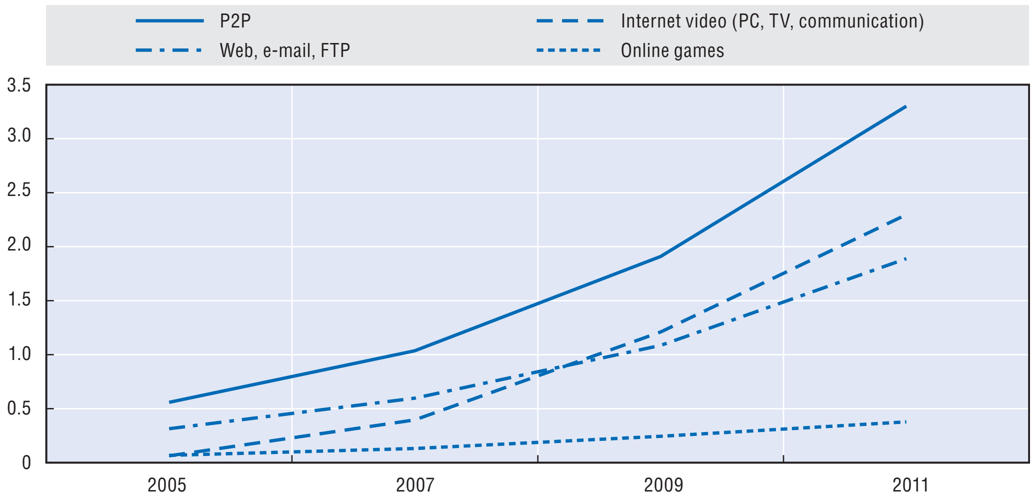


StatLink http://dx.doi.org/10.1787/475733644837

Source: OECD Broadband Portal, *www.oecd.org/sti/ict/broadband*.

Figure 5.2. **Global consumer Internet traffic 2005-11**

In million terabytes/month



StatLink http://dx.doi.org/10.1787/475765781701

Source: Based on Cisco, 2007.

as television over wireless networks, are taking longer to arrive than expected. Despite great potential and a large installed-user base, widespread use of advanced mobile broadband services (*e.g.* entertainment or health applications) have yet to emerge in most OECD countries. The goal of broadband content "anywhere, anytime and on any device" is still remote. Infrastructure challenges relate to availability, pricing, speed (*e.g.* for high-definition video), service quality, and other technical issues (*e.g.* interoperability). Commercial digital content revenues are also challenged by unauthorised use of music, films, games, etc.

There is considerable flux in business approaches, with broadband-based models already posing serious challenges to some established business models, and suppliers of broadband services and content having to reinvent their technology and services. The development of digital content services also requires co-ordinating a wide range of industry participants, some of which have not yet worked together, on complex issues such as developing new markets and revenue sharing. For example, broadband service providers are uncertain about how to recoup their large investments in the absence of new revenue-generating services, and content providers are waiting for improved connectivity and content protection technologies before providing content services. Furthermore, existing companies are still uncertain about whether to maintain current business models or to shift to Internet business models, potentially cannibalising their offline sales and risking unauthorised copying and downloads.

Market size and growth

Digital content revenues are growing rapidly across all sectors, but growth rates and shares in overall revenues vary (see Table 5.1 and Annex Figure 5.A1.1). Advertising represents the biggest online market in absolute terms, followed by computer and video games, online music, and film and video. Overall global market revenues (offline and online) generated by video games overtook music revenues for the first time in 2007 and revenues from the narrowly defined "online games" category are higher than those from online music. However, virtually all top-selling games are now Internet-enabled and the online game market is much bigger (closer to total revenues from "online games" and games software sales).

Table 5.1. **Market size and growth, 2007 or latest available year**

	Computer and video games[1]	Film and video[2]	Music[3]	Advertising[4]
Global revenues (offline + online)	USD 37.5 billion	USD 84 billion	USD 30 billion	USD 445 billion
Growth of market (offline + online)	19% (2006-07)	4% (2006-07)	–6% (2006-07)	5% (2006-07)
Global online revenues	USD 6.5 billion Increasingly all new games are Internet-enabled	Marginal	USD 4.7 billion	USD 31 billion
Growth of online market	28% (2006-07)	> 100% (2006-07)	27% (2006-2007)	28% (2006-07)
Share of online in total	17% but increasingly all new games are Internet-enabled	Marginal (under 1% in most markets)	16%	7.5%
Unauthorised downloading of online content and its impact	Low for Internet-enabled games but growing quickly (*i.e.* "server piracy")	Medium and growing	High	n.a.

StatLink http://dx.doi.org/10.1787/477773152446

n.a.: not available.

1. Global computer and video games revenues consist of console and PC games sales, online games, and mobile phone games. Figures for online revenues are based on a definition which includes casual games, online subscription offers (*e.g.* World of Warcraft; Xbox Live Marketplace), and paid downloads from websites (*e.g.* Electronic Arts; Ubisoft; GameTap). This definition does not include revenues from mobile phone games, trade in virtual items (*e.g.* skins, arms), and sales of online-enabled console and PC games. *Source:* OECD calculations; PricewaterhouseCoopers, 2007.
2. Global film and video revenues do not include television licensing. Online revenues include paid movie downloads, streaming, and (mobile) subscription offers; they do not include IPTV offers. *Source:* OECD calculations; PricewaterhouseCoopers, 2007; Screen Digest *et al.*, 2007.
3. Global music revenues represent estimates of physical and digital music sales as reported by IFPI. Online revenues include downloads to PCs and mobile phones, as well as subscriptions. (Online revenues indicated are retail values. Online revenues reported by IFPI refer to record company revenues, which differ from retail revenues.) *Source:* OECD calculations; IFPI, 2008.
4. Global advertising revenues include expenditure for advertisements in the following media: print publications, television, radio, cinema, outdoor and Internet. *Source:* ZenithOptimedia, 2007.

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Growth is fastest for online film, albeit from very low levels, followed by computer and video games, advertising, and online music. User-created content is not included as offline and online revenues are hard to define and measure.

Unauthorised downloading of digital content (online piracy) may be an important impediment to legitimate online distribution services and is putting pressure on content providers to craft innovative and appealing new business models and strategies. Online music is facing the greatest challenges, but as ever-faster uncapped broadband subscriptions allow sharing of larger files, the film sector, which had been shielded by low broadband availability and speeds, is increasingly faced with online piracy. Many pirated films are available online before or just after their official release dates. Piracy can be high for offline computer and video games, but manufacturers have been relatively successful in fighting online games piracy by adopting new business models (*e.g.* online subscriptions). But even this solution seems increasingly to face "server piracy" (servers that allow playing at lower prices or for free) especially in Asia.

Digital content value chains, business models and market structure

Broadband content relies on new value and distribution chains and business models. As new revenue streams and business models are explored, functions and control over the value chain are shifting among established and new entities vying to dominate certain parts of the value chain. Figure 5.3 displays a stylised digital broadband content value and distribution chain. Compared to offline value chains, certain activities become obsolete (*e.g.* manufacture of physical carrier media such as CDs, distribution of physical products) and certain value chain participants face disintermediation (Table 5.2). Digital content value chains are also seeing the emergence of new "digital infomediaries" that provide support functions (*e.g.* digitisation, digital rights management, hosting of content), content aggregation and distribution (*e.g.* Internet portals, search engines, online bookshops and online music providers), and new value-adding functions (*i.e.* reintermediation). Even offline retailers have gained an important foothold in digital content distribution (Table 5.3).

Figure 5.3. **Digital broadband content value and distribution chain**

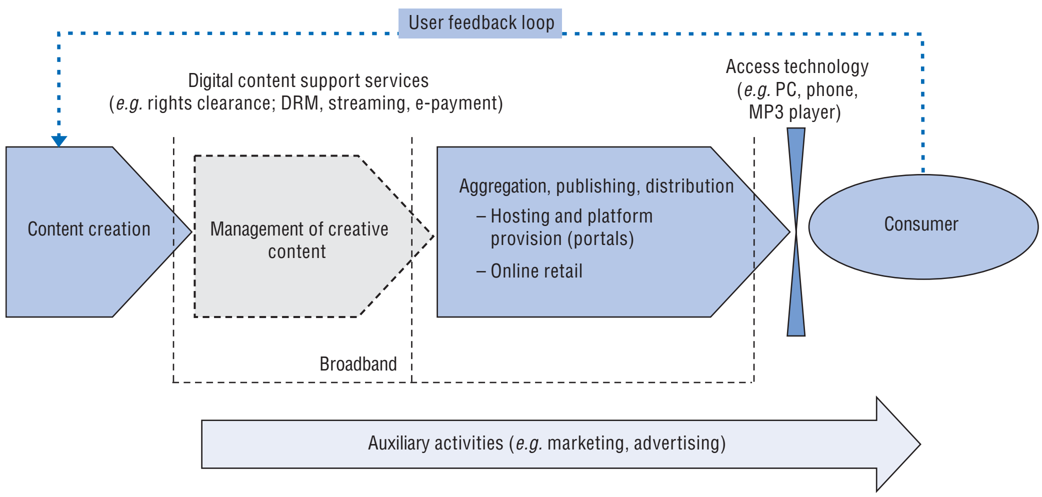

Table 5.2. **Impact of broadband on value chains, competition and market structure**

	User-created content	Computer and video games	Film and video	Music	Advertising
Impact of broadband on value chain	New value chain for production and distribution.	Medium to high on the production and distribution of online games.	Low to medium. While production greatly affected, not much impact on value chain. Growing impacts on distribution.	High for distribution but not production.	High
Impact of broadband on content creation	Very high	High	Medium	Medium	Low (text ads) to very high (interactive ads)
Importance of new digital intermediaries	Very high	Medium	High	Very high	Very high
Concentration/ variety of online suppliers or platforms	High concentration of traffic on few UCC platforms despite large number of new entrants.	Limited number of new entrants; traditional publishers still in charge.	Low but growing fast as online offers are still emerging.	Very high despite large number of new entrants.	High despite number of new entrants.
New broadband content cross-industry alliances	High	Medium	Low but growing as online offers are still emerging.	High	High

Table 5.3. **New cross-industry participation in broadband content distribution**

	User-created content	Computer and video games	Film and video	Music	Advertising
Internet service providers (ISPs)	ISPs distribute digital content to subscribers (*e.g.* Free: music downloads, film on-demand); and Internet consumers (*e.g.* Verizon: Games-on-Demand; Usen Group: GyaO, OnGen); Internet Web pages becoming important advertising platforms.				
Telcos	Most telecommunications providers (including mobile) involved in the distribution of digital content, mostly across sectors (*e.g.* Telstra BigPond); Deutsche Telekom (Musicload.de); KDDI (Chaku Uta), NTT DoCoMo, O2, Verizon)				
Internet businesses	Google (YouTube, Blogger), Yahoo!, Mixi, Naver	Yahoo!, Steam, Naver (Hangame)	Amazon (Unbox), MovieFlix	Amazon (Unbox), Yahoo!, Emusic, Excite Music Store	Amazon, Google, Yahoo!, Facebook, Mixi, Naver, Ebay
Content producers, media and broadcasting	News Corp. (MySpace), ProSiebenSat.1 (MyVideo.de), Viacom (Atom)	Electronic Arts, Ubisoft, Activision Blizzard, Time Warner (GameTap)	News Corp. (BitTorrent), ProSiebenSat.1 (Maxdome), NBC/Universal (Hulu), Lionsgate (CinemaNow)	Viacom (Rhapsody), NBC/Universal (DG Web shop)	News Corp., ProSiebenSat.1, Viacom (Atom)
Offline retailers	Fnac (Live), Tsutaya	Fnac, Wal-Mart (Wmtmobile.com), Tsutaya	Blockbuster (MovieLink), Fnac, Tsutaya	Fnac, F.Y.E., Wal-Mart, Tsutaya	Fnac, Tsutaya
Equipment and software manufacturers	Microsoft (MSN), Sony (Crackle), TiVo (Podcasts, Home video sharing)	Microsoft (Xbox), Sony (Playstation)	Apple (iTunes), Microsoft (Xbox), Sony (Playstation), TiVo, Cisco (CinemaNow)	Apple (iTunes), Nokia (Music store), Sony (Mora), TiVo (Rhapsody), Microsoft (Zune)	Microsoft (MSN), Sony (In-game advertising)

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For music and film, new value chain participants are mostly confined to the area of distribution, but online games and user-created content (UCC) also face large impacts on the production side. In the area of professional content production and advertising, the roles of artists and management of creative content (*e.g.* music labels, Hollywood studios, creative advertising studios) have not yet been strongly affected, but new approaches are being trialed for user-created content (direct links between content creators and users are indicated by the shaded "management of creative content" function in Table 5.3).

In spite of some instances of more direct producer-to-consumer relations, digital entertainment is mostly characterised by re-intermediation. Direct relations between content creators and consumers – full disintermediation – are still rare (*e.g.* musicians offering music for free to obtain revenue from donations, concerts without involvement of a music label, film writers offering short or feature films on video-sharing platforms to gain visibility; see Table 5.2). Contrary to early expectations, the role of intermediaries and aggregators for user-created content is large and growing.

The roles of value chain participants are changing throughout the sectors studied. Internet service providers (ISPs), telecommunication operators (telcos), Internet businesses, content producers, offline retailers and even equipment and software manufacturers are increasingly engaged in digital content distribution in one way or the other (Table 5.3). Some capitalise on existing consumer bases (*e.g.* retailers, telcos, hardware manufacturers) and possibilities to "bundle" different services into attractive offers or to "tie" them to devices or software (*e.g.* ISPs, telcos, hardware manufacturers). ISPs, telcos and IT firms are very large when compared to individual digital content sectors. Leading telecommunication operators such as NTT or Verizon have annual revenues (about USD 90 billion) which are much higher than entire content sectors (combined offline and online): the music sector is about USD 32 billion. The same applies to software and IT equipment firms.

As the boundaries between the IT, telecommunications, media, and entertainment industries blur, cross-industry collaboration and new business partnerships are emerging: Microsoft and Viacom are collaborating in online advertising, Viacom holds stakes in the online music service Real Rhapsody and Microsoft a share of Facebook (a social networking site, SNS); the equipment manufacturer Nokia is in distribution deals with major music labels; Korean telecommunications provider SK Telecom runs Cyworld (the country's most popular SNS). While initially surprising, these moves enable businesses to spread and increase their stakes in growing online sectors. Previously specialised companies may assume totally new roles (*e.g.* mobile phone companies buying music labels and becoming more involved in mobile television distribution, search engines increasing their involvement in the mobile phone business).

Despite their very recent emergence, some of these new value chain participants already significantly influence the value and distribution chain (*e.g.* certain online content platforms, digital rights management [DRM] and billing providers). Concentration and consolidation, in both production and distribution, tend to be high and growing despite many new entrants and great market dynamism. This is, for example, evidenced by the high market shares of the few successful online music distribution platforms, the limited number of participants in the online advertising value chain, or the very few successful UCC platforms (Table 5.3). The variety of product offers is also quite low in the area of new digital intermediaries (*e.g.* DRM).

Finally, new digital content business models are emerging, some of which mirror offline models (pay-per-item digital content sales, for example) and some of which innovate (*e.g.* sale of virtual items or professional subscription accounts). The seven main and existing generic categories are depicted in Figure 5.4 and correspondences to sectors are noted in Table 5.4. Except for online advertising, which is developing new, highly efficient and high-revenue business models (*e.g.* cost-per-click models; see the section on online advertising below), all other sectors are experimenting with new approaches to generating more, increasingly advertising-based, digital content revenue.

Figure 5.4. **Digital broadband content business models**

1. Voluntary donations and contributions
2. Digital content sales (pay-per-track, pay-per-view, pay-per-game, etc.)
3. Subscription-based revenues
4. Avertising-based revenues
5. Selling goods and services (including virtual items) to the audience
6. Selling of user data and customised market research
7. Licensing content and technology to other providers

Table 5.4. **Evolving sector-specific online business models**

User-created content	Mostly free or based on voluntary donations and contributions. Increasingly subscription- and advertisement-based revenues and business-to-business licensing of technologies. In the future, revenue will be generated by selling information about users or offering access to the user community.
Computer and video games	Mostly digital content sales (purchase of console game with Internet functionality) and subscription-based revenues. Increasingly advertising-based and selling of virtual items, etc.
Film and video	Mostly digital content sales (pay-per-view) and few examples of advertising-based business models. Increasingly subscription-based revenues.
Music	Mostly digital content sales (pay-per-track) and some examples of advertising-based business models. Increasingly subscription-based revenues and artists trying to derive revenues from concerts or even voluntary contributions.
Advertising	Mainly search advertising (cost-per-click and cost-per-action models) and display ads. Increasingly behavioural advertising linked to existing online ad models or stand-alone.

Digital content product characteristics and user acceptance

The different digital content product characteristics and functionalities summarised in Table 5.5 can help explain differences in user acceptance and potentially dissimilar online market growth trajectories.

Bandwidth requirements differ from sector to sector but requirements are high and growing in all (Figure 5.5), including in terms of latency.[3] Current average ADSL (asynchronous DSL) download speeds in OECD countries (around 9 Mbit/s) are sufficient for a range of existing digital content services, especially for online music. Yet many new video (especially high-definition streams and video-on-demand [VoD] downloads) and game services require even greater speeds. Moreover, gaps between OECD countries are wide, including with respect to pricing (average monthly prices per advertised Mbit/s range from USD 3 PPP in Japan to almost USD 100 PPP in Turkey).[4] Despite expectations regarding mobile content, wireless access speeds are low in most OECD countries. Furthermore, low

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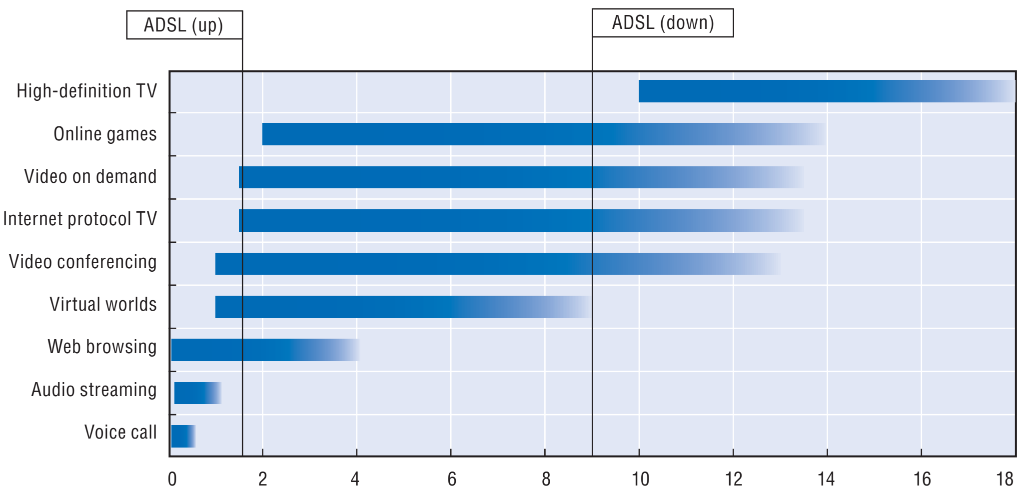
Table 5.5. **Digital content product characteristics and broadband functionalities**

	User-created content	Computer and video games	Film and video	Music
Bandwidth requirements	Low (such as text-based blogs) to very high (virtual worlds)	High to very high	Very high	Medium
Access point	Still mostly PC, except Japan and Korea	PC or console, except Japan and Korea	PC or set-top box	Still mostly PC, except Japan and Korea
Mobile access	Mostly PC, but mobile access growing	Low, but growing (*e.g.* PSP or mobile games)	Mostly no. Higher in Japan and Korea	Low but increasing. Very high in Japan and Korea
Online catalogue depth	Strongly growing with various quality levels	High percentage of new online games. But very thin catalogue of older games.	Very modest but growing	Modest but growing
Price attractiveness as compared to offline	n.a.	Variable. Online games can be more expensive due to subscription pricing	Mostly cheaper but usage restrictions	Mostly cheaper but usage restrictions
Offers with geographic access restrictions	Mostly no access restrictions but language as barrier and local offers exist	Mostly no	Yes	Yes (especially subscription services)
Personalisation, interactive and community features	Very high	Very high	Low	Medium
Limits on interoperability and content portability	Medium	High (PC) to very high (consoles)	Very high	Very high but falling

Figure 5.5. **Bandwidth requirements of selected digital content types, in Mbit/s, 2008**



StatLink http://dx.doi.org/10.1787/475775160214

Note: Horizontal bars represent approximate ranges of bandwidth requirements for 2008 and will increase; only minimum values are explicitly defined. Maximum requirements are open-ended (indicated by shading). Flags mark advertised average ADSL speeds in OECD countries (around 9 Mbit/s for ADSL downloads; 1.6 Mbit/s for uploads in early 2008).

Source: Estimates based on *OECD Communications Outlook 2007* and further analysis.

ADSL upload speeds (OECD area: 1.6 Mbit/s on average) restrict some kinds of interactivity and user-created content and applications such as video conferencing.

Access points and mobile access: The ways to access most broadband content offers are still limited (mostly PC-based access or consoles in the case of games). Sectors differ, however (Table 5.5) and new forms of access are developing, *e.g.* "triple play" set-top boxes offering TV services and mobile access possibilities by ISPs (except for Japan and Korea where this is already common for various types of content).

Online catalogue depth ("long tail"): For music and film, online catalogues are growing but still modest or low compared to offline. Difficult rights negotiations and at times costly digitisation processes are keeping the "long tail" (*i.e.* greater amount of content, including niche and non-mainstream content, in the absence of shelf-space constraints and associated costs) rather short. For instance, very popular online music stores currently offer around 5 million songs. Gracenote's MusicID, a music database, references 80 million songs; this indicates that only a small share of music is available online. Online film catalogues are even smaller: although Amazon Unbox indicates a catalogue of around 4 000 films, most competitors hold a maximum of 1 000, yet roughly 3 000 films are released each year in OECD countries alone. In the video and computer games industry virtually all new releases have online features, but a "long tail" of older releases is not available to consumers for online download.[5]

The modest depth of catalogues can partly be explained by a concentration on "blockbuster" content and/or the fact that few services offer access to truly international catalogues (especially content from other geographic regions or even non-OECD countries).

Price attractiveness: Online offers can make certain types of content more affordable for consumers. Most UCC is still free to users. For music and films, online prices can be substantially cheaper than purchase of the equivalent content offline (OECD, 2008a). Often, however, different usage restrictions are imposed. Video games show that online revenues can potentially be higher than offline as subscription-based models are replacing digital content sales models.

Offers with geographic access restrictions: Traditional content offers such as film and music are mostly limited to specific geographic regions, *i.e.* the service is inaccessible from other countries. National boundaries apply on the Internet for commercial (*e.g.* market segmentation), legal (*e.g.* territoriality of intellectual property rights) or cultural (*e.g.* language) reasons. This imposes significant costs on content delivery services for adapting their service to multiple destinations.

Personalisation, interactive and community features: Broadband offers unprecedented possibilities for personalisation, interactive and community features, *e.g.* personalised music and film suggestions; the ability to rate, recommend or share content; the ability to share playing or viewing experiences such as in online games; the ability to interact with the content or the creator; the ability to create or modify content. UCC and games already strongly rely on these features. Commercial content offers in fields such as music, and more importantly film, are just starting to capitalise on the Internet's possibilities. Mobile applications will further increase possibilities for personalisation and put pressure on providers to reinvent their service offerings.

Limits on interoperability and content portability: All digital content sectors face rather high interoperability constraints, mostly related to hardware, software and "built-in by design" as part of a business model (*e.g.* tying music purchases to specific portable music players or imposing limitations due to DRM software[6]); sometimes they are the result of the inability of the industry to agree on common standards or interoperability criteria. The portability of content from one device to another (*e.g.* from console to PC, from PC to mobile phone or TV, from set-top box and TV to PC or mobile phone) is usually extremely limited. With increasing user frustration and concerns among OECD governments, competition authorities and consumer associations, small but potentially growing interoperability is on the horizon (*e.g.* the rise of DRM-free content; the ability to play online videos on PC, TV or portable devices). At the same time, growing competition among UCC platforms may result in new formats and interoperability restrictions.

In sum, network, hardware and software infrastructures are increasingly in place that allow for the delivery of sophisticated and integrated broadband content offers covering a varied range of digital content. On the industry and company level, business models and value chains are adjusting to tap this potential. The resulting digital content value chains are more complex than ever before; they involve a range of new actors, some of which exercise considerable influence on terms, conditions and configuration of the final products. However, the changes, maturity of business models and user acceptance are not identical across content sectors. The following sections provide a more detailed analysis of similarities and differences.

Broadband content developments

User-created content

The Internet has altered the nature and the economics of producing content. Entry barriers for creation and distribution have declined radically and led to broader participation in media production, greater user autonomy, increased diversity and a shift away from passive consumption of broadcasting and other mass distribution models.

Terms such as the "participative web" or Web 2.0 describe an Internet increasingly influenced by intelligent Web services, based on new technologies which increasingly enable users to contribute to developing, rating, collaborating and distributing Internet content and to developing and customising Internet applications (OECD, 2007). Here user-created content (UCC) is defined as content which is made publicly available over the Internet, reflects a "certain amount of creative effort", and is "created outside of professional routines and practices" (OECD, 2007). Table 5.6 provides an overview of UCC platforms.

Table 5.6. **Platforms for user-created content**

Type of platform	Examples
Blogs	Blogs such as BoingBoing, Engadget, Ohmy News; Blogs on sites such as LiveJournal; Windows Live Spaces; Cyworld; Skyrock
Wikis and other text-based collaboration formats	Wikipedia, Wiktionary; sites providing wikis such as PBWiki, Google Docs
Sites allowing feedback on written works	FanFiction.Net, SocialText, Amazon
Group-based aggregation	Sites where users contribute links and rate them, such as Digg, reddit. Sites where users post tagged bookmarks such as del.icio.us
Photo-sharing sites	Kodak Gallery, Flickr
Podcasting	iTunes, FeedBurner (Google), WinAmp, @Podder
Social network sites	MySpace, Mixi, Facebook, Hi5, Bebo, Orkut, Cyworld, Imeem, ASmallWorld
Virtual worlds	Second Life, Active Worlds, Entropia Universe, Dotsoul Cyberpark
Video content or file-sharing sites	YouTube, DailyMotion, GyaO, Crackle

The traditional media publishing value chain depends on entities that select, develop and distribute the creator's work, often at high cost. Technical and content quality is guaranteed through traditional media "gatekeepers". In the UCC value chain, content is created and posted directly on UCC platforms at much lower cost, although the quality is potentially more diverse. Lower access barriers, increased demand for content downstream, and lower entry barriers in supply upstream may lead to recognition for creators who would not be selected by traditional media publishers.[7]

The production and consumption of UCC has been accompanied by social and behavioural changes, including increased participation and the creation of cultural content. Users often select content that is more personalised, and they assess content, for example, by recommendations and ratings. The nature of localised UCC platforms also triggers a greater availability of specialised local and minority content in diverse languages. UCC is also a form of personal expression that is increasingly used for critical, political, and social ends. Blogs, social networking sites and virtual worlds can be platforms for exchanging political views, provoking debate, and sharing knowledge about societal questions. In an educational context, platforms tend to be collaborative, encouraging the sharing of knowledge and "peer production".

Market development

Since 2006, a significant expansion of UCC platforms has offered users the possibility to upload and display content. Participative websites have benefited from an ever larger and more experienced broadband user base, more widely available access to software (*e.g.* music mixing or blogging software), technologies for interactive web applications (*e.g.* Ajax, RSS), as well as demographic factors, new investments and ways of monetising UCC. Institutional and legal developments have also acted as drivers, such as the rise of flexible licensing and copyright schemes and end-user licensing agreements that grant copyright for UCC (*e.g.* in SecondLife).

Video sites and social networking sites are becoming the most popular websites, ranking among the top 50 most visited websites in most OECD countries and among the top 10 fastest growing sites in terms of usage. Owing to strong network effects, a handful of UCC platforms receive the most attention, with, for example, MySpace attracting more than 110 million unique users in 2007.

Overall, little official statistical information on UCC is available.[8] However, existing data show that broadband users produce and share content at a high rate (several hundred million pieces of content on the Internet are under various Creative Commons licences)[9] and point to evolving intergenerational and gender differences in Web media usage.

By the end of March 2007, Japan had 8 million estimated bloggers and 35 million estimated blog readers (about 41% of Japanese Internet users), *i.e.* roughly one out of five readers created blogs (MIC, 2007). There were an estimated 10 million Japanese users of social networking services (SNS) (about 12% of Japanese Internet users). In Korea, roughly 16 million (*i.e.* close to half of all Korean Internet users) read blogs or visit "minihompys" (mini homepages) (Figure 5.6). About 8 million Koreans own a mini homepage (about one-quarter of all Korean Internet users) and around 40% of Korean Internet users use online communities (NIDA, 2007b). These numbers increased in 2008.

In 2007 in the United States, 29% of Internet users read blogs and 12% had created their own blog; the latter share is close to 30% for teenagers between 12 and 17 years old; and 17% of all Americans use online material in their own online creations (Pew, 2007b). In the EU in that year, 16% of all Internet users reported having created pages.[10]

Depending on the type of UCC and the country, the number of creators is often relatively small as compared to those simply viewing content, especially for blogs and

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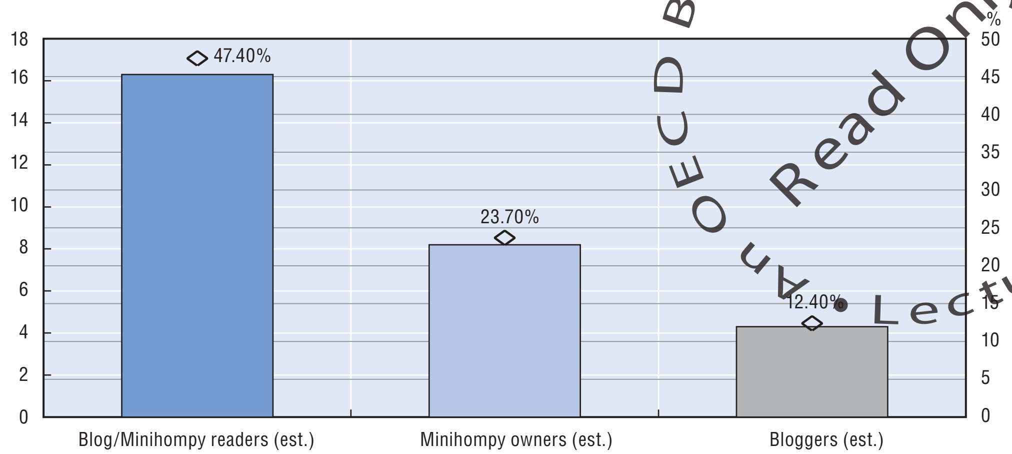
Figure 5.6. **Blog readers, bloggers, and minihompy owners in Korea**

In million users (left) and as a percentage of Internet users (right)



StatLink http://dx.doi.org/10.1787/475787824488

Note: A "minihompy" is a user profile page on popular social networking platforms such as Cyworld.

Source: Based on NIDA Survey on the Computer and Internet Usage, 2007a, 2007b (February; October).

online videos. In the case of Wikipedia, for example, in 2006 about 4% of all contributors made the majority of contributions.[11] This is less true for SNS, as most users create some form of content.

Age remains a determining factor in the degree of active contribution. Older teens are the most active users of social networking services in the United States: 55% of American adolescents between 12 and 17 years of age have created personal online profiles on sites such as Facebook or MySpace (Pew, 2007a, 2007b). In countries with a longer tradition of UCC, such as Korea, older age brackets (including over 40 years old) are increasingly involved, and users between 20 and 29 years old are the most active (NIDA, 2007b, 2007c).

Gender is another factor in online activity. In many OECD countries, the share of females who actively contribute by putting up a web page or a blog is smaller than the share of males. However, in the United States, 70% of all girls aged 15 to 17 are reported to have used an online social network compared to 54% of boys; and girls constitute nearly 60% of web page creators among teenagers aged 12 to 17 (Pew, 2007a, 2007b). In Japan, women in the 20-30 age group also more actively seek friends online (MIC, 2005) and blogging activity is high among Asian women.[12]

Online business models

Initially, most user-created content was not linked to expectations of remuneration or profit. Motivating factors included connecting with peers, self-expression, and achieving fame, notoriety or prestige. Today, UCC sites are of increasing interest to investors and businesses (see Table 5.7 for economic incentives). A number of new entities are now involved in content provision, especially the advertising industry, search engine operators, and media firms that own UCC platforms or select content from these platforms for distribution over traditional media publishing channels.

Most business models are still in flux and revenue generation for content creators or firms is only beginning. There are essentially six approaches to monetising UCC which are described below; combinations of these approaches are illustrated in two cases in Table 5.8.

Table 5.7. **Economic incentives and benefits for different UCC value chain participants**

Consumer electronics and ICT goods	Selling hardware with new functionality and interoperability for users to create and access content.
Software producers	Providing ICT services and software for creation, hosting and delivery of UCC.
ISPs and web portals	ISPs: using UCC to attract customers and build a user base for premium Internet services. Web portals: aiming to attract traffic, build Internet audiences and advertising revenues (and avoid losing traffic to UCC-related sites).
UCC platforms and sites	Attracting traffic, building Internet audiences and subscription and advertising revenues; increasing attractiveness for potential acquisition.
Creators and users	Non-commercial incentives (to entertain or inform other users, for recognition or fame); Commercial incentives to generate revenue through donations, sale of content or sharing revenue from advertisement-based models. Other users benefit from free access to content which is entertaining or educational (*e.g.* on purchasing decisions, or advice).
Traditional media	Participating in UCC online revenues (essentially through advertising-based business models); promoting own content to UCC audiences; broadcasting or hosting UCC to retain audience and advertisers and to prevent disintermediation.
Professional content creators	Reinventing business models to compete with free web content (*e.g.* photographs, images).
Search engines	Using UCC audiences to attract advertising revenues while improving searchability.
Web services that benefit from UCC	Using UCC to build more attractive websites and customer services and information (*e.g.* a travel agency or hotel chain that encourages users to post pictures and share appreciations).
Advertising	Benefiting from increased online advertising directed at communities on UCC platforms; using UCC content in advertising campaigns.
Marketing and brands	Expanding customer loyalty by promoting brands on social networking sites or advertising to UCC communities.

Some of the models include remunerating creators, either by sharing revenues or by direct payments from other users.

- *Voluntary donations:* Content creators make content freely available but solicit donations from users (online by credit card or via PayPal). Blogging and citizen journalism sites such as Global Voices Online are supported by bloggers who provide content for free; operating expenses are funded by grants from foundations or in some cases news companies.
- *Charging viewers:* Pay-per-item model: users make per-item (micro) payments to UCC platforms or creators to access individual pieces of content. Subscription model: consumers subscribe to services. Users pay a subscription for enhanced hosting services for their own content or for access to other users' content (subscriptions to the latter are rarely used). In two-tiered subscription services a user can opt for a "basic" account free of charge or for a paid "pro" account with advanced features.
- *Advertising-based models ("monetising the audience"):* Advertising is often seen as a more promising source of revenue and some UCC sites are distributing revenue among those who create or own content. "Branded channels" have been launched on UCC platforms with content from a special brand or media publisher. Virtual worlds allow firms to create and display advertisements.
- *Licensing content and technology to third parties:* Increasingly UCC is being used on other platforms, and licensing content to third parties (*e.g.* TV stations) may be a source of revenue. Users may agree to license the site to use their content without payment, sometimes reserving the right to exploit their work commercially, but a revenue-sharing model between content creators and the UCC site may apply. Mobile carriers are increasingly acquiring licences to distribute UCC and technologies that enable sharing of content.

- *Selling goods and services to the community ("monetising the audience via online sales"):* Owing to network effects, successful UCC sites are likely to have a large user base. This can be monetised by selling items and services directly to users or developing transactions among them (*e.g.* sale of avatars, virtual accessories or even virtual land). UCC sites can also co-operate with third parties to allow them to sell directly to their users but take a share of the revenue.
- *Selling of user data:* Other business models may involve the sale of mostly anonymous information about users to market research and other firms.

Table 5.8. **UCC platform business models: Citizen journalism and photos**

Citizen journalism: AgoraVox (France)	AgoraVox is a European site supporting "citizen journalism" which is currently based on voluntary in-kind contributions. Users submit news articles on a voluntary basis and the content is moderated by the small AgoraVox staff and volunteers. Readers also provide feedback on the reliability of the information. Despite its low-cost model, AgoraVox aims to generate revenue through online advertising. Similar citizen journalism sites such as OhmyNews in Korea remunerate their writers. OhmyNews redistributes advertising revenues to writers for highly rated articles. Readers also directly remunerate citizen journalists through a micro-payment system.
Photo: Flickr (United States)	Flickr is funded from advertising and subscriptions. A free account provides the possibility to host a certain number of photos. Advertising is displayed while searching or viewing photos. This revenue is not shared with users. A subscription "pro" account for USD 24.95 offers unlimited storage, upload, bandwidth, permanent archiving and an ad-free service. Flickr is part of Yahoo! and thus enhances membership and traffic to other Yahoo! sites. Similar photo sites such as KodakGallery are owned by photography firms. Users can create free accounts and revenues are generated through various photo services (*e.g.* purchase of prints).

Source: Based on company information and press reports.

Challenges

UCC raises a number of business, social and regulatory challenges related (see OECD, 2007).[13] To begin with, fostering more broad-based participation will be a continuing challenge, as an enduring gap between digitally literate users and others may accentuate social fragmentation and intergenerational differences. Moreover, most users consume UCC; only a limited number of mostly young early adopters contribute actively. Slow upload speeds on asymmetric networks pose a challenge (see Figure 5.5), but the deployment of fibre is helping to overcome this problem.

New sustainable business or other models for UCC platforms will have to be explored in the near future. Very few UCC platforms generate significant revenue, and online advertising is seen as the main future source. Yet it is unclear whether revenues will suffice to maintain the increasing number of UCC platforms and whether users will appreciate increased ads and commercialisation. Some video-sharing platforms are also scaling back UCC in favour of traditional, professional content.

With respect to IPRs, the ease with which Internet content can be reproduced makes UCC platforms particularly susceptible to copyright infringement. Encouraging transformative content creation and greater openness and access while ensuring rights of creators and fair use is an important issue. There are also questions regarding who retains copyright over works created by users (see Annex Table 5.A1.1) as well as questions concerning the copyright liability of UCC platforms (OECD, 2007).

With respect to illegal, defamatory and similar content, most UCC platforms emphasise that they do not assume editorial responsibility for the content created, although an increasing number of platforms and communities are adopting community standards and associated rules on issues such as harassment, privacy and advertisement. Age rating systems or age limits are seen as important to ensure protection of minors.[14] Concerns relating to privacy and digital identity are mounting. Most UCC platforms collect and use personal information relevant to the service and most reserve the right to transfer personal information in the event of a transfer of ownership or sale of assets. Finally, with increased interactivity and uploading of content from a large user base, the participative Web is prone to information security risks.

Outlook

The popularity of UCC is likely to continue to grow and new drivers will further its creation and use:

- The increasing use of mobile phones to watch and capture mobile UCC with higher uplink data transmission speeds and other consumer devices allowing easier content upload.
- New types of UCC around more interactive social networks, video-sharing sites and new types of virtual worlds.
- New types of software and services for creation of content, including social networking applications and personal profiles/digital identities, that work across different UCC platforms.
- Economic incentives for users to create their own content, for instance by offering a share of revenues generated through sales, advertising, or licensing to traditional media outlets.

However, a number of issues need to be addressed: Copyright infringement often involves disputes between copyright holders, UCC platforms and users. UCC platforms will also have to address privacy concerns of users and regulators as popular platforms will increasingly be victims of "phishing" and other attacks, making user data vulnerable. Content quality, safety on the Internet and possibly better self-governance of users are issues to be dealt with. Increased concentration of UCC platforms and the growing role of gatekeepers will be continuing business and policy issues.

The impacts of UCC are wider than commercial applications and despite increased attention to related business ventures, harnessing the participative web's potential for educational, political and social objectives has to remain a priority and will have major impacts.

Film and video

The film and video market (*i.e.* filmed entertainment excluding TV) is composed of cinema box office revenues, the sale of physical media such as DVD formats, the rental market and online film distribution (OECD, 2008a).[15] The most recent estimates suggest that worldwide revenues of the film industries (excluding TV revenues) were roughly USD 84 billion in 2007 (PwC, 2007), an increase of 3.8% compared to 2006 and roughly triple revenues of the music or computer and video game industries.

Most of the total value of the film and video market is produced in only a few OECD countries. In 2007, the United States accounted for over 40%, Europe for about 20%, Australia, New Zealand, Asia/Pacific for about 20%, and Canada for about 7% (PwC, 2007). Although Chinese and Indian film and video markets are large in terms of audiences and numbers of films produced, revenues are still a small fraction of global film and video markets.

The filmed entertainment market in OECD countries is characterised by large vertically integrated multinational conglomerates. With the exception of public broadcasters, virtually every audio-visual media undertaking in the OECD area is now wholly or partly owned by one or more of perhaps 50 conglomerates based mainly in eight countries.[16] All of the studio-owning conglomerates hold substantial interests in commercial Internet operations (ISPs or major commercial portals). Time Warner owns America Online (AOL); News Corporation includes Fox Interactive Media which owns MySpace; others are involved in consumer electronics (*e.g.* Sony).

Relative to other media products, film production requires by far the largest initial investment per unit, most of it high-risk. Average costs have soared over the past 20 years, driven largely by the "blockbuster" phenomenon (an average USD 100 million per Hollywood film, including marketing costs[17]). The film industry is spreading revenue flows over a carefully timed and sequenced set of distribution windows: *i)* cinema box-office markets, *ii)* television markets, *iii)* consumer markets (including home video sales and rentals) *iv)* and increasingly online markets (including video services, interactive television, and wireless digital content).

In many respects, the basic structure of the film industry has not changed significantly in nearly 100 years despite rapid adoption of new technologies. However, digitisation has had major impacts and the film and video value chain is already heavily digitised. It has helped streamline the increasingly international production process (including digital special effects) and enabled repeated exchange of content with no loss of technical quality.

The potential for Internet distribution of films is large. The adoption of broadband at ever-faster speeds and the development of popular video-sharing platforms have helped mainstream audiences embrace online video viewing. Furthermore, online distribution encourages consumption of higher bandwidth products from broadband network providers. Media conglomerates owning both film studios and Internet-based platforms with large viewer bases (*e.g.* Internet portals such as AOL or social online networks such as MySpace) are increasingly using this new window to release films and video.

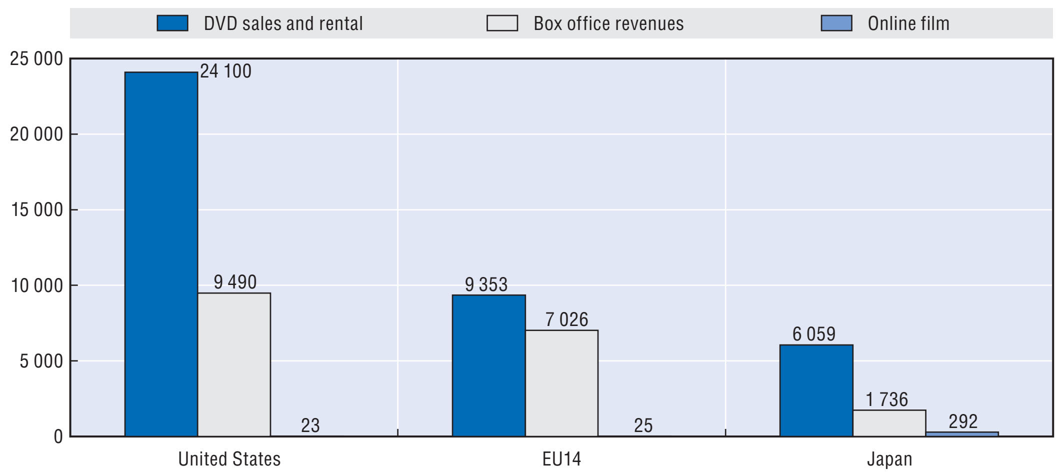
Market developments

The film and video market continued to grow and changing user behaviour or online piracy have not affected the film sector in the same way as the music industry. The film and video industry has grown every year, except for 2005 which saw a fall of the market by roughly 2.5%, reaching a high-point in 2007 of USD 84 billion (PwC, 2007). DVD sales experienced strong growth for more than a decade, but the increase has been slower since 2005; worldwide cinema box office receipts grew from USD 17 billion in 2001 to USD 27 billion in 2007 with a fall in revenues only in 2005 (MPAA, 2008; EAO, 2007). The major new innovation is the increasingly rapid introduction of digital cinema following the development of industry standards and new financing mechanisms for the conversion of existing cinemas to the digital format. This is revolutionising the technology at the filming and projection stages of the value chain without fundamentally changing it. These developments will have major effects on the film industry as it completes the digitisation of the value chain.

Whereas a few years ago, film revenues of major studios were mainly generated by cinema box office receipts, DVD (and negligible VHS) sales and rentals now make up more than half of the major US studios' revenues; cinema box-office receipts are around 20%.[18] In Japan, the share of DVD sales revenues is larger than in the United States, and in western Europe, box-office revenues take a larger share of total revenues. Figure 5.7 shows the size and composition of the three biggest film markets in 2006, demonstrates the relative importance of DVD sales, and the still relatively minor contribution of revenues from online film distribution. The most common online business model for filmed entertainment is still linked to rental or purchase of physical DVDs online, which are then delivered via postal mail.

Figure 5.7. **Major film market revenues, 2006 (excluding TV market)**

Million USD



StatLink http://dx.doi.org/10.1787/475834060040

Notes: The three regional or country entities do not necessarily use the same data definitions, and expenditures in certain categories across countries/regions are not directly comparable. Online film distribution in Japan, for instance, includes revenues generated from distribution over the Internet of TV series and animated films. EU14 comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

Sources: Based on Digital Entertainment Group, 2007; Screen Digest *et al.*, 2007; European Audiovisual Observatory, 2007; Digital Content Association of Japan, 2007.

In 2006, film downloads in western Europe generated revenues of USD 25 million, a small fraction compared to USD 9.4 billion in physical format (DVD) sales and less than 0.1% of total filmed entertainment revenue (Table 5.9). In the United States, online film revenues were USD 23 million in 2006, a negligible amount when compared to DVD sales and rentals and less than in western Europe. Other data sources put the revenue of Japanese online movie ventures considerably higher at USD 292 million (2.2% of total filmed entertainment revenues) (DCAJ, 2007); however, these figures include revenue from the distribution of TV productions and animated films.

While online film revenues are expected to grow, projected values up to 2010 are still relatively small (Table 5.9). For the EU14, the share of online movie downloads in total revenue (excluding TV licensing) is expected to rise from 0.1% to 7% (Screen Digest *et al.*, 2007), equivalent to the share of online music distribution in many European countries in 2006.

Table 5.9. **Actual and projected online cinema product revenue, 2004-10**

USD millions

	2004	2005	2006	2008p	2010p
United States	9.5	11.8	22.9	455	1 975
EU14	1.8	3.7	24.6	269	1 356

StatLink http://dx.doi.org/10.1787/477784320845

Note: EU14 comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom.

Source: Screen Digest *et al.*, 2007.

Despite the initially slow uptake, the number of online film suppliers is increasing. In Europe, the number of Internet sites providing Video-on-Demand (VoD) doubled in 2007 with France, Germany, the Netherlands, and Spain leading (NPA Conseil, 2008). The majority of sites aim at specific national markets, and no European video provider offers access to the rich library of films of various European countries. Cross-border services are limited to markets with shared languages, *e.g.* SF Anytime in the Nordic countries; in2movies in Austria, Germany and Switzerland. Online film services and video-sharing sites have also created a strong demand for new video software and services (*i.e.* video hosting, editing and delivery). Firms such as VideoEgg provide video tools and advertising features for online video providers and Web application developers.

Online business models

There are four principal online film business models; examples are provided in Table 5.10:

- *Rental downloads (R):* The film is downloaded for a specified period of time (DRM disables playback beyond the agreed rental period, allowed storage and viewing periods differ). Prices range from USD 1-4. Download rentals are on average comparable or cheaper than DVD rentals, but the period of use is shorter. Many DVD rental firms offer up to 30 days possession with unlimited plays for under USD 6.
- *Purchase downloads (P):* The purchased movie is delivered online, like the established DVD sell-through model. The range of prices for online purchases varies from USD 10 to USD 40 depending on the type of product and country. Generally, prices are comparable to or even slightly cheaper than offline forms of distribution. But content portability is often restricted.
- *Subscription downloads (S):* This model allows consumers to access a range of titles on a monthly or yearly basis for a single subscription fee. DRM technologies prevent the film from being watched once a subscription expires. Transfer to other devices is mostly restricted or impossible. “Triple play” Internet providers have recently added unlimited VoD offers to their broadband subscriptions (*e.g.* Free in France). Prices vary according to the package, but one of the market leaders, CinemaNow, has a USD 30 monthly subscription; Maxdome in Germany offers a monthly EUR 10 subscription. Depending upon frequency of use, these prices may be a considerable bargain over DVD and cable.
- *Advertising-based (A):* Initially, this business model applied to independent and low-budget productions only; examples include platforms such as Joost and Guba. But major studio productions and recent TV productions can increasingly be viewed online for free. Gyao, a Japanese Internet portal backed by the Usen Group, streams a limited catalogue of older studio content; Hulu, an Internet portal backed by NBC Universal and News

Table 5.10. **Online full-feature film providers, selected examples from OECD countries, January 2008**

Provider	Cost	R	P	S	A	Service
Amazon Unbox (United States)	Rental: from USD 0.99; Purchase: from USD 1.50 (around USD 10 for newer releases)	♦	♦			> 4 000 films; rentals are available for 30 days with a 24-hour viewing period; viewing on PC, portable device (PlaysForSure), or TiVo
Apple iTunes (United States)	Rental: from USD 2.99; Purchase: USD 10-15	♦	♦			> 500 films, including high-definition content; rentals are available for 30 days with a 24-hour viewing period; playable on PC, Mac, iPod, iPhone, TV (via AppleTV)
BitTorrent, Inc. (United States)	Rental: from USD 0.99; Purchase: from USD 2.99 (around USD 10 for newer releases)	♦	♦			Around 2 000 films, including shorts and user content; peer-to-peer based, PC only; burn option for backup only, not viewable on DVD playback devices; major studio productions for United States use only
CinemaNow (United States)	Subscription: USD 29.95/month, USD 99.95/year; individual purchase: USD 9.99		♦	♦		> 900 films, for viewing on PC only; service available in Japan
Glowria (France)	Rental: from EUR 0.99	♦				Glowria services a number of French VoD providers, *e.g.* Canal Play; > 1 000 films; PC or IPTV via "triple play" broadband subscriptions; language choice available
Gyao (Japan)	Free				♦	> 100 films; free, advertising-based streaming of films, TV series, etc.
Jaman (United States)	Rental: from USD 1.99; purchase from USD 4.99	♦	♦			> 900 films; rentals are viewable for seven days; peer-to-peer based, playable on PC, Mac, TV; eased geographic access conditions
Lovefilm (United Kingdom)	Rental: from GBP 2.99; purchase: from GBP 9.99	♦	♦			> 500 films; PC and portable (PlaysForSure); bundles with physical DVD available
Maxdome (Germany)	Rental: from EUR 0.99 subscription: EUR 9.99/month;	♦		♦		> 800 films, viewing on PC or TV via set-top box; no purchase option
MovieFlix (United States)	Subscription: USD 9.99/month			♦		Around 1 500 films, including shorts, documentaries and free content; RealPlayer compatible
SF Anytime (Sweden)	Rental: from EUR 1	♦				> 800 films; available in Denmark, Finland, Norway, Sweden; PC and IPTV

Note: Rental downloads (R), Purchase downloads (P), Subscription downloads (S), Advertising-based (A).

Corp., streams feature films and TV shows in North America; Paramount and MTV were the first major studios to launch a movie, "Jackass 2.5", for unpaid streaming on the Internet before switching to DVD sales.

Around one third of European VoD services are operated by ISPs and telecommunications operators. Telecom Italia, France Telecom and Deutsche Telekom are prominent suppliers in different European markets (NPA Conseil, 2008). These services are usually bundled with broadband subscriptions and accessible to subscribers only.

Broadcasters, content producers, and non-media companies increasingly offer download services. Amazon's digital video download service was launched in September 2006 exclusively for the United States market; other general and specialised retailers (*e.g.* Fnac) distribute films online; Apple iTunes launched film downloads for the United States market in 2007 and film rentals in 2008; Microsoft's Live Marketplace is developing a popular video rental and purchase location for owners of the Xbox 360 game console (Screen Digest, 2007). However, overall even major Internet market participants have difficulties offering a rich film catalogue and mostly target the United States market.

Given bandwidth constraints and the fact that the current infrastructure may be unable to deal with the increasing volume of video content (especially high-definition content), the distribution of films over peer-to-peer networks is an alternative and is being trialled by BitTorrent, Jaman, Vuze, Guba, Joost, etc. (OECD, 2004; de Fontenay *et al.*, 2008). However, despite the potential distribution cost savings, peer-to-peer distribution of licensed online content has not yet taken off.

Challenges

The film industry still performs well with existing business models via its strategy of release windows. The slow appearance of online distribution may be due to difficult rights negotiations or the hesitancy of right holders to make new films available online out of concerns about online piracy and so as not to reduce box office and DVD sales or threaten existing exclusive arrangements, *e.g.* with cable and TV providers, often part of the same conglomerate.

Apart from these business considerations, technical obstacles remain. The benchmark in terms of image and sound quality set by digital cinema, (HD) DVDs, and home cinema equipment is very high. Current broadband speeds and compression techniques often do not meet such quality standards. The demand for film content for portable devices is still low. Many value-added features of DVD packages (additional content, interactive features, language tracks) are not part of Internet downloads, and usage restrictions are less attractive.

On the demand side, although watching videos online is increasingly popular, consumers have not replaced TV or DVDs with online movie consumption. It appears, however, that Internet business models are now competitive in terms of price both with offline distribution methods and with e-commerce DVD rentals and sales. The remaining problems are limited catalogues and the geographic market segmentation which dominate Internet distribution. More extensive film catalogues over a single platform covering film of different origin (including European and Asian productions) would be a competitive advantage.

A major step towards increasing consumer uptake will be the removal of technological hurdles to online film downloads. First, the lack of interoperability between operating systems and media playing software limits the hardware that can be used to watch films. Many online content platforms use proprietary formats for streaming and/or file downloads. The user is "locked in" to a provider's software, a concept similar to the "walled-garden" set-top VoD systems. Second, although several of the major online download services provide an interface to enhance home entertainment set-ups, the process is never as straightforward as playing a DVD. Nevertheless, this is changing as games consoles and set-top boxes such as Vudu, TiVo, and Apple TV offer better viewing environments.

Outlook

Growing broadband speeds and the transition to fibre, the increased availability of online film content with more favourable access conditions, solutions for streaming content onto televisions, and the emergence of high-definition digital films and digital cinema will underpin growth of online film markets. Given the increased prevalence of triple play broadband services, it is very likely that, at least in Europe, online VoD services will be part of these services and peer-to-peer services are likely to expand.

In the future, falling revenue or a rise in online piracy may increase the emphasis on online downloads and changes in release windows. Slow growth in DVD sales in 2007 and lower than expected sales of high-definition DVDs – initially largely owing to competing standards (Toshiba's HD DVD and Sony's Blu-ray) – are also factors that could favour online services. Furthermore, while the film industry has so far not suffered major effects from Internet-based piracy, unauthorised access to films is increasing, often before their official release dates.

The Internet may also encourage film writers and producers to engage in online production and distribution. Eventually, the online environment and social networks may develop commercial potential from entirely new interactive relationships between film viewers and publishers.

Music

Market developments

Online music distribution has grown rapidly since 2004 and has become a significant market with a rich catalogue (OECD, 2005a, 2006a). Digital music sales (defined as online and mobile music downloads) were close to USD 5 billion in 2007 (from near-zero revenues before 2002) with about 500 online music services in over 40 countries (IFPI, 2007, 2008). In 2007, digital music sales accounted for 16% of the world market (Table 5.11). In countries with a more developed "wireless access culture" downloading of music to portable devices dominates. The move to online music reflects strong consumer demand and there are various online distribution models for streaming and downloading of music, with newer approaches such as advertising-supported services. Other broadband-based business models such as Internet radio are helping to generate music industry revenues and are also developing rapidly.

Online distribution of singles is the largest part of music downloads. It accounts for over 80% of worldwide single sales, physical and digital, and in the United States, Canada, and Korea it has replaced physical single sales (IFPI, 2007). Although single music tracks are

Table 5.11. **Evolution of digital music sales and yearly per capita music spending, selected countries, 2006**

	Total digital sales (incl. mobile music) USD millions	Mobile music sales USD millions	Digital as % of total sales	Per capita digital sales USD	Per capita total sales (physical + digital) USD
United States	1 849	754	16	9	58
Japan	778	709	15	9	62
United Kingdom	201	82	6	5	82
Korea	151	78	61	4	7
France	128	88	8	3	43
Germany	117	54	6	2	38
Canada	51	25	7	2	32
Italy	41	27	7	1	15
Australia	37	20	6	3	45
Spain	32	27	7	1	17
Mexico	17	17	5	0	6
Belgium	16	9	5	2	48
Sweden	14	8	6	2	39
Austria	13	10	5	2	48
Netherlands	13	3	3	1	36

StatLink http://dx.doi.org/10.1787/477808587873

Source: Calculations based on data obtained from IFPI. Per capita calculations are based on OECD population figures for the age group 15-64 years. Figures are rounded.

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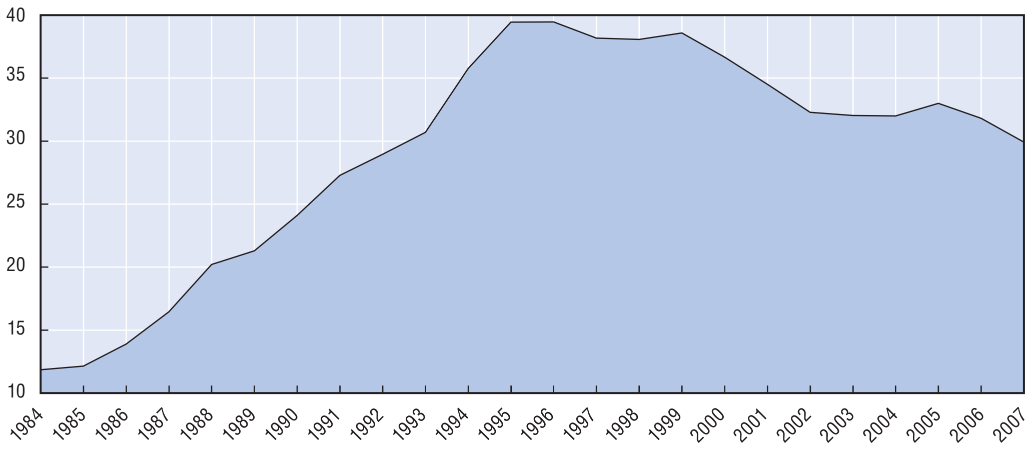
the biggest part of online music downloads, album downloads are gaining in popularity, reflected in increasing ratios of album *versus* single-track downloads.

Despite fast take-up, digital music sales have not (yet) made up for losses on physical unit sales or reversed the trend of revenue decline in the music industry after rapid CD-led growth peaked in 1995 (see Figure 5.8). In 2007, worldwide music sales amounted to USD 30 billion, down by 6% from 2006. The United States, Canada, Australia and most European countries have seen music sales decline by around 10% or more, but they increased in a few countries such as Korea.

Figure 5.8. **Value of global music sales, 1984-2007**

Current USD billions



StatLink http://dx.doi.org/10.1787/475848812102

Source: Based on IFPI data and updated from OECD (2005a).

In most countries for which data are available, per capita revenues from digital music downloads are still modest: less than USD 10 per capita is spent annually in the population aged 15 to 64 (see last two columns of Table 5.11). However, with more digital music available online, the rise of generations that rely predominantly on music in digital format and on portable music players is set to evolve quickly. Therefore new business models are likely to lead to rising revenues in this area.

The advent of digital music has also driven revenue and growth in sectors other than the music industry (OECD, 2005a). It has been a driver for broadband uptake and use and has benefited ISPs. It also continues to boost global technology markets: consumer electronics manufacturers, PC and hard drive vendors. Revenue from MP3 players grew by 37% in 2007 in the United States market alone.[19] Finally, the online music business has led to new businesses. Contrary to earlier expectations, distribution of digital music is complex and far from costless. The creation of an online music store requires content creation and production, the digitisation of content, the clearing of rights, the creation of online music storefronts, secure billing systems and new digital intermediaries (*e.g.* digital rights clearance, software such as the Windows DRM, online billing). Real Networks is an example of a business centred on distribution of digital content (including sales, streaming, and hosting of music and filmed content), mobile distribution and DRM solutions.

Online business models

New business models are mainly built around digital download and streaming subscription models, although portable subscriptions, online music bundled with subscriptions by ISPs and advertising based-business models are also developing. However, most online music sales still rely on pay-per-track or pay-per-album download models. There are three online music business models:

- *Digital download:* The pay-per-track business model is dominated by a few firms, which are not directly linked to the music industry, but which generate revenues from the sale of portable music players or have an interest in setting software standards (*e.g.* Apple, Microsoft). They have been joined by retailers such as Amazon and Wal-Mart as well as ISPs offering music download services. While globally the number of online music stores is growing, the supply side is consolidating as many new online music stores cannot generate enough revenue, especially those that rely exclusively on music and are not affiliated with an existing business; they either close (Virgin Digital in the United Kingdom) or are merged (MTV Urge into Real's Rhapsody). The market leader iTunes Store (70% of paid music downloads, *cf*. NPD Group, 2007) has simplified music downloading using a unique-pricing model: USD 0.99 per song and USD 9.99 per album. This lead is being challenged by competitors with comparable catalogues and DRM-free sales as well as cheaper offers from retailers such as Amazon and Wal-Mart.
- *Subscription:* Subscription-based business models with monthly prices starting from less than USD 10 have the potential to generate significantly more revenue than digital download music services (OECD, 2005a). With a large subscriber base, subscription revenues could easily generate more revenue than traditional offline music. For instance, in 2006 the country with the highest yearly per capita music consumption, the United Kingdom, still only generated a monthly average of USD 7 per person in total music revenues (offline and online). For other countries this average is far less (*e.g.* in Korea and Mexico an average of less than USD 1 per month per person).

  Various online music subscription models exist: streaming an unlimited amount of music to the computer (*e.g.* Yahoo! offers unlimited basic access for a monthly minimum fee of USD 9 a month) or downloading songs to portable devices (*e.g.* Napster and Rhapsody "To go" for USD 15 a month); monthly subscriptions to download a set number of songs (*e.g.* EUR 12.99 a month for 30 downloads on the European eMusic store); music services for a given portable device, *e.g.* Microsoft Zune at USD 14.99 a month. However, in 2007 there was still relatively low market penetration and slow growth for music subscription services. Existing music subscription services are developing mobile access services and are increasing compatibility with existing hardware to allow portability of content.

  Services can also be bundled into existing subscriptions and new forms of online music subscriptions have emerged, *e.g.* ISPs that sell unlimited music downloads or streaming as part of their triple play packages (Internet, voice and TV). The French ISP Neuf offers free unlimited music downloads in one music genre to its triple play subscribers, and a complete music subscription to all music genres is available for EUR 4.99 a month (including to non-subscribers and for transfer to portable players).
- *Advertisement-based business models* are being tested but have not yet widely developed. Deezer.com, for instance, offers free on-demand streaming beyond the United States and Canada and remunerates the creation of music (artists, record companies, etc.)

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through revenues generated by advertising. Free music is being provided through authorised peer-to-peer downloads (*e.g.* iMesh, which offers DRM-protected file sharing) and communities such as Last.fm, MySpace, MOG, and imeem, which connect people through their tastes in music and allow for new ways of exploring available music. Social networking activities are thus becoming more attractive to advertisers and marketers.

Challenges

A major challenge for the development of online music markets is to reduce online piracy and develop business models that are attractive to consumers and provide revenue streams from the creation and legitimate distribution of original recordings.

Online music markets currently face many hurdles for becoming major revenue drivers. Barriers to development include the lack of an industry standard (music format and DRM standards), incompatibilities between content and playing devices, differing and hard-to-understand usage rights, difficulties associated with securing distribution rights, and cumbersome licensing processes for different national territories (*e.g.* for a pan-European release).

Beyond these issues, it will be important to devise revenue models which remunerate artists and content right holders fairly. Online music sales at USD 0.99 per song, with usage restrictions and in a proprietary format, marked a turnaround and is providing new music industry revenue flows. Yet, it is unclear whether this will be a viable long-term business model for artists and the music industry. Artists currently earn about 10% of each track sold on popular online music stores (*i.e.* roughly EUR 0.10). While this is about the same share in overall revenues as most artists achieve in the offline model (OECD, 2005a), it may not prove to be a viable revenue model in a market still dominated by single-track downloads. Increasing the price of online music at this point is however a risky strategy that may alienate new online music consumers.

Outlook

Online distribution of music will most likely adopt Internet-specific business models to cater to user habits and expectations. Shifts away from the traditional pay-per-album or more recent pay-per-track (with usage restrictions) business models are likely to be coupled with models with greater flexibility (*i.e.* without DRM) or in universally compatible formats. New forms of bundling music into existing or new subscriptions and advertisement-based business models will continue to develop and achieve greater market penetration. Social networks will play an increasing role in the discovery of artists and the purchase of music; some are offering ad-supported content or developing partnerships with mobile music providers.

Music will increasingly be used to promote other brands or to federate users around products or services. A new trend may be the purchase of music labels by ISPs, search engines, online advertisers or even consumer product companies. Korea's SK Telecom has purchased the country's biggest music label (YBM Seoul Records), its service MelOn offers a USD 4.50 monthly subscription, which lets users stream for free on their PC and to download tracks onto mobile handsets. The impact of this "commodisation of music" on artists and music creation, *i.e.* free advertising-supported music or full music catalogues bundled into existing subscriptions, is far from clear.

Direct sales from artists to consumers without the involvement of record labels are still rare although some independent artists are achieving visibility from Internet marketing and distribution (*e.g.* through sites such as Indiestore.com, SellABand.com), a trend that is likely to continue. New approaches (*e.g.* well-known artists leaving record labels to derive revenues solely from concerts and merchandising or popular artists giving away new albums) may lead to new business models and even greater reorganisation of the value chain.

The downloading of mobile music (including ringtones) is growing fast from low levels in most OECD countries. This is fuelled by an increase in mobile broadband subscriptions (in Japan and Korea growth rates are lower owing to earlier growth). Partnerships such as that between AT&T and Napster to offer pay-per-track or music packages will increase mobile music use as will Nokia's plans to offer unlimited music downloads to mobile phones with the music label Universal Music Group.

Advertising

Advertising is an important driver of free content services and content offered to consumers in newspapers, radio or broadcasting. In this two-sided market, publishers are often willing to subsidise one group (usually consumers), in order to have a large enough audience to attract the other (usually advertisers).

The global advertising industry had revenues of some USD 445 billion in 2007 (ZenithOptimedia, 2007; PwC 2007). The United States and Canada account for over 40% of global advertising spending, but the region's share has been declining as advertising markets in the Middle East, Asia, and Central and Eastern Europe are growing fast.

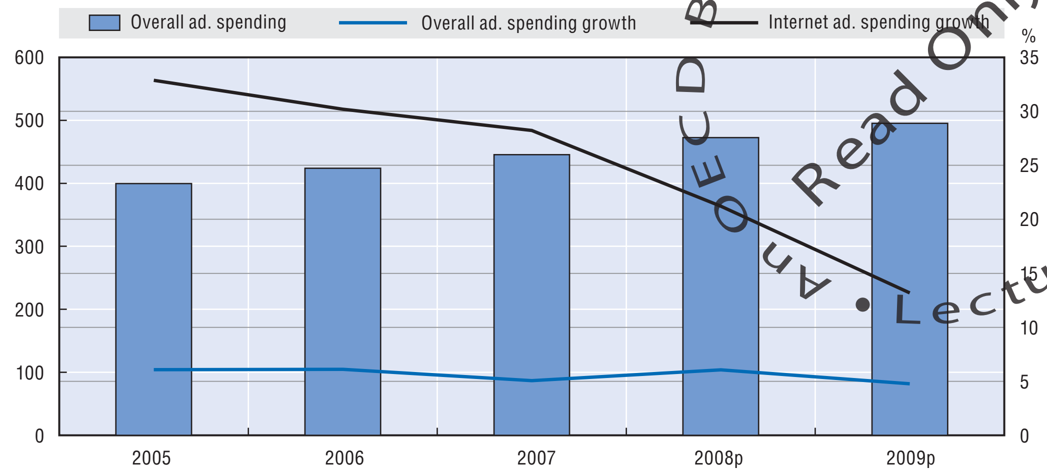
Throughout the 1980s the advertising market experienced a wave of mergers and acquisitions after which it became highly concentrated and dominated by a few global holding companies (GHCs) which controlled large numbers of agencies and were capable of providing all ad-related services, although individual value chain activities remain distinct (OECD, 2008b). Today the creation, placement and media purchasing services for most medium to large advertising campaigns are provided by vertically integrated GHCs, *e.g.* Omnicom, WPP, Interpublic, and Publicis Groupe, each of which controls various marketing services, advertising and media agencies.[20] These GHCs thus intermediate between advertisers, content publishers and the consumer. There are also numerous mid-sized holding companies, *e.g.* Havas, Aegis, Dentsu and Hakuhodo DY, and small businesses that specialise in one or more of these value-adding steps or in direct marketing services.

Market developments

Increasing broadband penetration and e-commerce, the increasing power of online transactional platforms and tracking technologies, as well as changes in consumers' behaviour and Internet use have fuelled investment in online advertising and allowed for a steady supply of funds. Broadband in particular has amplified the Internet's media substitution effect, and trends in various OECD countries indicate that young people in particular increasingly replace traditional media consumption with Internet usage. Around 70% of Korean Internet users access traditional media on the Internet, with newspaper, films and television content leading the field (NIDA, 2007b). At least 30% of US online users consumed less televised content, newspapers and magazines in 2006 (WAN, 2007), and 26% of Canadian Internet users are reported to watch less television, a rate that is slightly higher in the United Kingdom, Italy, Germany, and is valid for more than 50% of Internet users in France (Ofcom, 2007).

Figure 5.9. **Growth of worldwide advertising spending**

Total values in USD billion (left scale); yearly growth in percentages (right scale)



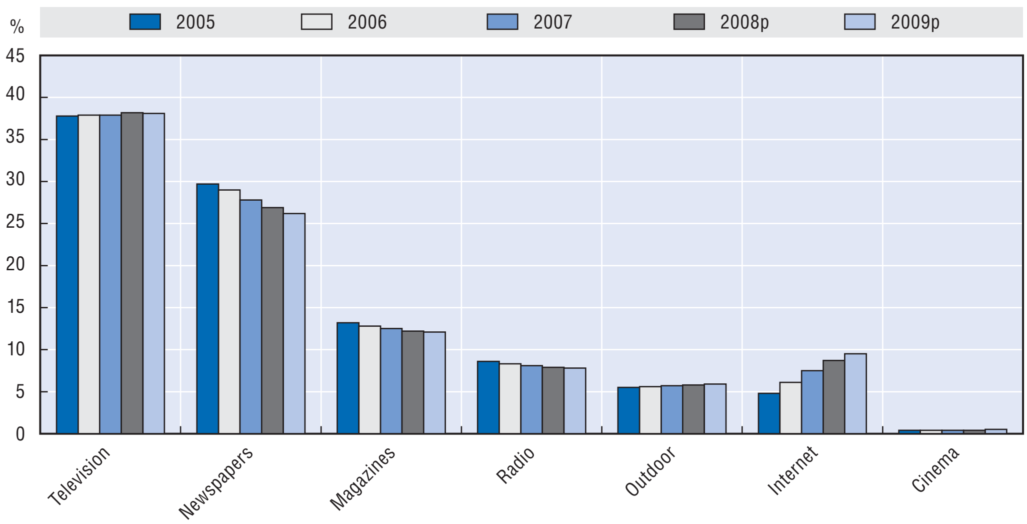
StatLink http://dx.doi.org/10.1787/476047040383

Note: 2008 and 2009 figures represent forecasts.

Source: Based on ZenithOptimedia, 2007.

Figure 5.10. **Worldwide shares of advertising expenditure by medium**

As a percentage of total advertising spending



StatLink http://dx.doi.org/10.1787/476126875742

Note: 2008 and 2009 shares are forecasts.

Source: Based on ZenithOptimedia, 2007.

Online advertising was estimated at USD 31 billion in 2007, still a relatively small segment of the advertising industry (around 7%). However, online advertising growth outperformed overall growth by a factor of five in 2007. It contributed significantly to overall industry growth: the USD 7 billion increase in 2007 represents over 30% of worldwide advertising growth (USD 22 billion). In general, online advertising has seen double-digit growth for the past ten years, with a significant drop after the "dot.com" bubble and a recovery since 2003 with growth rates of around 30%, although they are slowly declining (Figure 5.9). The online sector has already surpassed cinema and outdoor advertising revenues and is expected to surpass radio advertising revenues in 2008 (Figure 5.10) (ZenithOptimedia, 2007). However, it is not expected to break through the 10% barrier globally before 2009 (Fitch Ratings, 2006)

Online advertising activity is also high in individual OECD countries. Expenditures in Canada, for example, are estimated to have grown by approximately 80% in 2006 to CAD 1.01 billion and to increase by a further 32% in 2007, making it one of the fastest growing markets for online advertising (Interactive Advertising Bureau Canada, 2007). The United Kingdom, Norway and Sweden have the highest shares of domestic online advertising revenues worldwide, all surpassing 10%. In 2006, online advertising in Korea grew by an estimated 34% to reach 12.2% of the total domestic advertising market (NIDA, 2007c).

Online advertisers have begun to move into the traditional domains of GHCs. The main providers are Google and Yahoo!, with 17% and 16%, respectively, of the United States online advertising market in 2006, followed by AOL (8%) and MSN (7%).[21] These new entrants offer affordable advertising to small- and medium-sized businesses and reach consumers that are beyond the mainstream targets of advertising. Their customer base is very large. For example, WPP, the world's largest media buyer, is reportedly Google's largest single customer, but it represents a very small portion of Google's revenues (only 1.5% of its search advertising revenues) (Mandese, 2007).

A major advantage of online advertising is the capacity to track a user's behaviour over time, allowing for more accurate, effective and efficient targeting. Targeting and pay-per-click models seem to be giving online advertising a considerable advantage by reducing ineffective advertising budgets and securing enhanced levels of engagement from recipients by tracking responses to ads placed; they charge advertisers only when consumers react to advertising by taking measurable action (performance-based advertising). Behavioural targeting allows an unusual level of precision in identifying a potential consumer and his/her likelihood to purchase products. EMarketer estimate that USD 1.2 billion is going into behaviourally targeted advertising in the United States; it estimates that the number will almost double to USD 2.1 billion in 2008 (EMarketer, 2006).[22]

Beyond the move of new online entrants into the traditional domains of media buying companies, other areas are also beginning to experience competitive pressure. The entry of new high-traffic user-created content sites, notably MySpace and YouTube, means that advertisers can turn to other suppliers. Low entry barriers for creators and dramatically reduced transaction costs for advertisers are slowly creating a long tail of small content producers that are capable of participating in the advertising industry and of competing with GHCs.

Cumulatively, these transformations are driving convergence of offline and online advertising platforms and disintermediation in the demand, creation and allocation of advertising. However, the biggest online advertising platforms produce almost no ad content. Unlike GHCs or most traditional offline advertising platforms, search engines by and large neither create advertising campaigns nor produce or contract out the production of any content destined to be paired with advertising.

Online business models

There are five main types of online advertising:

- *Search ads* involve advertisers bidding on keywords that affect the position of their text ads on the user's results page.
- *Display ads* tend to be static or hyperlinked banners for which an advertiser pays an online company in order to appear on one of its pages.
- *Classified ads* are listings of certain products or services on a web page, *e.g.* eBay's gumtree.com.
- *E-mail* advertising consists of ads delivered through any type of electronic mail.
- *Referrals* are a method by which advertisers pay fees to online companies that refer purchase requests or provide customer information.

Search ads are the most popular form of online advertising, mostly due to the dominance of search engines as entry portals for Internet users. In the United States, the USD 17 billion online advertising market was led by search ads in 2006, followed by display ads and referrals. While most western European countries display similar shares, Japan and Korea show much higher shares of mobile advertising owing to their advanced mobile broadband usage (NIDA, 2007c).

Pricing for online advertising initially mirrored traditional pricing models (see Box 5.1); roughly 50% of online advertising is charged at cost-per-thousand-impressions (CPM), a reflection of traditional publishing in which advertising rates are determined by circulation (PwC/IAB, 2007). While this form of pricing means less risk for publishers, it fails to exploit the Internet's possibilities for performance tracking. Consequently, performance-based pricing is gaining importance, including cost-per-click (CPC) and cost-per-action (CPA) models. These models depend on measuring exposure to advertising in terms of occurrence and time as well as tracking user actions across Websites.

Box 5.1. **Prevalent pricing models in online advertising**

Cost-per-thousand-views/impressions (CPM). In this pricing model every time an ad is displayed the publisher is entitled to receive revenue. The CPM model is usually preferred by publishers since it involves little financial risk. Online advertising rates average USD 3-5 CPM for bulk ads. However, prices vary widely depending on format, accuracy and target audience. Dynamic video-game advertising rates, for example, typically resemble cable TV rates; IGA, a popular game producer, currently charges USD 25-40 CPM (Snyder Bulik, 2006).

Cost-per-click (CPC). A performance-based model, the CPC model requires users to click on an ad in order to generate revenue for publishers. Performance-based models are favoured by advertisers since they provide a higher return on Investment. In the case of search ads, advertisers bid for keywords to which their ad is associated. Prices can range from USD 0.01 to over USD 5 per click to be associated with the search term "Internet marketing" on Google's AdWords.

Cost-per-action (CPA). A performance-based model, CPA does not generate revenue for the publisher each time the ad is displayed but when a user takes an action which actually benefits the advertiser, such as purchasing online, registering, etc. (Fitch Ratings, 2006). Advertisers tend to prefer this model since it gives them a better return on investment.

Source: Adapted from PwC/IAB, 2007.

Search advertising

Marketing revenues through search grew to USD 5.1 billion for the first half of 2008 in the United States alone (PwC/IAB, 2008). Google reported advertising revenues of close to USD 17 billion in 2007, which accounts for virtually all of its revenues (the figure also includes revenues from advertising activities other than search). Naver dominates Korean searches with a 75% market share in 2006, followed by Daum and Yahoo! (NIDA, 2007c). Several forms of paid search may appear on these and similar Websites:

Paid listings. An advertiser is guaranteed the ad will appear high on a user's search results page. The ad is usually related to certain keywords and payment is usually on a pay-per-click (CPC) model. By auctioning multiple ad spaces for specific searches, search engines assign the most desirable space to the advertisers willing to pay the most.[23]

Contextual search. Ads are placed on content pages contextually related to the ad rather than on the results page of a search engine and uses a pay-per-click model. The two leading companies in this area are Google and Overture (now part of Yahoo! Search Marketing). Most online publishers easily allow advertising intermediaries to place relevant ads on their sites and thus automatically share a percentage of the profits with these intermediaries.

Paid inclusion. Advertisers pay a fee to have their Websites included in the search engine's search results.[24] Payment is usually by fixed fee per URL (for small web pages) or by cost-per-click (for large web pages).

Challenges

Hopes surrounding the potential of online advertising to support Internet-based businesses are enormous. In early 2008, online advertising was seen as the new business model for any web platform in search of a source of income, especially for entertainment content. These hopes are sometimes augmented by the fact that it has been difficult to develop other revenue streams (*e.g.* subscriptions or pay-per-play). While behavioural advertising promises even greater efficiency, it remains to be seen whether the technology will be developed and whether consumers will tolerate intrusive advertising.

Other challenges relate to market structure and competition, privacy and security, and click fraud.

Market structure and competition: While the online advertising industry is relatively young and very innovative, it is also highly concentrated. Tracking networks have strong incentives to increase the number of clients and tracking posts, and clients (publishers and advertisers) have equally strong incentives to belong to the largest tracking network in order to better predict the online behaviour of their potential consumers. Information about consumers tends to be aggregated in fewer hands and this raises potential issues for privacy and competition. A very few commercial entities dominate online advertising, especially in the area of search; the trend seems to be towards further concentration, and recent mergers are being reviewed. In addition, advertisement-funded search engines may have a significant influence on structuring access to the Internet and its information sources.

Privacy concerns and security: While generating efficiencies, the technologies that facilitate the collection, aggregation and analysis of enormous quantities of consumer data and preferences also raise serious challenges to the privacy and security of Internet users, particularly in the case of behavioural advertising. In the presence of booming online data

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gathering activities and increased demand for consumer profiling, marketers may be less likely to invest as heavily in protecting the information gathered through tracking networks as others with different incentives (*e.g.* consumers and governments) would like. Breaches in security are often hard to identify. Even supposedly anonymous search queries and data-saving activities have been shown to lead potentially to the identification of users (Barbaro and Zeller, 2006).

Online advertising fraud: The flexibility that allows almost unrestricted entry into ad-supported publishing has also meant an increase in undesirable activity, such as the proliferation of spam blogs ("splogs" or, more general, impression fraud). Designed to pass off as relevant sites, splogs mostly provide only a deceiving front intended to boost ad impressions or attract clicks and inflate the publisher's ad-related revenue from CPM. Click fraud relates to organised networks that pay private individuals to click on hyperlinks in e-mails or on pages that compile advertisements priced using CPC models ("Paid to read"); these fake clicks are estimated at about 10-15% of all advertisement clicks (Grow and Elgin, 2006).

Outlook

Online advertising is increasingly at the core of the evolution of the Internet economy. Although it has grown rapidly, online advertising budgets still represent less than 10% of total advertising spending. Growth in online advertising is expected to slow and already is at the expense of advertising budgets for traditional channels. At some point, advertisers will expect to reap the benefits of more efficient online advertising and be able to reduce growth in online advertising budgets. However, new tracking technologies, more time spent online and other drivers can be expected to sustain online advertising growth.

Video advertising, in-game advertising, and mobile advertising are likely to grow rapidly. In Korea, 3G mobile broadband advertisements already had revenues of around USD 80 million in 2006 (NIDA, 2006). New network-ready games consoles open markets previously precluded for lack of connectivity, *e.g.* for pre-launch product placement advertising. This advertising will increasingly be entertainment (*e.g.* the Toyota Yaris game), and advertising models based on social networking sites are likely to proliferate.

Behavioural advertising, *i.e.* the use of interactive monitoring technologies to target consumers based on their online behaviour, is a further, potentially intrusive, step towards efficient advertising. Technically, behavioural targeting would be able to offer different prices for the same product depending on the characteristics of the potential customer. Privacy and security concerns in the use of online advertising (especially behavioural advertising) may grow. Consumers' willingness to view rich media and targeted ads will grow if consumers feel that they are worthwhile. Younger Internet users appear less hesitant to reveal personal details online. Yet as the incentives to gather, process and sell consumer data escalate with increasing online advertising revenues and increased propensity of users to share content online (*e.g.* through UCC), national regulations and enforcement practices are likely to be put to the test. Attention will need to be given to working out how to regulate and enforce effectively in global Internet advertising markets.

Overall, the development of Internet services will be intimately linked to how advertising develops, how its efficiencies in linking information to users are applied and how advertising click-fraud is combated. Business models based on online advertising may become the most prevalent, superseding payment- or subscription-based models.

Conclusion

Digital content markets have double-digit growth rates across the industry sectors examined and increasing shares of total revenues, but with significant differences among sectors. Growth is driven by the transfer online of existing commercial activities and by innovative content from new enterprises and Internet users. Despite the high growth rates, the impact on content industries is still unclear. Established firms face adjustment pressures, the increasing numbers of businesses competing for relatively small direct revenues, and the complexity of setting up new partnerships and revenue sharing agreements in new digital content value chains.

So far, the impact of digital content on established value chains is largely on the distribution side (*e.g.* for music), but the impact on the production side is also increasing as user-created content, computer and video games, and advertising often create entirely new production value chains. The Internet and greater interactivity may also increasingly affect the supply of creative content owing to the impact of new business models (*e.g.* pay-per-track or advertisement) and free access to content (content "commoditisation") on artists and content creators.

Business models are still evolving. The simple migration of business models from the offline retail environment to the Internet (*e.g.* digital content sales: pay-per-item model) is often not enough to achieve adequate revenues and satisfy user demand. Online advertising is hailed as the "new business model" for the content industry and for user-created content platforms but other business models, including subscriptions, will need to develop.

However, the impact of digital content is much broader than the revenues provided by the content industry. As users purchase broadband connections, software, computers and electronic equipment to create and consume content, ICT and Internet industries increasingly rely on digital content to drive demand for their services and products. The boundaries between IT, telecommunications and media industries are blurring and new digital intermediaries and hosting platforms have emerged.

Broadband content will continue to grow rapidly as it overcomes various barriers to creation, distribution and access and thus to growth. With broadband content increasingly designed for mobiles, future growth will also come from mobile content. Although digital products are often substantially cheaper than their analogue equivalent, the depth of online catalogues is often shallow. The promised "long tail" has not yet materialised, but is likely to appear in the future. Problems relating to interoperability continue. These and other developments will require ongoing analysis of the broader impact of the development and distribution of digital content on value chains, business models, growth and employment and associated policy implications.

Notes

1. See: *www.oecd.org/sti/ict/digitalcontent and www.oecd.org/futureinternet/participativeweb.*
2. Digital content policy principles have been developed in the context of the 2008 OECD Ministerial on the Future of the Internet Economy (*www.oecd.org/futureinternet*).
3. Latency is another factor in access to content. It is the time needed for a data packet to travel from the user's computer to the server and back and is important when real-time response times are needed, *e.g.* online games, video and voice communications.
4. See: *www.oecd.org/sti/ict/broadband.*

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5. Paid download offers for older games are rather limited (below 100 for publishers such as Electronic Arts or Ubisoft; below 1 000 for GameTap, a game subscription service) compared to 20 000 or more entries in video and computer game databases, *e.g.* AMG, *www.allmediaguide.com/game.html* and Game Collector Connect, *www.collectorz.com/connect/games*.
6. On DRM issues in digital content distribution, see OECD, 2005a, 2006b, 2006c; Cabrera, 2007.
7. OECD-BIAC Workshop on Future of Online Audiovisual Services, Film and Video: Issues for Achieving Growth and Policy Objectives, 29 September 2006, *www.oecd.org/dataoecd/33/42/37866987.pdf*.
8. National statistical offices have only started to include related questions in surveys. Examples include the "Communications Usage Trend Survey for Households", conducted by the Japanese Ministry of Information and Communication; the "Survey on the Computer and Internet Use", by the National Internet Development Agency of Korea; and the "Community survey on ICT usage in Households and by Individuals" by Eurostat.
9. Counted using the number of "link-backs" to these licences on the Internet as tracked by Google.
10. Based on the Eurostat survey "Community Survey on ICT Usage in Households and by Individuals", April 2007, Luxembourg, Statistical Office of the European Communities.
11. Based on Wikipedia (4 August 2007) at *http://stats.wikimedia.org/EN/* and a presentation of Frieda Brioschi (Wikipedia) at the OECD, available at *www.oecd.org/dataoecd/15/14/36133622.pdf*.
12. See Xinhua-PRNewswire (2006), "Microsoft Windows Live survey: Blogging Phenomenon Sweeps Asia", 28 November.
13. See also the OECD-Canada Technology Foresight Forum on the Participative Web, fn. 1.
14. Most sites require users either to be at least 13-14 or 18 years old. Some have special sub-sites or parts of virtual worlds which are reserved for teenagers.
15. This definition of filmed entertainment only deals with the viewing, purchase and rental of cinema films. It excludes TV productions as well as licensing revenues from films distributed over television networks, digital TV, IPTV.
16. The United States, United Kingdom, France, Germany, Italy, Canada, Australia, and the Netherlands. Holdings include Axel Springer Group, Bertelsmann Group, Vivendi, Berlusconi, Carlton Group and Granada Group, but most of these are much more heavily invested in print, music and networking businesses than in film and television production.
17. See MPAA Research Statistics at *www.mpaa.org/researchStatistics.asp*.
18. Adams Media Research at *www.adamsmediaresearch.com/comersus/store/comersus_viewitem.asp?idProduct=25*.
19. CEA Market Research, May 2007, Product Sales Data, *www.ce.org/Research/Sales_Stats/1218.asp*. Apple shipped around 52 million iPods and over 1 million iPhones in 2007.
20. Advertisements may be placed in periodicals, newspapers, radio, television, online, billboards and flyers. Market research or advice can be included if provided in conjunction with ad creation or placement. Media buyers purchase ad space from media outlets and resell it primarily to advertising agencies. Marketing services refers to advertising which communicates with the audience directly, for example by direct mail or other methods which require a direct communication ("publishers" in the value chain). Advertising agencies are in charge of creating large marketing campaigns.
21. Yahoo News, 2007, "Yahoo closes Internet advertising gap on Google; AOL and MSN complete Big Four" 21 March.
22. Currently, there are two major business models for behavioural targeting in online advertising: First, publisher networks specialise in collecting and combining behavioural data across Websites. Expected to be a USD 1.5 billion industry in 2007 (Advertising Age, 2007), these networks mainly provide behavioural targeting services for publishers and advertisers. Second, Adware is a rapidly growing segment despite the deceptive and malicious "malware" that is regarded as a major threat to security on the Internet. Tracking software continuously monitors, collects and reports the user's online moves and displays targeted pop-up ads.
23. Under generalised second price (GSP) auctions, the highest bidder submitting bids for a particular keyword only pays a per-click price equal to the bid placed by the second highest bidder plus a minimum increment (of usually USD 0.01). In 2005 over 98% of Google's revenues and over half of Yahoo!'s came from such GSP auctions (Edelman, 2006).

24. There are two types of paid inclusion. Under the first type a fee is paid to have an editor review the Web site and include it to their directory. Under the second type an advertiser submits his web page for indexing by a search engine which guarantees its inclusion in the results search page.

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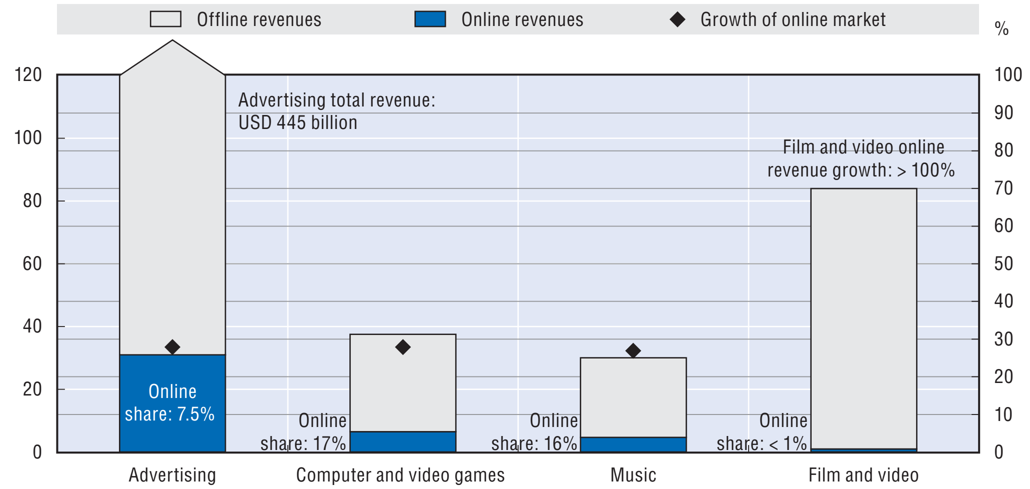
ANNEX 5.A1

Figure 5.A1.1. **Market size and growth, 2007 or latest available year**

In USD billion (left-hand); in % year-on-year growth (right-hand)



StatLink http://dx.doi.org/10.1787/476155357582

Source: OECD based on various sources as under Table 5.1.

Table 5.A1.1. **Intellectual property provisions in terms of services of UCC sites**

Content created by site	Most sites specify that they retain IPRs in their respective content (*e.g.* text, software, graphics, layout, design) under copyright.
Content created by users	• Most sites specify that users who post content retain ultimate ownership, but that they have given the site a licence to use content without payment. In other words, by posting the content the sites receive a limited irrevocable, perpetual, non-exclusive, transferable, fully paid-up, worldwide licence (with the right to sub-license) to use, modify, publicly perform, publicly display, reproduce and distribute such content. • Most sites specify that this licence does not grant the site the right to sell the content or to distribute it outside of the respective service. • Most sites pledge to mention the identity of the user, the author of the work, and also the title of the work, in so far as technical conditions make this possible. • Most sites specify that the licence terminates at the time the user removes his/her content. • Some sites reserve the right to prepare derivative works (modify, edit content posted by users) or the right to adapt. At times, it is specified that the site may commercially exploit the works posted by users. • Some sites specify that users lose their IPRs and forfeit payment in perpetuity (even when the content is removed). Sometimes the sites also ask the user to admit "moral rights" (meaning that the site does not have to give the author credit). • Some sites require the user to agree that content will be subject to the Creative Commons licence. • Some sites reserve the right of reproduction, *i.e.* the right to reproduce, without limitation, on any known or unknown medium, current or future, especially optical, digital, paper, disc, network, diskette, electronic, DVD, etc. • Some sites reserve the right to distribute the work or to sub-license rights to third parties. Mostly, it is proposed that revenue from these activities be shared between the user and the site. • Some sites reserve the right to use the name and content of users for advertising and promotional purposes (promotional licence).
Reservation to terminate the service	Most sites reserve the right to modify or terminate the service for any reason, without notice, at any time, which may have consequences on content stored or acquired by users.

Source: OECD, 2007 based on a review of the terms of service of a sample of 15 widely used English-speaking UCC sites.

ISBN 978-92-64-05553-7
OECD Information Technology Outlook 2008

Chapter 6

Economic Implications of Broadband

Broadband and networked ICTs are diffusing rapidly, but there are significant differences in use among countries, sectors and firms, and their manifold impacts are only beginning to be felt. Broadband and networked ICTs are important for meeting environmental, health and demographic challenges, and policy plays an important role in expanding their use and enhancing their impact.

Introduction

This chapter examines broadband networks and the role they play in creating the conditions for sustainable economic growth and prosperity and the structural changes they enable. The important economic impacts of information and communication technologies (ICTs) are well recognised. This chapter considers some of the economic implications of broadband and the networks that increasingly link ICTs in ways that should ultimately have very significant and positive effect on economic activity,[1] productivity, output growth and quality of life. Broadband is a relatively new development and take-up has been rapid, but it is difficult to disentangle its impact from the overall impact of ICTs, already a challenging area for measurement. However, evidence of a positive impact is increasing as statistics improve (see the OECD Broadband Portal[2]) and as studies from official statistical agencies or studies based on official statistics become available.

Broadband networks are an increasingly integral part of the economy. As the technology evolves and bandwidth increases, the scope for broadband to enable structural change expands as it becomes part of an increasing number of economic sectors and activities. Direct effects result from investments in the technology and from rolling out the infrastructure. Indirect effects come from factors that drive growth, such as innovation, firm efficiency, competition and globalisation. Broadband facilitates the development of new inventions, new and improved goods and services, new business models, and new processes; it increases competitiveness and flexibility in the economy, contributing to occupational change and job creation.

More generally, broadband improves the performance of ICTs. ICTs are a general purpose technology (GPT), *i.e.* a technological improvement that fundamentally changes how and where economic activity is organised. As such, the economic impacts of broadband are likely to be significant, for example by enabling organisational change and enhancing co-ordination to reap productivity gains from investments in ICTs, although it is likely to be difficult to disentangle the economic impact of broadband from that of ICTs more generally. Relative to other historical GPTs, such as railways and electricity, the impacts may also be larger and materialise more rapidly.

Broadband has become an important part of almost every aspect of the knowledge economy, especially in activities that rely on the provision of data and information in the services sector. Many aspects of production, delivery, consumption, co-ordination and organisation now take place over broadband communications networks. This increased pervasiveness gives rise, however, to security and privacy concerns. Protecting users' security will be paramount as the broadband-enabled Internet becomes a core part of the economic infrastructure.[3]

This chapter gives more attention to potential than to measured impacts. The evidence to date suggests that the largest productivity gains come increasingly from the use, rather than the production, of ICTs. ICT and e-business skills as well as the

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organisational changes enabled by ICTs are playing an increasingly pivotal role in achieving productivity gains. The diffusion of broadband and wireless developments are expected to encourage organisational change and fuel associated productivity gains. Informational mobility is also gaining in importance with the diffusion of mobile broadband (OECD, 2008a). The following section discusses the expected and potential economic impacts of broadband. Next, some evidence of productivity gains from broadband and ICTs is discussed, and the increasing reliance on this infrastructure illustrated. The final section looks at broadband and small and medium-sized enterprises (SMEs).

The expected economic impact of broadband

Broadband, when combined with ICTs,[4] operates through many channels both directly and indirectly. It enables the emergence of new business models, new processes, new inventions, new and improved goods and services. It increases competitiveness and flexibility in the economy, for example by the increased diffusion of information at lower cost, by improving access to increasingly larger markets, by allowing people to work from multiple locations with flexible hours, and by generally speeding up procedures and processes, thereby boosting the economy's dynamism. Finally, by nature these technologies create network externalities such that the benefits that accrue from using them increase as diffusion spreads. There may be further spillovers as well, for example when companies adopt broadband and ICTs that transform their supply chain and thereby prompt other companies to change theirs, either because they are part of the chain, or because they copy the innovative leader.

Broadband as an infrastructure enabler of a general purpose technology

Economic growth is driven by many things, notably product, process and organisational innovations related to technological change. Technological change usually involves small incremental improvements. However, technological improvements, when they are general purpose technologies, can fundamentally change how and where economic activity is organised. Earlier GPTs include printing with moveable type, electricity and the dynamo, the internal combustion engine, steam engines and railways. ICTs, including computers and the Internet, are generally considered a GPT. A GPT evolves over time and goes through phases involving efficiency, applications and diffusion. It creates spillovers throughout the economy, not merely in the sector that produces the GPT, it leads to fundamental changes in the production processes of those who use it, and it spurs further inventions and innovations.

ICTs are the GPT for today's world, with broadband acting as the required infrastructure enabler, and the Internet as the platform supporting a widening variety of applications whose effects are likely to raise productivity and give rise to network effects that increase over time. Already, many new products, both goods and services, have been created as a result of ICTs and have been fully integrated into everyday life, and working life.

GPT-type effects suggest that measured total factor productivity (TFP) should rise in ICT-using sectors, probably with considerable time lags. However, investment in ICTs may initially be associated with declines in TFP as reorganisation and learning require resources (Basu *et al.*, 2003). This is also consistent with David's (1990) "delay hypothesis" or "learning hypothesis" which relates to the time it takes to learn to use and apply new technologies. In fact, technological revolutions may occur but not be reflected in major accelerations in measured productivity. Efficiency has been growing rapidly, although there are physical limits, at least with the current networks, but there is still room for further diffusion of existing applications, and completely new applications appear regularly in many different parts of the economy (Carlaw *et al.*, 2007; see also Crafts, 2003).

Overall, it is very likely that broadband and associated ICT applications will replicate the positive and transformative effects of previous GPTs and possibly exceed them (see OECD, 2004; OECD, 2008c). The prices of ICTs have fallen more dramatically than the prices of other GPTs, such as electricity and the combustion engine, even though they require, like other GPTs, complementary investments, so that the innovations that drive change may take time to make their contribution (Fernald *et al.*, 2007).

Applications generated by broadband

The Internet has been widespread since the mid-1990s, but faster speeds and greater bandwidth continue to increase the range of activities that are carried out online. For example, traditional telecommunications increasingly take place over broadband communications networks, in particular IP networks, rather than circuit switched networks, and IP telecommunications (*e.g.* Skype) are also increasingly used. Public infrastructure greatly depends on broadband communications networks, from control of traffic lights to control of sewage systems to many forms of transport – air traffic control, maritime and rail transport, and logistics management systems. Governments increasingly maintain online relations with citizens and firms through the provision of e-government services (*e.g.* applications for permits of all sorts, tax authorities, information etc.). Military and defence systems also depend on broadband and the Internet. Global positioning systems (GPS) and other navigation systems all rely on this means of information transmission and they enable new applications such as monitoring of patients and prisoners at a distance. Natural and other disaster prevention and warning systems also rely heavily on the Internet and broadband communication networks.

Many aspects of business now take place over broadband communications networks: supply chain management, fleet management, e-procurement, e-invoicing, online recruitment, customer service, call centres, e-commerce, online payment systems, co-ordination of fragmented production processes both within and between firms, and the connection of teleworkers to their employers' networks. Further gains can be expected as possibilities for the use of virtual private networks and video conferencing, for example, expand with increased bandwidth.[5] Broadband is especially important in all sectors that rely on provision of information, such as financial markets, insurance and accounting firms and systems. Other examples include consultancies, weather forecasts and reports, research (from school homework to professional and academic research and R&D activities), online databases, banking (offline and online) and ATM services, marketing, online advertising, advertising and graphics design, and news distribution (offline and online). Broadband also plays a wider and important role in enabling innovation, another factor that contributes to creating the conditions for sustainable economic growth.

Broadband and innovation

Broadband has an impact on innovation[6] both through innovation in ICTs and through innovation enabled by ICTs, such as collaborative R&D networks, virtual simulation, artificial intelligence, grid computing, e-business processes, and new work practices.

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Broadband enables innovation both through new applications and through the diffusion of existing innovations, two mutually reinforcing channels. There is also some evidence that firms that use ICTs more intensively innovate more, creating larger spillovers and productivity gains (Koellinger, 2006). Broadband reinforces such effects by enabling more intensive use of ICTs and enhancing possibilities for exploiting the benefits of ICTs.

Broadband also increases firms' ability to move more quickly from idea to product, for example by allowing around around-the-clock R&D, "24x7x52", and concurrent development of multiple phases and projects in different locations. Thus, ICTs and broadband tend to transform how innovative activity is carried out. New forms of ICT-related innovation processes are emerging and are fundamentally changing how research takes place. ICTs and broadband enable faster diffusion of codified knowledge and ideas, linking science more closely to business. They lower barriers to product and process innovation,[7] encourage start-ups, improve business collaboration, enable small firms to expand their R&D and collaborate in larger R&D consortia, reduce cycle times, and foster greater networking in the economy.

The focus of ICT-related R&D has shifted from computer hardware to software, computer and related IT services, including Web services, and digital content (*e.g.* OECD, 2007b, 2008b). Broadband enables innovation in these areas and can be expected to drive further innovations in the future, especially in broadband-enabled services and digital content. Furthermore, with the diffusion of ICTs throughout the economy, ICT-related R&D is also increasingly carried out in other sectors (see Chapter 3).[8]

With the diffusion of broadband Internet, people outside traditional institutions and hierarchies can also innovate to produce new goods and services and content. The role of network users and consumers in the innovation process increases as they actively participate by generating or contributing to new product ideas (user-led innovation, or "the democratisation of innovation", see von Hippel, 2005) and collectively develop new products (*e.g.* Wikipedia, open source software).

The trend towards this democratisation of innovation applies not only to information products, such as software, but also to physical products. However, especially for services and knowledge and information products, the process is enabled and greatly enhanced by the use of broadband communication networks (see Box 6.1).

Broadband and the globalisation of services

ICTs and broadband facilitate the globalisation of many services, as broadband makes it feasible for consumers and producers of services to be in different locations. ICT-enabled globalisation of services involves highly skilled and relatively higher value-added services as well as lower-skill services such as back-office and administrative functions and call-centre activities. Examples of such ICT-enabled services include legal, accounting, advertising, design, R&D, IT-related services (such as software programming, IT support and consultancy), technical testing and analysis, marketing and advertising, management consultancy, and human resource management and labour recruitment. Broadband also raises product market competition in many sectors, especially in services.

The ICT-enabled globalisation of services is beginning to affect how economies work and the global allocation of resources. It also contributes to productivity growth by reinforcing competitive pressure and increasing business efficiency as firms focus on their core activities and outsource/offshore others. Given that services are often intermediate

Box 6.1. Open source software: User-driven innovation and the role of broadband communication networks

ICTs and broadband create new ways for companies to exploit the creativity and innovativeness of their workforce. Blogs, wikis, podcasting, tagging technologies, and other lessons of community and social networking sites are increasingly seen as important tools to improve the efficiency of employees. An important advantage is that innovation by users results in a more adequate response to their heterogeneous needs.

An open source software project illustrates the role of new ICT tools and how broadband enables interactions. The necessary tools and infrastructure include: e-mail lists for specialised purposes that are open to all and are publicly archived; common software languages (often available on the web); common basic toolkits. All greatly facilitate interaction, and version-control software allows contributors to insert new code into the existing project code base and test to see if the new code causes malfunctions in existing code. If so, the tools allow easy reversion to the previous version. This makes "try it and see" testing much more practical, because there is less risk of a new contribution inadvertently breaking the code. Toolkits used in open source projects have evolved with practice and are continuously being improved by user-innovators. Individual projects can now start up using standard infrastructure sets offered by sites such as Sourceforge.net.

Source: Adapted from von Hippel (2005).

inputs in other sectors, increased productivity in services because of globally distributed value chains is likely also to improve productivity in the sectors purchasing these services. The globalisation of services may also have broader welfare benefits for consumers, increasing the range and variety of services available. Potential productivity gains may also arise from greater access to a larger variety of inputs.

Broadband-enabled global sourcing can affect a country's services productivity in other ways as well. If imports compete with domestic production, efficiency gains can be achieved when the least efficient firms are driven out and competitive pressures force the remaining firms to become more efficient and innovative. Furthermore, when global sourcing allows countries, or firms, to focus on their areas of competitive advantage, overall productivity is likely to increase as a result of the increased specialisation of tasks and activities.

Reliability of the infrastructure

As broadband and rapid, high-capacity communication networks become increasingly widespread they are also increasing the reliance of the economy on their continued and permanent operation. Damage to the physical infrastructure has increasingly important economic ramifications. Incidents have been relatively minor to date, but they give an idea of the kinds of activities affected and of the duration of disruptions, some of which are described below. As more and more activities take place over these cables, faults in the infrastructure will have increasingly wide and disruptive repercussions. Box 6.2 describes some of the deep-sea cable infrastructure.

Internet activities, e-mail and telecommunications were affected when Telstra, Australia's biggest Internet service provider (ISP), lost around 60% of its Internet transmission capacity in 2000 as a result of damage to a major Internet backbone cable (Figure 6.1), situated in less than 100 feet of sea 40 miles off Singapore. Initially Telstra was

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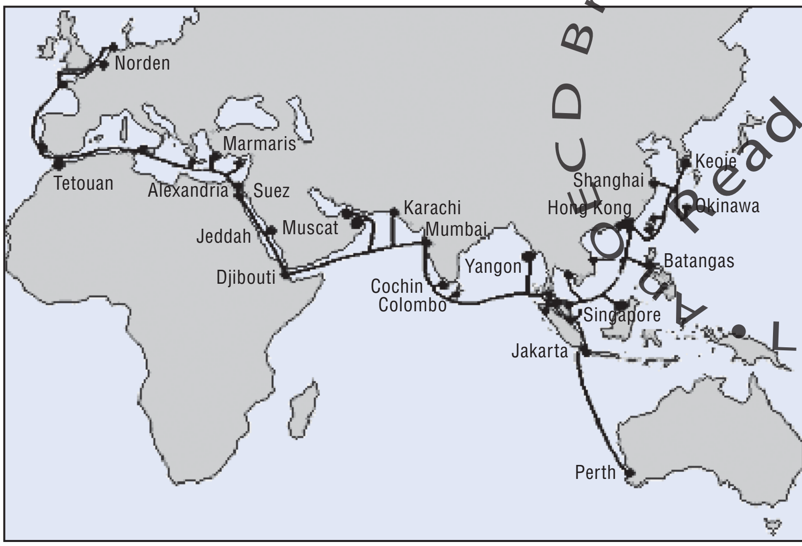
Figure 6.1. **The 23 600 mile SEA-ME-WE 3 Cable**



StatLink http://dx.doi.org/10.1787/476157204117

Source: Forbes, *www.forbes.com/2000/11/21/1121disaster.html.*

able to cover only 30% of its usual capacity, but after rerouting data around the damage service rose relatively quickly to 75%. To avoid disruptions of this kind, improve service and provide increased network capacity and reliability, Telstra announced in early 2007 that it was investing in a new 5 600 mile deep-sea cable linking Australia to Hawaii, and then to the United States mainland.[9]

Sri Lanka's communications link to the rest of the world, a single fibre connection, was cut in 2004 by a ship's anchor. News reports indicated that its Internet and long-distance phone service were cut off, with potentially major economic implications for Sri Lanka given the importance of its call centre activity. In mid-December 2006, hundreds of thousands of people in Iceland suffered severe disruptions to their use of the Internet and Iceland's universities and hospitals suffered a temporary shut-down of data communications when a deep-sea cable break caused an interruption of CANTAT-3 services. During the repair the affected institutions relied on emergency connectivity obtained via local Internet providers.[10]

In December 2006, an undersea earthquake and rockslides damaged undersea cables off Chinese Taipei's southern coast causing outages in Chinese Taipei, China, Korea, Japan and India. This incident, dubbed "a digital tsunami",[11] disrupted financial markets, phone calls, online banking, computer kiosks at airport check-ins, ATMs, logistics companies, communications and Internet sites. Chunghwa Telecom, Chinese Taipei's largest telephone company, reported that all of the island's phone communications with other Asian countries were disrupted and that capacity to the United States was cut by 60%. Japan's NTT reported damage to 1 400 phone lines and 84 international phone lines, disrupting phone capacity to Southeast Asia. China's access to major international Websites was also affected, as were phone calls to Chinese Taipei and Hong Kong, China. Korea's leading fixed line company KT reported that some 90 leased lines had been destroyed, but that telephone and Internet lines had been re-routed rapidly with minimal disruption.

Box 6.2. **Deep sea cable infrastructure**

Much ICT-enabled activity takes place over deep-sea cables. Experiments with deep-sea cables started in Europe and Japan in the mid-1980s, but the large-scale laying of optical deep-sea cables took off in 1996-97. At the time, the demand for International bandwidth was driven by simple Internet connections, wireless and wire-line voice traffic. Ten years later, Internet video traffic on peer-to-peer networks and websites such as YouTube are driving demand. While deep-sea networks are growing strongly, there has been little build-up of terrestrial networks. Instead of adding more cables, some carriers (such as Level 3 and Global Crossing) are using next-generation optical equipment from companies such as Infinera to send more bandwidth cheaply over their existing terrestrial fibre. Such a solution does not yet exist for the deep-sea sector, which partly explains the increased laying of undersea cables. In recent years investment in the deep-sea cable market has shifted to South Asia, and two of the largest owners of deep-sea cable networks are in India: Reliance Globalcom (FLAG) and Tata Communications (VSNL).

The largest amount of construction activity is on the trans-Pacific route, and according to Telegeography estimates, only 18% of the potential trans-Pacific capacity is lit at present. The total potential capacity on existing cables is about 17 terabits per second (Tbps), but as some 75% of it is on a single cable, VSNL Transpacific, global carriers are looking for second and third sources. Four new cables are being proposed that would increase the potential capacity to about 39.8 Tbps. The Trans-Pacific Express (TPE) went live in the third quarter of 2008, connecting China, Korea and Chinese Taipei to the United States (see below). The other three cables planned were (in order) the Asia America Gateway (AAG) project, the EAC Pacific and FLAG NGN-Pacific.

The TPE is a network costing over USD 500 million with an 18 000 kilometre cable system and a maximum capacity of up to 1.28 Tbps, created by Verizon Business with a multitude of Asian telecommunication operators including China Telecom, China Netcom, China Unicom, Korea Telecom and Chunghwa Telecom of Chinese Taipei. The network will land on Nedonna Beach (Oregon), on the United States side and in China at Qingdao and Chongming. It will also have landings in Tanshui, Chinese Taipei and Keoje, South Korea.

Indian companies have been buying up large shares of the cable market. For example, VSNL bought the Tyco Global Network. It is likely VSNL will upgrade its networks to meet capacity demands and face the challenge posed by the new China-United States TPE network. Another recent example of dynamic Asian growth involves Spice Telecom, Indian state Karnataka's oldest cellular service provider. It was reportedly looking at using Telecom Malaysia's international long distance (ILD) infrastructure to enter the international market. Spice Telecom is also reported to be setting up three ILD points of presence (POPs) – the United States, the United Kingdom and Singapore – to distribute its traffic across India, along with its two national long distance POPs. This will allow Spice to compete with other ILD major carriers, like BSNL, Bharti, Reliance and VSNL. Telecom Malaysia (TM), which has a large share in Spice Telecom, is a consortium member of all submarine cable systems that land in Malaysia, with access to capacity in other submarine cable systems globally. It also has co-location facilities at major data centres. The relationship between Spice and TM will allow Spice to access those cable systems and facilities.

Source: OECD, 2008c.

Overall, most network operators and data providers were able to re-route traffic without too much disruption. For example, Cable and Wireless used back-up terrestrial circuits through China, and Reuters, whose main regional data centre is located in Singapore with a back-up in Hong Kong, China, restored services to Japan and Chinese Taipei on the same day and to Korea on the following day. Bloomberg suffered more, as it supplies its information from New York. Traders, investment bankers and Bloomberg's editors based in Hong Kong, China, could not access the company's terminals for two days.[12] The Hong Kong stock market returned to normal after a few days, and China Telecom had recovered 70% of its Internet service and all of its phone calls to Hong Kong and Macau. Singapore Telecom's Internet access and voice services had also been restored. Five days after the event, Indonesia's PT Indosat had 80% capacity.[13] This incident shows that a great deal of data transfer relies on deep sea cables and that the network is quite resilient, since at least partial service was restored in most affected networks in less than 12 hours. Companies also reverted to using fax and mobile phones.

India is particularly aware of reliability and interruption issues given its huge call centre, software and business process outsourcing industries which cannot afford to be offline for an extended period of time. During the December 2006 incident, only one company suffered a major outage lasting around eight hours; other large companies only suffered slight disruptions. This is because Indian companies rely on a multitude of telecom service providers and use four different cable systems that land in different Indian cities: diversity is the key to reducing impact from such outages.[14]

Repairing breaks in deep-sea cables is complicated by the need for ships with special equipment, which may take some time to arrive and are very costly. Also, the full extent of the damage cannot be known immediately, as the equipment can only scan the cable to the first break, so that further breaks are not discovered until the first is repaired. The sequence must be repeated until all breaks have been repaired. Parts of severed cables may also be far removed from the breakage point if they have been dragged by currents or moved by rock slides, for example. Increasingly, efforts are being made to keep local Internet traffic local, which not only lowers costs but also improves performance and reliability (Gibbard, 2007).

In general, because Asia has fault lines and is vulnerable to quakes, it is necessary to study carefully where to lay the cables and to diversify cable loops and landing points. For example, the Trans-Pacific Express cable system, linking the United States to China and other countries in Asia will use a "mesh system" which will run three different loops connected at switching stations on land. This should make re-routing easier in case of a break. Geographical diversity in landing points is also important.

Evidence on the productivity impacts of broadband

Only a few studies have so far looked directly at the economic impact of broadband, and there are very few cross-country comparisons. Most studies consider the impact of ICTs more broadly, but to some extent the results for broadband can be extrapolated, even though the impact of broadband will also depend on other factors. Indeed, with the very rapid advances in ICTs that have and are still taking place, productivity gains are no longer limited to or dictated by the technology but by the use made of it and the (organisational) capacity to exploit the gains that it allows to achieve.

Productivity effects of ICTs

The productivity impact of ICTs has been studied at the aggregate, sector and firm level. Macroeconomic studies of the impact of ICTs on the economy can be broken down into two types: growth accounting and country-level econometric studies. Overall the evidence finds a positive impact on productivity. In neoclassical growth accounting, productivity impacts show up in measured total factor productivity (TFP), whereas the direct impact of ICTs leads to capital deepening which boosts labour productivity. The drawbacks to using growth accounting techniques include: the limiting assumptions and hypotheses that are needed; data limitations especially for the data on investment in ICTs; the need for hedonic deflators adjusted for quality change; and international comparisons remain difficult. Many studies find that much of the acceleration of TFP comes from greater use of the technology (see *e.g.* Basu *et al.*, 2003; Pilat, 2005).

ICTs essentially have a productivity impact through three channels: *i)* the ICT-producing sector, *ii)* ICT investment in ICT-using sectors, and *iii)* complementary factors, such as organisational capital, firm organisation, skills and human capital. Regarding organisational capital, studies have shown United States affiliates in the United Kingdom to be more productive than United Kingdom firms because of their relatively more efficient use of ICTs but that this is not necessarily the case for other countries' affiliates (*e.g.* Bloom *et al.*, 2007; Oulton, 2001). Thus, the productivity of United States multinationals operating in the United Kingdom has been found to exceed that of non-United States multinationals operating in the United Kingdom and this applies to their acquisitions (Bloom *et al.,* 2007; see also the role of organisational capital and other intangible and complementary factors in Box 6.3). The competitive environment, the general macroeconomic climate and the state of the economy are also important, as are competitive pressures, especially in recent years (Oliner *et al.*, 2007).

The impact of ICTs on productivity may also change over time. Growth accounting estimates for the United States in Oliner *et al.* (2007) suggest that the direct impact of ICTs on labour productivity growth peaked in 1995-99, accounting for around three-quarters of productivity growth. Nonetheless, the direct impact of ICTs remained substantial from 2000 to 2005, accounting for around two-fifths of labour productivity growth. The latter period also saw a marked acceleration in multi-factor productivity growth outside IT-producing sectors, suggesting that the continued diffusion of ICTs and the move towards an increasingly broadband-enabled economy may have had important indirect impacts on productivity growth.

Cheap ICTs will only have a productivity effect if firms fundamentally change their organisation of production in order to enhance productivity. If the diffusion of ICTs subsequently leads to complementary innovations in ICT-using industries, increasing the demand for ICT capital, such innovations can have important long-term effects before diminishing returns set in (Basu *et al.*, 2003). A similar point can be made for diffusion and roll-out of broadband and continuously increasing bandwidth.

Studies using more disaggregated data (at sector and firm level) provide useful additional insights. Productivity effects are likely to vary across sectors and firms and may be masked at the aggregate level where effects may cancel each other out. There may also be a role for firm entry and exit, over and above the productivity impact of IT, when low-productivity firms exit and high-productivity firms enter the market (Foster *et al.*, 2002). A

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Box 6.3. **The role of intangible capital and other complementary factors for ICTs**

For broadband to achieve its impacts, it requires other ICTs and a range of other complementary, often intangible, assets. Basu *et al.* (2003) argue that the United States-United Kingdom TFP differentials from 1995 onwards can be explained by a combination of unmeasured investments in intangible organisation capital and the role of ICTs as a GPT. The existence and importance of intangible capital helps to explain both the Solow productivity paradox of the 1980s and early 1990s and why productivity growth remained strong after 2000 when ICT spending fell dramatically (Baily, 2003). The idea is that it takes time and resources to learn how to use ICT (or any GPT) properly. Initially productivity may even decline as resources are allocated to learning. If ICTs are used to do the same things in the same way as they were done before or if the purpose of the investment in ICTs is not clear, the impact will be limited. Improvements in workplace organisation, enabled by ICT, have also improved productivity. The main driver of productivity improvements has been the changes and innovations that ICT investment has enabled, such as the re-organisation and streamlining of existing business processes, including order and delivery tracking, inventory control and accounting services (Atrostic and Nguyen, 2006). When considering ICTs as a GPT, the expected economic impact will be far greater than what is predicted by just examining the capital investment associated with ICTs because this does not take into account the widespread complementary innovations enabled by ICTs (Brynjolfsson and Hitt, 2000).

The effects of organisational change may rival the effects of changes in the production process in terms of their impact on productivity at the firm level (Black and Lynch, 2001). The ability to create economic value from intellectual assets is highly contingent on the management capabilities of individual firms and the implementation of appropriate business strategies. The ability of ICTs to enable complementary organisational investments in business processes and work practices also constitutes a significant component of the value of ICTs. These investments, in turn, lead to productivity gains by allowing firms to reduce costs and increase output quality, for example in the form of new products or improvements in intangible aspects of existing products, such as convenience, customisation, timeliness, quality and variety (Brynjolfsson and Hitt, 2000). However, the productivity effects of these complementary factors may take time to appear. The longer-term contributions of computerisation to productivity and output at the firm level have been found to be up to five times greater than the short-term contributions (Brynjolfsson and Hitt, 2003).

Quantitative studies of the effects of intangible investments, such as organisational changes and management practices, on growth are relatively recent and require new frameworks and measurement practices (OECD, 2006b). Corrado *et al.* (2006) argue that the conventionally measured US capital stock is underestimated by some USD 1 trillion and the business capital stock by up to USD 3.6 trillion (equivalent to around 29% of United States GDP in 2005, or around 12% of United States business capital stock). Adding this capital to the standard growth accounting framework changes the observed patterns and sources of United States economic growth significantly. In particular, the rate of change of output per worker increases more rapidly in the presence of intangible capital, and capital deepening becomes the dominant source of labour productivity growth. Oliner *et al.* (2007) also provide preliminary estimates of the growth contributions of intangible capital using an augmented growth accounting system. Intangible investment is estimated to have surged during 1995-2000, boosting growth in aggregate output, but then retreated during 2000-06. The contribution of intangible capital deepening to growth follows the general pattern for IT capital, high during 1995-2000 and then falling. This similarity reflects the strong association between intangible capital and IT capital. Nevertheless, intangible capital increases less rapidly than IT capital in each period, and particularly during 1995-2000, as a result of the quality-adjusted declines in computer prices that lower the user cost for IT capital.

lack of competitive conditions may keep unproductive firms in business and thus drive down aggregate productivity growth.

Most of these studies looked at the aggregate level, while pointing out the importance of disaggregation in order to better understand the mechanisms and conditions that affect productivity. Overall, sector level evidence on the impact of ICTs generally confirms aggregate level evidence, namely that investing in ICTs alone is not enough to reap the benefits. However, at lower levels of aggregation, the effects may be larger, as broader aggregation may hide substantial productivity and performance differences at the sector and firm level.

Broadband can also be expected to have a very large impact on the services sector as it enables dispersion of production and international trade in services that were not previously tradable or contestable. Furthermore, the increased management, communication and information processing possibilities offered by broadband can be expected to become especially important in the services sector.

The impact of the "C" in "ICT"

This section focuses on research that has singled out the "C" in ICTs, *i.e.* the communication factor, and has examined its impact on productivity.[15] Whereas rapid developments in ICTs have tended to focus on advances in the "I" of ICTs, greater attention has recently been paid to the "C", in particular with the advent of broadband and wireless (broadband) technologies.

While initial productivity gains from ICT investment are most likely to have stemmed from investment in IT itself, investments in the "C" link individual computers and result in gains from network effects. The "C" saw little change until relatively recently, but as a result of infrastructure roll-out, regulatory changes and technological advances in wired (particularly optical) and wireless networks, a range of sources of potential productivity gains becomes possible, owing not only to increased sharing and networking, but also to updating of information in real time, on-the-run decision making and more flexible working relationships than what was feasible without the more advanced "C" in ICT. The productivity gains likely to lie ahead are expected to be large with the spread of broadband, but will require even more intangible investment, especially in organisational change.

For example, earlier studies have shown that computer networks have a positive impact on total factor productivity in the United States (Atrostic and Nguyen, 2002) and the United Kingdom (Criscuolo and Waldron, 2003). Other studies have found a positive impact on labour productivity from using computer networks to link business processes in firms, especially in conjunction with the creation of intangible assets through investments in human and organisational capital, with the effects varying by sector (Clayton and Goodridge, 2004; Brynjolfsson and Yang, 1999). Fuss and Waverman (2006) attribute Canada's lagging productivity growth relative to the United States[16] to less intensive use of ICTs, based on a range of variables, such as telecommunications and PC penetration, mobile and fixed telecom retail and supply prices, IT prices, and digital mainlines. Broadband potentially magnifies and widens these effects.

Farooqui (2005) has taken the use of telecommunications services by United Kingdom firms as a proxy for external relationships in work. He finds that employees' use of the Internet has a positive effect on productivity beyond what can be explained by IT investment. The purchase of external infrastructure constitutes the bulk of spending on

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communications technology equipment for firms outside the communications sector (which in turn accounts for less than 15% of investment in telecommunications products). Use of telecommunications is found to have a significant and positive effect on output in both manufacturing and services. The author suggests that the impact of IT through the management of complex supply chains and external links is greater than its impact as a driver of internal efficiency.

Richer communications structures can lead to multitasking, which, in turn, drives productivity up to a certain point. For example, the structure and size of workers' communication networks have been found to be highly correlated with performance (Aral *et al.,* 2007). Both synchronous communication technologies (*e.g.* telephone and video-conferencing) and asynchronous communication technologies (*e.g.* e-mail, sharing large data and graphics files) support the ability of geographically dispersed groups to collaborate seamlessly. It is not the speed of communication that makes the difference, but its use to reorganise work and perform tasks more efficiently. This confirms that it is not ICT equipment but how it is used that matters most and this applies to communications and broadband.

Oliner and Sichel (2000) and Oliner *et al.* (2007) take communications equipment into account as a vital component of computer networks along with computer hardware and software. These three components determine the contribution of the use of ICTs to growth. Their results are broken down for the periods 1973-95, 1995-2000, and 2000-06. While computer hardware accounted for the largest contribution in each of the three periods, followed by software and then communications, the contribution of communication equipment to labour productivity growth increased relative to that of computer hardware and software, with the contribution of the latter two decreasing while that of communications equipment remained constant, probably in part linked with the increasing efficiency and importance of communications networks. Baldwin and Sabourin (2002), in a study of Canadian manufacturing firms, also differentiated between three groups of advanced ICTs: software, network communications and hardware. They found that establishments that had adopted network communication technologies experienced significantly higher productivity growth than those that had not, and that the largest gains were in establishments that had adopted combinations of all three types of ICTs.

By focusing on the networking capabilities of communications equipment, Fuss and Waverman (2005) attempted to capture the spillovers from the diffusion of computers, software and telecommunications. They model diffusion of telephones and computers as an increase in the capital stock and also account for the interaction between the digitisation of telecommunications networks and the diffusion of computers, which they find to have a positive impact on productivity. In addition to a positive impact from ICT-related capital deepening, spillovers are found to explain at least some of productivity differences between the United States and some other countries.

Most of the studies discussed so far have considered computers and ICTs as a form of capital to be used as an input into the production process. However, computers can also be used to transform business processes; in this context, computer networks are examined as a productivity-enhancing technology by Atrostic *et al.* (2002) in a study covering Denmark, Japan and the United States. Different types of networks are distinguished, such as wireless, Internet, intranet, and electronic data interchange (EDI). The results for Japan and the United States indicate that manufacturing firms/plants with networks have higher labour productivity and tend to be larger than those without networks. Furthermore, the use of both intra-firm and inter-firm networks is found to be positively correlated with the level of TFP at the firm level. For Japan the productivity impacts are also shown to differ by type of network. In Denmark, firms with networks were found to achieve higher growth rates both of value added and employment, leading to a lower rate of labour productivity growth.

Some of the diverging effects of different types of network use have been disentangled by Atrostic and Nguyen (2006) who also report further evidence confirming the positive link between computer networks and productivity. In particular, online supply chain activities driven by communications networks, such as inventory control, order tracking, transport and logistics management, are consistently positively linked to productivity and productivity impacts tend to be higher in newer plants which are likely equipped with faster and more effective communications networks.

The productivity impacts of broadband

Broadband is an enabler of change – it has an impact on the economy and restructuring when it is combined with other ICTs, such as computer hardware and software, and complementary factors such as skills and organisational change. The study of the economic impact of broadband is complicated by data availability and measurement problems, reminiscent of the early days of the study of the impact of ICTs more generally and Solow's productivity paradox[17] (IT is everywhere except in the productivity statistics). Another factor complicating the identification of the economic impact of broadband is that the impact is likely to be large in the services sector (non-farm, non-manufacturing industries) where output and productivity changes are not yet well captured. Furthermore, data on the availability and even the adoption of broadband do not necessarily adequately reflect its use and the impacts of use. Merely investing in acquiring the technology does not suffice to achieve productivity gains – here as elsewhere, what matters is how it is used. It is also difficult to establish causality owing to the difficulty of disentangling the effects of infrastructure availability and economic growth.

Nevertheless, studies are increasingly being undertaken on the specific productivity impacts of broadband. For example, Lehr *et al.* (2006) use a cross-sectional panel data set at the zip-code level for the United States to examine the impact of broadband on variables such as employment, wages and industry mix. They find some evidence that broadband positively affects economic activity. In particular, they find evidence of more rapid growth in employment and the overall number of businesses and in IT-intensive sectors. However, they also find a negative impact on the growth rate of salaries in areas with earlier access to broadband. This result is not yet well understood and is being investigated.

Analysis for Australia[18] finds a positive productivity impact from ICTs, focusing on effects in new industries, such as the film and animation industry, where broadband can be expected to matter even more than in "traditional industries". The analysis could not distinguish the effect of broadband on e-commerce, but this is not very surprising since much e-commerce can also be done with narrow band. The results confirm that what one does with ICTs and broadband matters more than having it.

A project constructing ICT-related indicators, including broadband, based on microdata has been developed under the auspices of Eurostat. It aims to build a set of indicators of ICT intensity[19] and impact that are comparable across countries and compatible with macro databases such as EU KLEMS in an attempt to bridge the gap between macro and micro data approaches, which can subsequently be used in international comparisons and analysis. One of the objectives of the project is to help identify the impact of ICT readiness and intensity on firm-level performance. Building on earlier analysis by Hagén and Zeed (2006), new results for Sweden for 2002 appear to point to a negative impact from faster broadband when looking at gross multi-factor productivity (MFP) and to a positive impact on value added labour productivity. A possible explanation may be simultaneous large capital investments. However, by 2004 the impact on both variables is positive, suggesting that the benefits of broadband appear over time. Data for the Netherlands show that by 2004, only 5% of firms had reached the highest level of ICT use. First results from analytical work show that broadband is very significant for determining the production frontier, but that, conditional on using broadband, the distance from the frontier is determined by ICT usage (the level of ICT maturity), without a significant contribution from broadband intensity.

Sadun and Farooqui (2006) find broadband adoption to be related to e-commerce, ICT-equipped labour intensity and external demand. Investment in hardware was found to be higher in regions and sectors with broadband availability especially among United Kingdom domestic firms in non-IT intensive industries. Broadband users are also more likely to have multiple business links, and multiple links with broadband technology improve labour productivity. Firms with a large share of labour equipped with broadband have higher productivity.

As direct data on broadband are under constant development and since broadband complements other IT tools, related measures can be used to gauge potential broadband impacts. Several possible measures are interlinked: data on the hardware capital stock, the software capital stock, the number of employees using ICT, use of telecommunications services and e-commerce can each tell part of the story. Results for the United Kingdom show that the impact of IT varies greatly across sectors and is highest in the services sector (Farooqui, 2005). Firm age also appears to matter, with younger manufacturing firms achieving greater benefits than older firms. In the services sector, however, there is a time lag due to a learning effect: IT capital and networks are used together to build up knowledge bases of clients and services provision. A strong relationship also exists between spending on telecommunication services and productivity, and between investment in IT and spending on communication technologies, the latter reinforcing the effect of IT investment.

The importance of attaching geographical location to broadband data is highlighted by Di Gregorio (2006). Anecdotal evidence reveals that local businesses and home-office workers experience benefits such as efficiencies in administration, purchasing and less time searching for information.

Although few studies have estimated macroeconomic effects on growth and employment and tried to model future impacts, a new study for the European Commission has undertaken this kind of research (see Box 6.4).

Overall, as Lehr *et al.* (2006) point out, although broadband appears to have positive measurable economic impacts, it has been difficult to draw precise conclusions owing to the lack of firm-level (and employee-level), geographically disaggregated time-series panel data. It is nonetheless obvious that as broadband spreads throughout the economy, changes are taking place in the way business is done, work is organised and resources are

Box 6.4. Modelling the macro-impacts of broadband deployment and use in the European Union

A recent study for the European Commission collects evidence of the economic impact of broadband Internet on labour productivity, employment level and growth. The investigation focuses on the improvement of business processes through the use of online technologies and particularly of broadband. According to the model on which the study is based, broadband leads to net growth of the European gross value added of EUR 82 billion (+0.71%). Employment creation in new activities compensates for job loss due to process optimisation and structural displacements with net creation of jobs in 2006. However, depending on broadband access and levels of use, impacts are not uniform across European countries, with some seeing more positive broadband-related results than others. The study concludes that the key to significant positive impacts are not only access to the infrastructure but also the integration of value-added online services in company processes. According to the study, in the best case scenario, broadband could lead to the creation of more than 2 million jobs in Europe in the period until 2015.

Source: MICUS, 2008.

allocated. These effects are observable especially in some very large services sectors which account for a large share of the total economy, such as communications, financial services, business services, transport, real estate, travel and tourism and retail, and in growing impacts on public services such as health,[20] education,[21] government and addressing environmental challenges. Content provision and advertising are also rapidly changing in the face of broadband. As a result, larger effects than those currently identified can be expected.

The impact from informational mobility

A relatively new aspect of ICTs that is rapidly gaining in importance is that ICT devices are becoming ever more portable (laptops and other portable devices), and that widespread fixed and mobile broadband increasingly allows "informational mobility". This makes the "C" in ICT increasingly important. Increased ICT penetration is no longer a major source of productivity growth in developed countries,[22] but new features (such as portability and wireless connectivity) can boost productivity in activities requiring information and communication. Mobility has become an integral part of communications.

Maliranta and Rouvinen (2006), in a study for Finland, find that a computer with only processing and storage capabilities boosts labour productivity by 9%, portability boosts it by 32%, wireline connectivity by 14% and wireless connectivity by 6%. As the study was carried out on data for 2001, when wireless connectivity was still in its infancy, the impacts are likely to have increased significantly with more intensive use of wireless devices and mobile broadband. However, "selectivity" is an issue, as the more productive workers may be those who get the better equipment.

The economic benefits of mobile phones in developing countries are often studied. McKinsey (2006), in a study for China, India and the Philippines, estimates that mobile phones may add as much as 8% to a nation's GDP. The contribution has three components: a direct impact from mobile phone operators, and indirect impacts from other firms operating in the mobile sector (*e.g.* hardware, software and handset vendors), mobile content providers, and end user benefits (*e.g.* increased productivity of mobile workers, increased access to employer, family and friends, and improved security). Similarly, Waverman *et al.* (2005) find that mobile telephony has a significantly positive effect on economic growth and that the effect in developing countries may be twice that in developed countries. Furthermore, as mobile telephony will increasingly be related to wireless broadband, future impacts may be even larger. Mobile phones increasingly constitute a working tool, not simply for communication but because of the increasing number of applications and tasks they support and the increasing capability for mobile Internet access. As mobile Internet access increases user flexibility in terms of time and location of use, it can be expected to add additional benefits

Wireless devices can also have a huge impact on productivity in transport, delivery and courier services, for example. Mobile broadband devices can help drivers to identify optimal routes, in terms of delivery points, distance, traffic congestion, etc., and increase the number of deliveries that can be made in a given day. Mobile devices, when used in conjunction with RFID technologies, for example, can also be used to download information about stocks in different sales/delivery points while "on the road" so that these can be managed more efficiently. As wireless technologies become increasingly widespread, their ability to function anywhere in real time constitutes an additional determinant of competitiveness.

The productivity impact of ICT and broadband-enabled globalisation

Some of the beneficial effects of ICT- and broadband-enabled offshoring in the services sector are emphasised by Mann (2003), who suggests that the globalisation of production of IT and ICT-enabled services should result in lower prices for ICTs and ICT-related goods and services, encouraging their diffusion and use throughout the economy and enhancing productivity. Abramovsky and Griffith (2005), in a study using data for the United Kingdom, argue that the positive effects from services offshoring arise in the form of productivity gains stemming from the increased fragmentation and specialisation enabled by ICTs.[23] Amiti and Wei (2006) also find positive effects of services offshoring on United States manufacturing productivity (contributing around 11% to labour productivity growth, *versus* only about 5% from materials offshoring).

Some studies have been devoted to the productivity impacts of services outsourcing and offshoring.[24] For example, Görg *et al.* (2005) find that plant-level heterogeneity matters when analysing the productivity effects of international services sourcing. Their plant-level study for Ireland takes characteristics such as plant ownership (domestic or foreign) and whether or not the plant is an exporter into account. They find positive effects from both material and services outsourcing, but only for foreign-owned exporting plants. While there is a positive effect from materials outsourcing for domestic exporters, no such effect is observed for services outsourcing. It is suggested that being part of a foreign multinational and an international production network may provide advantages such as better knowledge about how and where to procure competitively priced services, resulting in lower search costs. It may also provide negotiating advantages with suppliers, further lowering the price of intermediate services, and output economies of scale may lower the unit cost of sourced services.

Broadband thus appears to be very important for reaping potential benefits from ICTs. It is instrumental in efficiency and productivity gains and increased competitiveness not only from ICTs, but also from complementary factors that increase efficiency and raise productivity, such as innovation and organisational change.

Broadband and SMEs

SMEs are a very large share of OECD countries' businesses. In 2003, 99.8% of enterprises in the enlarged EU were SMEs (< 250 employees) and small enterprises (< 50 employees). They accounted for over 95% of manufacturing enterprises and an even higher share of many service industries. In many OECD countries, micro-enterprises (< 10 employees) account for more than 90% of enterprises in computer services and related activities, and for large shares of R&D and innovation. SMEs tend to generate two-thirds of private-sector employment, and are the principal creator of jobs. High firm entry rates have been recorded in dynamic services sectors, such as business services or ICT-related industries, health and age-related services.

ICTs and e-business applications can offer SMEs a wide range of benefits in terms of efficiency and market access, reducing costs and increasing the speed and reliability of transactions. However, even though ICT connectivity (PCs and Internet) is widespread in businesses of all sizes, small businesses tend to be slower than large ones to adopt new ICTs and e-business applications, mainly because of a perceived lack of applicability and uncertain returns (OECD, 2005; Vickery, 2005). In a survey conducted among UK SMEs by BT research,[25] 78% cited speed and flexibility as a reason for broadband uptake. Voice over Internet Protocol is used by 20% of SMEs and a further 23% indicated they intended using VoIP within a year, although use appears to decrease with the size of the SME.

The impact of ICTs on SMEs

ICTs and broadband allow SMEs to buy services they previously could not afford, for example, IT and IT-enabled legal, accounting, and advertising services, and managed services provided by broadband providers such as application service provision (ASP). A study by Analysis (reported in *The Register*, 2007) based on a survey of 184 SMEs in France, Germany and the United Kingdom estimated that SME spending on broadband-managed services was some EUR 5.7 billion in 2006 and was forecast to increase by more than EUR 4 billion in western Europe by the end of 2011.

Canadian survey data show generally high connectivity levels for Canadian businesses of all sizes, with broadband connectivity now the norm, and the use of ICTs, *e.g.* for Web site development and use and purchasing online has increased substantially over the period 2000-06. However, the growth of more sophisticated e-business activities, *e.g.* transactional applications like selling online, remains slow and concentrated among large firms and a few sectors. ICTs in general, and e-business activities in particular, affect productivity and competitiveness, and the lag in the adoption of e-business applications by SMEs, and the nature of the perceived barriers, raise concerns. Targeted sector-specific interventions may be necessary in some cases, both by governments and the private sector, to help SMEs in lagging sectors to increase and more efficiently use broadband (Neogi *et al.*, 2003; Neogi and Brocca, 2007).

At the same time, ICTs and broadband-enabled trade in services offer SMEs increased market access abroad and opportunities to become part of the value chain of production of other, larger firms. A survey by Value Leadership (2005) among European SMEs in the IT sector present in India found that the advantages included lower costs, ease of hiring talented workers (in fact, size, flexibility and quality of the labour pool was found to be at least as important as labour cost advantages), greater flexibility and scalability of operations, market access, and shorter product development cycles. Broadband also

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increasingly enables people to start small businesses from home, which can contribute to a more dynamic and entrepreneurial business sector. ICTs and broadband networks also increasingly allow small firms to increase their R&D activities and to participate in larger research networks (Hunt and Nakamura, 2006).

Conclusion

While ICTs have been employed for many decades, it is only relatively recently that widespread networking of ICTs has taken place, enabling them to play an increasingly pivotal role in an ever-rising number of activities. This development has been enabled and greatly enhanced by the roll-out of broadband Internet. Almost every aspect of economic activity and everyday life is affected by broadband-enabled ICTs, and rapid technological developments and a continuous stream of new applications mean that ICTs are likely to become even more pervasive.

There is significant heterogeneity in the use of ICTs and broadband at sector and firm levels, and optimal diffusion and use of these technologies would mean significant gains in terms of productivity and efficiency and overall welfare. For example, flexible working practices enabled by broadband can help to increase labour market participation and reduce problems related to transport (*e.g.* pollution and congestion). They can help address concerns related to ageing populations and improve functions in the health sector, for example by monitoring patients at a distance. On the other hand, global restructuring, and ICT-enabled offshoring and globalisation of the services sector, raises the challenge of how OECD countries should adjust to a new global environment with rapidly growing economies such as China and India, and deal with short-term adjustment costs in employment and the geographic location of economic activities.

The government's role in maximising the economic benefits of broadband is multiple. Policies and practices encouraging investment, innovation and competition in the development of infrastructures and the delivery of services should aim at reaching full diffusion and mainstreaming of ICTs and broadband where this has not already taken place. A competitive business environment is also necessary to stimulate productivity gains, innovation, and the development and delivery of improved products and services in flexible and efficient markets (see OECD 2008a). It is important that policies that facilitate change are accompanied with those supporting adjustment.

Governments help create the macroeconomic framework conditions for a favourable investment and innovation climate and they play an important role as regulators, in setting standards, as infrastructure providers, customers and, innovators. Government-funded basic research has often led to the development of ICT-related innovations (see Chapter 3). Overall, new broadband-enabled technologies and platforms, products and services, skills and jobs are changing the ways of consuming, producing and innovating and recent policies supporting these changes are discussed in Chapter 7.

Notes

1. The chapter does not look at the economic impact of e-commerce, the impact of broadband on business-to-consumer relations or on individuals (see Chapter 4), or the use of broadband by governments for on-line services. See the extensive review of broadband impacts and policies in OECD (2008a), *Broadband Growth and Policies in OECD Countries*, OECD, Paris (monitoring the Recommendation of the OECD Council on Broadband Development), and in OECD (2008c).

2. The *OECD Broadband Portal* provides access to a range of broadband-related statistics gathered by the OECD at *www.oecd.org/sti/ict/broadband*; see also OECD, 2007a.
3. Protecting users' security is crucial as the Internet is becoming *the* platform for voice, content, data and a core part of the economic infrastructure. Data security breaches in 2005 are estimated to have caused USD 100 billion in damages, more than the United States illegal drug trade (Swindle, 2006, p. 18).
4. And *vice versa* : ICTs without broadband would not nearly be as effective and transformative. As Atkinson and McKay (2007, p. 15) put it: "without a World Wide Web to connect to, many computing devices acted as nothing more than glorified typewriters".
5. However, asymmetric connections could become a bottleneck for multiple-play services that require fast upload speeds. The move towards more symmetric bandwidth as in fibre networks may be important as multiple play services increase usage of the upstream path (Okamoto and Reynolds, 2006).
6. Innovation can help address major global challenges such as climate change, energy security and health. It can help boost income and productivity growth, the key to fighting poverty and other social ills. Countries, regions, cities and firms can become more competitive, and better prepared to face the challenges of globalisation. These issues are being addressed in the OECD Innovation Strategy, launched in 2007.
7. Survey results for EU10 countries show that ICTs are a key enabler and driver of process innovation in most industries: 32% of firms (by employment share) had introduced "new or significantly improved internal processes" in the 12 months prior to the interview, and 75% of these claimed that these process innovations were "directly related to or enabled by ICT". *e-Business W@tch*, Chart Report 2006, Slide 8, *www.ebusiness-watch.org/resources/charttool.html*.
8. For example, the bulk of software patents in Europe are filed by companies whose primary activity is not in the software sector (Hall *et al.*, 2007).
9. See *www.businessweek.com/ap/financialnews/D8O5330O0.htm?chan=search*.
10. See *http://en.wikipedia.org/wiki/CANTAT-3*.
11. See *www.wsws.org/articles/2007/jan2007/taiw-j09.shtml*.
12. *Financial Times*, 29 December 2006.
13. See *www.businessweek.com/magazine/content/07_03/b4017068.htm?chan=top+news_top+news+index_businessweek+exclusives*, and *www.wsws.org/articles/2007/jan2007/taiw-j09.shtml*.
14. See *www.businessweek.com/magazine/content/07_03/b4017068.htm?chan=top+news_top+news+index_businessweek+exclusives*.
15. Röller and Waverman (2001), in a study for 21 OECD countries over a 20-year period, find evidence of a positive and causal impact of telecommunications infrastructure on economic growth, especially once a critical mass of infrastructure, which appears to be near universal service, is in place.
16. Labour productivity growth over the period 1995-2001 was 1.76% in Canada *versus* 2.49% in the United States, and the ICT contribution was 1.25% in Canada and 2.14% in the United States (Fuss and Waverman, 2006).
17. It is often argued (*e.g.* Lehr and Lichtenberg, 1999) that this productivity paradox is largely a measurement problem closely related to the problem of measuring output and productivity of the service sector. This is especially so since computers are used most intensively in the service sector and in the service functions of non-service sector firms (see for example van Welsum and Vickery (2005) and OECD (2004a, 2006a, Chapter 6). The same argument is likely to hold for broadband.
18. Joint OECD WPIIS/WPIE Workshop, "The economic and social impacts of broadband communications: From ICT measurement to policy implications", London, 22 May 2007. Presentations available at: *www.oecd.org/document/48/0,3343,en_2649_33757_38697712_1_1_1_1,00.html*.
19. The continued importance of using such indicators in analysis is shown in a recent study that found evidence of a link between IT intensity and productivity acceleration in the United States (Corrado *et al.*, 2007).
20. The potential impacts of broadband networks in health care are multiple. For example, patients have greater access to health-related information and opinion; medical research can be enhanced; grids and distributed computing allow faster and more complex calculations; diagnostics and second opinions are facilitated by electronic images; remote patient monitoring can reduce

congestion in hospitals and enhance the quality of care provided; better records may reduce the time patients have to wait, improve patient identification, drug prescription and avoid drug interactions; and medical records systems can improve the efficiency of hospitals and medical practices and save administrative costs (see OECD, 2004a, Chapter 5).

21. There are many applications and uses of ICTs in education which can be enhanced by broadband, from young pupils searching for information to do their homework to collaborative R&D networks; online education and tutoring; educational services and software; open and distance learning; production and access to academic and educational journals, and books, knowledge and research content. See also Brynjolfsson *et al.*, 2006, for "long-tail" implications of digitisation.

22. As ICTs are ubiquitous, merely investing in ICT is unlikely to yield a competitive advantage. Instead, performance differences depend on the way ICTs are used (*e.g.* Atrostic and Nguyen, 2006).

23. Abramovsky and Griffith (2005) report that establishments using the Internet outsourced about 10.6% more than those that did not. There is an endogeneity issue when firms start to use the Internet to place orders if they anticipate starting to out*Source:* using the Internet increased the probability of offshoring by about 2%. These results suggest that when a firm either invests in ICTs or uses the Internet it increases the probability of offshoring by 6%. When it does both the probability it offshores increases by about 12%.

24. In the absence of official data and measures on outsourcing and offshoring each of these studies use slightly different proxies, making comparisons difficult.

25. See *http://businessclub.bt.com/stateofthenation.pdf*.

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ISBN 978-92-64-05553-7
OECD Information Technology Outlook 2008

Chapter 7

ICT Policy Developments

Information and communication technologies are increasingly seen as a source of innovation, growth, and employment. ICT policies are being integrated into long-term socio-economic strategies and co-ordinated across government, but levels of co-ordination differ. This chapter outlines recent policy changes and continuities in national ICT policies. Highly prioritised policy areas include: fostering innovation in and through ICT R&D, improving online government activities, spreading broadband, increasing the diffusion and use of ICTs, raising ICT skills and employment, and supporting digital content development. Policies to promote RFID applications are relatively new, but dedicated programmes are in place in one half of OECD countries. Lack of consistency in policy assessment and evaluation remains an important weakness, including evaluation of broadband uptake and use.

Introduction

Information and communication technology (ICT) policies are increasingly integrated into overall strategies for enhancing economic growth, employment and welfare in OECD countries. They have shifted in the last decade from dealing with sector-specific infrastructure issues towards the formulation of long-term strategies on how ICTs, the Internet and other types of networks can enable information societies to achieve wider socio-economic objectives.

The *OECD Ministerial Meeting on the Future of the Internet Economy* in June 2008 underlined the importance of ICTs and the Internet as a fundamental economic infrastructure. The *Seoul Declaration for the Future of the Internet Economy*, adopted by 30 OECD member countries, nine non-member economies and the European Community, emphasised that ICT policies are no longer narrow sectoral policies but mainstream economic policies which encompass creativity, convergence and confidence.[1]

Replies to the OECD IT Outlook Policy Questionnaire 2008 indicate that governments continue to integrate ICTs into most aspects of business and societal activities, but challenges relating to policy assessment and evaluation remain. Most OECD countries aim to co-ordinate ICT policies with policies to support growth, generate employment, adapt education systems to reduce "digital divides", improve delivery of health care, and address emerging challenges. E-government activities are a part of strategies to boost public-sector efficiencies. ICTs are also increasingly used to address wider socio-economic issues at the national level (*e.g.* social cohesion, ageing societies, national security) and globally (*e.g.* climate change, energy-efficiency, global health issues).

This chapter first highlights current priorities in ICT policy-making and then describes the changing ICT policy environment in OECD countries. Next, it turns to a more detailed analysis of specific ICT policies and programmes. A discussion of national policy assessment and evaluation efforts is followed by the chapter's conclusion.

The analysis of trends in ICT policies and programmes is based on detailed information provided by all OECD countries.[2] Survey results have been analysed and published four times, beginning with the *OECD Information Technology Outlook 2002*. This makes it possible to follow over time the ICT policy environment covered by the survey: ICT innovation, diffusion and use of ICTs, the business environment, infrastructure and security issues of ICTs (see Annex Figure 7.A1.1 for areas covered).

Overview of ICT policy priorities and developments

Governments recognise ICTs' potential as a major driver of innovation and economic growth across industries. Strategies that aim to harness this potential are commonplace in OECD countries and encompass policies aimed at:

- Individuals and citizens (*e.g.* information technology education).
- Business and industry (*e.g.* technology uptake).

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- The public sector (*e.g.* government online activities and public sector transformation).
- Scientific research (*e.g.* broadband research networks and research clusters).
- Improving welfare (*e.g.* ICT R&D for better provision of health care or environmental performance).

Regardless of their level of development, most OECD countries are developing long-term ICT strategies. They typically aim to harness ICTs to promote economic growth and employment and increase welfare; those with more widespread technology diffusion, *e.g.* Finland, Japan and Korea, are weaving these strategies into broader visions of how information and communication technologies can transform virtually all areas of society.

The increasing focus on ICTs as drivers of socio-economic change has led to a somewhat decreased priority for more narrowly based improvements to the ICT business environment as compared with survey results described in previous editions of the *OECD Information Technology Outlook*. Governments continue to prioritise competition in domestic ICT industries, but there appears to be less formulation of new policies and more continuity in established policies. Moreover, ICT policies no longer concern the ICT sector alone, but increasingly target ICT-related developments in other sectors, *e.g.* the automotive and healthcare sectors.

Ranking ICT policy priorities

These trends are summarised in a composite ranking of replies to the OECD IT Outlook Policy Questionnaire 2008. Table 7.1 lists the top ten policy priorities (for a detailed ranking, see Annex Table 7.A1.1). The ranking is based on how many countries have specific ICT-related policies (see Table 7.2) and their level of priority (measured by the number of countries attributing high and increased priority, see Table 7.3). This section briefly outlines the most prominent policy areas and noteworthy developments with regard to policies not contained in the top ten.

Table 7.1. **Top ten ICT policy priorities, 2008**

1	Government online, government as model users
2	Broadband
3	ICT R&D programmes
4	Promoting IT education
5	Technology diffusion to businesses
6	Technology diffusion to individuals and households
7	Industry-based and on-the-job training
8	General digital content development
9	Public sector information and content
10	ICT innovation support

Note: For a detailed ranking, see Annex Table 7.A1.1.
Source: Based on detailed responses to the OECD IT Outlook Policy Questionnaire 2008.

At the top of the ranking stand **government online activities** and policies to promote **broadband uptake and use.** A majority of countries attribute high priority to both areas and they also featured prominently in past *OECD Information Technology Outlooks*, indicating the continuing importance given to bringing the public sector online and building a high-speed Internet economy to link citizens, business, researchers and the public sector

Table 7.2. **Summary of ICT policy replies, 2008, 2006, 2004 and 2002**

	Number of country responses			
	2008	2006	2004	2002
Co-ordination and priority setting	**29**	**22**	**22**	**20**
Fostering ICT R&D and innovation	**30**	**24**	**26**	**20**
ICT R&D programmes	24	22	26	19
Government development projects	20	20	21	12
Government ICT procurement	17	20	17	11
Venture finance	14	19	16	9
ICT innovation support	24	22	18	n.a.
Internationalisation of R&D and innovation	12	n.a.	n.a.	n.a.
Increasing ICT diffusion and use	**30**	**24**	**25**	**21**
Technology diffusion to businesses	27	20	21	20
Organisational change	19	14	10	n.a.
Demonstration programmes	19	17	10	17
Technology diffusion to individuals and households	28	20	21	20
Government online, government as model users	30	23	22	19
Government programmes to promote or encourage e-procurement and/or e-invoicing	22	15	n.a.	n.a.
RFID programmes[1]	14	n.a.	n.a.	n.a.
ICT skills and employment	**26**	**23**	**24**	**n.a.**
Promoting IT education	24	19	n.a.	n.a.
Industry-based and on-the-job training	19	10	n.a.	n.a.
Foreign workers	5	3	n.a.	n.a.
International sourcing	2	3	n.a.	n.a.
Improving labour market information	7	8	n.a.	n.a.
Digital content	**27**	**23**	**16**	**n.a.**
General digital content development	22	19	n.a.	n.a.
Public sector information and content	22	11	n.a.	n.a.
The ICT business environment	**22**	**23**	**25**	**20**
Competition in ICT markets	15	18	19	n.a.
Intellectual property rights	12	23	19	14
Trade and foreign direct investment	18	17	15	8
International co-operation	15	19	15	17
Enhancing infrastructure	**30**	**24**	**26**	**n.a.**
Broadband	30	23	24	n.a.
Electronic settlement/ payment	18	18	22	19
Standards	18	21	20	11
Policy assessment and evaluation	**28**	**15**	**17**	**n.a.**
Programme evaluation	26	15	n.a.	n.a.
Broadband uptake and use	24	5	n.a.	n.a.
RFID development and applications[1]	2	n.a.	n.a.	n.a.
Total responding countries	**30**	**25**	**30**	**21**

StatLink http://dx.doi.org/10.1787/477813236881

1. New policy area in the 2008 survey.
n.a.: not available.
Source: Based on detailed responses to the OECD IT Outlook Policy Questionnaire 2008.

(see also OECD, 2008a). There is increased focus on extending (affordable) broadband access to rural areas, to persons with special needs and to disadvantaged minorities.

Two specific policies to foster innovation in ICTs feature among the top ten: **ICT research and development (R&D) programmes** and **ICT innovation support.** The former is one of the most highly prioritised policy areas in the current survey and in previous *OECD Information Technology Outlooks*, highlighting the sector's role as a driver of scientific advances, innovation and economic growth. Small- and medium-sized enterprises (SMEs)

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engaged in ICT research are often a focus of policies designed to increase national innovation potential.

Beyond promoting ICT uptake in government, almost all respondents cite policies to promote **technology diffusion to businesses** and **to individuals and households** and the number of related policy programmes has gradually increased over time. Many OECD governments seek to increase the competitiveness of SMEs through effective use of ICTs, *e.g.* by supporting uptake and use of business intelligence applications. Moreover, even where high rates of Internet penetration and access have been achieved, policy makers continue to focus on individuals and households, *e.g.* with policies aimed at minorities and persons with special needs.

Specific policies to **promote IT education** and to encourage **industry-based/on-the-job IT training** have also featured prominently since the question was introduced in 2004. Governments promote overall ICT literacy through national education systems, but also focus on providing advanced skills to those already at work. This includes training civil servants but also encouraging business leaders to integrate skill formation in company ICT strategies. Other policies within the area of ICT skills and employment feature at the lower end of the overall ranking (see Annex Table 7.A1.1).

The ranking underlines the importance attributed to **general digital content development** and the growing importance of **public-sector digital information and content**. The number of related policies has risen since the question was introduced in 2004. In particular, the number of programmes for government content, including provision of information and policies for the free (or low-cost) reuse of government information has greatly increased.

The top ten do not include policies to enhance the ICT business environment, which appears lower in the overall ranking (see Annex Table 7.A1.1). The number of responses has declined and only around half of respondents indicate new developments in sub-areas. This can be partly explained by the effectiveness of earlier policies and is supported by Table 7.3, which shows that most countries continue their efforts in this area. Moreover, specific ICT policies may not always appear necessary as policies for overall business promotion also apply to the ICT sector and ICT policies are becoming part of mainstream general economic policies.

RFID programmes appear rather low in the overall ranking despite their implementations in around half of responding countries. The question was only introduced in the last questionnaire and their low priority is partly explained by some governments' preference to let the technology develop in the marketplace with little public intervention (see also OECD, 2008b, 2008c).

Policies to promote trust online often have high priority, especially as regards security of information systems and networks. This area is not included in summaries of the questionnaire as it features in only one section (see Table 7.3). OECD countries increasingly focus on protecting critical infrastructures (*e.g.* energy) through secure ICT systems and R&D activities into Internet security (see also Chapter 3). As Internet penetration and uptake among individuals grows, governments are increasing their focus on privacy and consumer protection in the Internet environment to underpin growth and ensure that offline policy and regulation, *e.g.* for consumer protection, is also applied online.

Table 7.3. **Summary of ICT policy priorities, 2008**

	High	Medium	Low	*Total*	Increased	Continued	Decreased	*Total (change)*
Fostering ICT R&D and innovation								
ICT R&D programmes	20	6	1	*27*	10	16	0	*26*
Government development projects	14	9	2	*25*	5	17	1	*23*
Government ICT procurement	8	13	3	*24*	10	11	1	*22*
Venture finance	7	11	8	*26*	9	15	1	*25*
Innovation networks and clusters	13	12	1	*26*	7	17	1	*25*
Increasing ICT diffusion and use								
Technology diffusion to businesses	18	8	2	*28*	8	19	0	*27*
Organisational change	6	14	7	*27*	6	19	1	*26*
Demonstration programmes	3	13	9	*25*	6	16	2	*24*
Technology diffusion to individuals and households	18	8	2	*28*	7	20	0	*27*
Government on-line, government as model users	23	5	0	*28*	11	16	0	*27*
RFID programmes[1]	3	5	15	*23*	3	16	1	*20*
ICT skills and employment	18	9	1	*28*	12	16	0	*28*
Digital content	14	11	3	*28*	12	16	0	*28*
ICT business environment								
Competition in ICT markets	12	11	3	*26*	8	16	0	*24*
Intellectual property rights	7	17	3	*27*	6	19	0	*25*
Trade and foreign direct investment	11	10	5	*26*	5	20	0	*25*
International co-operation	11	12	3	*26*	6	18	0	*24*
Enhancing the infrastructure								
Broadband	21	6	1	*28*	9	17	1	*27*
Electronic settlement/payment	12	11	4	*27*	7	17	2	*26*
Standards	16	8	4	*28*	8	18	1	*27*
Promoting trust online								
Security of information systems and networks	17	9	1	*27*	10	15	0	*25*
Privacy protection	14	10	3	*27*	7	18	0	*25*
Consumer protection	12	12	2	*26*	9	16	0	*25*

StatLink http://dx.doi.org/10.1787/477833175654

1. New policy area in the 2008 survey.

Source: Based on 28 detailed responses to the OECD IT Outlook Policy Questionnaire 2008, section "Current IT policy priorities and new directions".

ICT policy environment: Co-ordination and priority setting

Better co-ordination of ICT policies and clearer priority setting can help improve internal government efficiency as well as the effectiveness and coherence of policies (*e.g.* the impact on businesses and citizens). The survey asks governments to indicate the institutional settings and procedures for the formulation of ICT policies. The number of responses has increased over the years, suggesting a greater focus on mainstreaming national ICT policies and improving the overall efficiency of delivery, but the level and extent of co-ordination varies among countries.

Efficiency of ICT policy making

Public authorities and government organisations are taking more steps to co-ordinate and set priorities in order to avoid overlapping and sometimes duplicating ICT initiatives, but most countries still have rather decentralised structures for formulating and implementing ICT policies. Co-ordination is however gaining in importance as ICT policies increasingly seek to address wider socio-economic objectives and involve ministries and agencies, such as employment, social security, and education ministries, that have not traditionally been the source of ICT-related policies.

Japan and Korea, two countries with a high level of technology diffusion, have established central government institutions to formulate ICT policies and oversee their implementation across ministries. Japan's IT Strategic Headquarters and Korea's Informatisation Promotion Committee have been active for some years and are chaired by each country's prime minister. Other countries have established advisory bodies that co-ordinate the implementation of ICT policies across government. Some report directly to the prime minister (*e.g.* Ireland, Turkey) while others are located in a ministry or government agency (*e.g.* Denmark's Council for ICT, Finland's Advisory Board for the Ubiquitous Information Society, Switzerland's Interdepartmental Committee for the Information Society and non-OECD member Singapore's Infocomm Development Authority). With the change of government, Italy has formulated policies for innovation and re-organisation in the public administration, judicial and education systems, including increased broadband deployment and improved public sector connectivity.

The majority of countries, however, have adopted a decentralised approach to priority setting of ICT policies. While this may be of advantage in some respects, ICT policies require broader *ad hoc* co-ordination because they touch upon many ministries' portfolios and two or more ministries are often in charge of different issues, such as infrastructure, e-government, applications and uptake, science, research and higher education, skills and employment.

Centralised ICT procurement is another way to increase organisational efficiency as it helps governments to reduce ICT investment costs and avoid redundant or incompatible purchases. Examples include Finland's central procurement unit "Hansel", the US "SmartBuy" programme for commercial software, and the Czech Republic's government's electronic marketplace. Some countries without such measures point to the risk of ICT procurement being poorly co-ordinated and not taking into account broader objectives of ICT policies as well as government efficiency.

Effectiveness of ICT policies

Long-term strategies for information economies/societies are linking ICT and Internet-related policies with strategies to promote a range of socio-economic objectives (see Box 7.1). Mainstreaming of ICT policies is not new, but the scope and implications of ICT-related policies have continuously widened. Whereas the 2002 and 2004 editions of the *OECD Information Technology Outlook* highlighted countries' focus on ICT policies to foster economic growth and employment, the 2006 edition showed that the focus had shifted towards using ICTs as an agent of change and societal transformation, a trend that continues in 2008. Policies seek to exploit the Internet and other forms of networks to stimulate national innovation potential in many areas.

To increase overall policy coherence, some OECD countries have shifted the focus of ICT policies from simple development and diffusion to the promotion of ICTs as part of the overall socio-economic context. The u-Japan policy, for instance, regards ICTs and particularly network-based services as a key enabling technology. It builds on results achieved through the "e-Japan" strategy (in place until 2006), which focused on advancing broadband infrastructures and exploring applications. Similarly, Finland's National Knowledge Society Strategy and the u-Korea Master Plan were built on the

Box 7.1. **Achieving socio-economic objectives**

A growing number of countries adopt ICT policies to address key issues such as economic growth, sustainable development, and improving social welfare.

Denmark: The "Action Plan for Green IT" contains initiatives to mitigate the environmental impact of ICT deployment and to exploit ICTs' huge potential for enabling other industries to reduce their environmental impact. The plan highlights the leading role of the Ministry of Science, Technology and Innovation in applying such measures.

Japan: The u-Japan policy aims at widespread diffusion of broadband applications and network-based services to create a "ubiquitous network society" by 2010. Seamless networking is a key element in this vision which encompasses objectives relating to health care, inclusiveness, the environment and public safety.

Korea: The u-Korea Master Plan aims to build a "ubiquitous society" by 2010. ICTs are seen as the key to exploiting the country's innovation potential in various industry sectors and for socio-economic applications.

Turkey: The Information Society Strategy (2006-10) has as major focus areas: development of an effective ICT infrastructure and a competitive industry, promotion of ICT R&D, use of ICTs to increase competitiveness across industries; facilitation of public sector reforms and widespread social transformation.

Source: Responses to the OECD IT Outlook Policy Questionnaire 2008.

results of earlier policies that helped to develop ICTs in a national context and promoted their uptake.

Measures to ensure policy coherence between ICT policies and attainment of long-term socio-economic objectives often include a focus on:

- Joint innovation activities in high-technology areas, including ICTs and nanotechnology, biotechnology, and medical research, through co-ordination with ministries for science and technology, research, higher education, etc.
- Technology uptake in industry sectors not typically covered by ICT policies, *e.g.* business intelligence software across industry sectors.
- Government leadership, *e.g.* by acting as model users.
- Co-ordination with stakeholders, *e.g.* public consultation processes in the drafting of legislation.

Specific ICT policies and programmes

This section covers six areas in more detail: fostering ICT innovation, increasing diffusion and use, skills and employment, digital content, the ICT business environment, and enhancing the infrastructure. Promoting trust online is not covered in detail in the policy questionnaire, but countries indicated their priorities in this area along with other ICT policy priorities (see Table 7.3).

Fostering ICT R&D and innovation

Fostering ICT and ICT-related research and innovation are of major importance for economic growth, boosting national innovation potential, and stimulating supply of and demand for highly skilled labour. For the first time, all responding OECD countries reported

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dedicated policies to support ICT innovation. This includes domestic programmes to support ICT-related R&D and measures to provide ICT innovation support.

ICT R&D programmes

Policies for ICT R&D are a top priority for respondents to the 2008 survey. A total of 23 countries point to a policy in place (Table 7.2) and 20 gave the area high priority (Table 7.3). Within the OECD, only the Czech Republic, Greece, Hungary, Iceland, the Slovak Republic and Sweden do not attribute high priority to this area. In previous years many countries supported the area as part of general science and technology (S&T) policies, but they increasingly establish R&D programmes that explicitly promote ICT-related R&D. As part of a focus on enhancing competitiveness, SMEs are often targeted by ICT R&D programmes. This can include facilitated bidding for public R&D tenders and joint research conducted by public and private research institutes, governments and SMEs.

The form of ICT R&D programmes varies, and it is difficult to pinpoint a specific determinant. In 2004, a dividing line was visible between countries with higher GDP per capita which had dedicated ICT R&D programmes and countries with lower GDP per capita which embedded such programmes in national S&T strategies, but this line has now blurred. On the one hand, the United States has had a large ICT-specific research programme in place for a long time, while countries such as Germany and Norway have recently implemented such programmes (see Chapter 3). On the other hand, ICT-related policies are a major pillar of S&T policies in Canada, Finland, Japan and Spain, countries with high GDP per capita. In fact, the funds allocated to the Networking and Information Technology Research and Development (NITRD) programme in the United States and to the ICT branch of Japan's S&T strategy are comparable, suggesting that a distinction in terms of funding and impact may be more apparent than real.

Survey replies underline two trends identified in Chapter 3 of this volume: *i)* increased channelling of support mechanisms towards specific goals and instruments (*e.g.* to foster research into digital content technologies, embedded systems and software); and *ii)* an expanded focus on public-private co-operation in applied ICT research to further socio-economic goals, *e.g.* improved health care, environmental protection. Details and outcomes of such focused policies are discussed in Chapter 3.

Government development projects

Government development projects are mostly geared towards the provision of public services online. This is not a new trend; already in 2004 most countries focused on developing e-government applications and services, *e.g.* electronic authentication and tax filing. A few countries report no particular government development projects as systems have been in place for a number of years, *e.g.* for electronic payments and revenue collection in Finland.

An increasing trend is the employment of e-health strategies, mostly in the form of pilot projects rather than fully implemented policy measures (Box 7.2). Nonetheless, such projects can have a major impact on the use of ICTs and the Internet beyond the health-care sector.

Box 7.2. **Government e-health projects**

Germany is upgrading its system of electronic health insurance cards for cross-institutional co-operation between patients, practitioners, hospitals, pharmacies and health insurance funds. The new e-Health cards are expected to lead to more comprehensive ICT applications, *e.g.* electronic health records. Also, electronic prescription handling is reducing side effects and undesirable interactions of pharmaceutical products and providing efficiency gains.

Mexico envisages ICTs as a key enabler to modernise health-care management within the national health-care system at federal and state levels. The programme foresees integrated information systems for practitioners, electronic health-care records, a public health-care portal for citizens, continued education of health-care staff.

The **United States** has set the goal of providing most Americans with an electronic health record by 2014. In line with this goal, the Department of Health and Human Services (HHS) issued a strategy on how to improve health-care systems and population health by 2012 through the use of ICTs. The strategy defines objectives in four categories: interoperability, adoption, collaborative governance, privacy and security. From 2009, a Nationwide Health Information Network (NHIN) is expected to be used for health data exchange.

Source: Responses to the OECD IT Outlook Policy Questionnaire 2008; United States Department of Health and Human Services, 2008, "The ONC-Coordinated Federal Health Information Technology Strategic Plan: 2008-2012", *www.hhs.gov/healthit.*

Government ICT procurement

Government ICT procurement policies aim primarily to improve public-sector efficiency, reduce procurement costs, ensure interoperability and enhance the integrity of systems in place. They can also be a tool to increase innovation in the business sector by co-ordinating procurement of IT systems and services with overall ICT policy goals, *e.g.* in order to foster specific technology developments. A total of 17 countries mentioned ICT-specific government procurement policies (Table 7.2) and ten reported that they were of increased importance (Table 7.3). Examples include preferential access to public procurement for SMEs (Australia); agreements between IT companies and governments for preferential purchase terms and training programmes for civil servants (Greece). Countries such as Sweden accentuate the neutrality of their procurement procedures, *i.e.* decisions on government procurement are based only on price; Switzerland and Finland indicate similar approaches.

Governments continue to focus on open source applications in ICT procurement and a number of countries actively promote these (see Box 7.3). They are often seen as a means of increasing competition in ICT markets, enhancing interoperability, improving the security and effectiveness of the public administration, *e.g.* in data exchange.

Venture finance

Around half of the countries surveyed in 2008 have ICT-specific venture finance initiatives. While most indicated medium priority, one-third attributed increased importance to policies and programmes to encourage risk investment in the ICT sector. Venture finance programmes include public-sector start-up and growth funds, facilitation and support for partnerships between companies and investors, programmes to foster spin-offs from research organisations, and support for venture capital firms (see Box 7.4).

Box 7.3. **Open source applications**

Out of 30 countries, 14 indicated having specific policies or programmes relating to open source applications (Austria, Belgium, Denmark, Germany, Hungary, Italy, Japan, Korea, the Netherlands, Norway, Portugal, the Slovak Republic, Switzerland, Turkey). In the *OECD Information Technology Outlook 2002*, there were only eight. Governments can promote open source developments in a variety of ways, many of which are directly related to government ICT procurement. Other policies aim at diffusing open source technologies more generally and creating frameworks for effective deployment in the public sector.

Front-end software and back-office applications (operating systems, databases, middleware)

Austria: The Vienna city government uses WIENUX, a client operating system based on the Debian GNU/Linux distribution. Open source software is also being used for various front-end applications such as Internet browsers, e-mail and SAP client software.

Germany: Open source software is used to combine geographic maps with public information in some German cities (*e.g.* Bonn, Mainz, Nuremberg) for electronic citizen and visitor services.

Government institutions as open source repositories and knowledge providers

Denmark: The National IT and Telecom Agency (NITA) operates an open source software exchange, *Softwarebørsen* (Software Exchange). The repository provides the public sector with project management tools for sharing open source software.

Italy: Italy established an Internet repository for the development of open source software for public administrations. The Ministry for Innovations in Public Administration launched the website for the project called *Ambiente di Sviluppo Cooperativo* (Environment for Co-operative Development).

Turkey: The Ministry of National Education together with IBM co-founded the Public Sector Linux Competency Centre. The centre provides Linux training for technical staff of government institutions.

General open source policies

Japan: The Ministry of Economy, Trade and Industry (METI) promotes pan-Asian research on open source software for multilingual information processing. The aim is to enhance the circulation of information in various languages within Asia's multi-language environment.

Korea: Korea supports domestic open source development communities and the Northeast Asia Open Source software Promotion Forum for exchanging information and related policy among Korea, Japan and China.

Netherlands: The programme Open Source as Part of the Software Strategy focuses on the implementation of open source software within government ministries.

Switzerland: As part of the country's open source strategy, Switzerland commissioned a study to assess the legal impact and requirements for public procurement of open source applications. It provides the legal framework for public ICT procurement with regard to open source applications.

Source: Responses to the OECD IT Outlook Policy Questionnaire 2008; official sources.

Box 7.4. **Venture finance policies**

Hungary: The Hungarian Investment and Trade Development Agency mediates between Hungarian IT firms and venture capital investors, collecting business plans and forwarding them to the major international high-technology funds. Additionally the Hungarian Development Bank has various capital development programmes for IT companies.

Korea: The Ministry of Information and Communication (MIC) (partly replaced by the Korean Communications Commission), in co-operation with the private sector, established an investment corporation which focuses investments on SMEs in the ICT sector. The ministry also supports training on investment screening and provides information on market and technology trends and various legal issues.

Source: Responses to the OECD IT Outlook Policy Questionnaire 2008.

Government-sponsored venture capital funds are often managed independently and typically co-invest with business angels or other private and public capital sources. Venture finance initiatives are often combined with goals such as fostering ICT R&D (*e.g.* Austria's PreSeed IT and Physical Sciences), supporting SMEs (*e.g.* Enterprise Ireland), or fostering regional development (*e.g.* Italy's High-Tech Fund).

ICT innovation support

Most respondents mentioned programmes to support innovation in ICTs through the establishment of clusters of firms and innovation networks. Countries' approaches to cluster development vary largely, but they typically establish centres of competence and technology parks along sector value chains and across sectors and combine them with policies for regional economic development. Examples include the competitiveness clusters (*pôles de compétitivité*) in France and Japan's Okinawa Development Plan to cluster international ICT businesses. To help industrial and academic research communities to co-ordinate their activities, the European Commission supports a number of European technology platforms, *e.g.* the Networked European Software and Services Initiative (NESSI).

Internationalisation of R&D and innovation

At least 12 OECD countries have measures to promote cross-border R&D and innovation in ICTs. Japan, for instance, has initiated a collaborative project to develop ubiquitous networking technologies that allow for seamless access to context-sensitive information in any of Asia's languages. Denmark has developed a strategy for scientific collaboration with China which includes ICTs as one of the key areas and is partly co-ordinated by the Danish Innovation Centre in Shanghai. The European Union encourages pan-European collaboration in ICT-related R&D, *e.g.* via an initiative called Co-ordination of the Information Society Technologies Research and National Activities (CISTRANA). Moreover, a number of countries cite initiatives to attract research laboratories of multinational ICT companies (*e.g.* Korea, Singapore, Turkey).

Increasing ICT diffusion and use

Technology uptake is essential to the success of information societies/economies and governments play a role through both enabling policies and their own use of ICTs. All responding countries have initiatives in place with a focus on government activities online as well as technology diffusion to businesses, individuals and households. Organisational change and demonstration programmes are commonplace, but usually of medium priority. Programmes to promote RFID technologies are in place in around half of responding countries. Business leaders are often seen as potential multipliers of government efforts to increase technology diffusion to employees through top-down approaches (see the section on ICT skills and employment and OECD, 2005).

Technology diffusion to businesses

Almost all respondents mentioned initiatives for technology diffusion to businesses. The focus has shifted from basic technology diffusion (PC and Internet usage) to more complex applications. The Korean Ministry of Commerce, Industry and Energy, for instance, established a programme to promote inter-company integration of product design and manufacturing processes, RFID usage, and supply-chain management systems. At the same time, governments continue to focus on the adoption of ICTs by SMEs, as in earlier surveys (see Box 7.5).

Box 7.5. **Business innovation in SMEs**

Austria's Protec II programme supports the implementation of ICT-aided strategic product development in SMEs and is based on the recommendations of an evaluation of its predecessor programme Protec 2002+.

France's *TIC-PME 2010* (ICTs-SMEs 2010) aims to advance ICT uptake in SMEs. Measures include ICT training for SME managers and directors, uptake of software for business intelligence and enterprise resource management.

Japan's Ministry of Economy, Trade and Industry (METI) supports ICT diffusion to SMEs, *e.g.* through best practices, facilitation of IT investments, ICT training of managers and chief information officers, and technology uptake. METI aims to achieve an ICT uptake within basic business processes in 60% of medium-sized enterprises by 2010 and an uptake of e-commerce by 50% of trade partners of SMEs.

Korea's SME Production Digitalisation Project introduces measures to lower initial investments and maintenance costs for SMEs which are clearly lagging major companies in using ICT solutions for business operations (*e.g.* integrated systems for supply-chain and customer-relationship management).

Spain's *Avanza* Plan is intended to increase the use of ICTs in SMEs. The aim is to connect to the Internet 99% of companies with over ten employees and 79% of micro-businesses and self-employed. It also promotes the integration of ICTs in business processes, *e.g.* electronic invoicing.

Source: Responses to the OECD IT Outlook Policy Questionnaire 2008.

Organisational change

The share of countries citing programmes for organisational change has increased since 2004 when the area was added to the questionnaire (Table 7.2) and a majority of countries report continued efforts (Table 7.3). Measures promoted include telework applications, improving working conditions through ICTs and changing managerial behaviour in both the private and public sector to make more effective use of ICTs, often to achieve wider goals such as raising productivity or tackling socio-economic challenges such as climate change. Although the uptake of telework has been rather slow, governments still refer to its importance, *e.g.* in combating climate change, as in Denmark's recent Action Plan for Green IT, or Ireland's Work Flow project. In another instance, the Slovak Republic amended labour laws in 2007 to lay down provisions for a widespread introduction of telework.

Policies also focus on organisational change at managerial level in the private and public sectors in order to provide information on how process efficiency can be improved by introducing ICT solutions throughout an organisation. The Japanese Ministry of Economy, Trade and Industry, for instance aims to raise acceptance of ICTs in major companies by promoting the establishment of chief information officer (CIO) posts in firms in all sectors. In the United Kingdom, the government launched a scheme to recruit technology graduates to foster organisational change through the use of advanced ICTs in the public sector.

Demonstration programmes

The number of countries with demonstration programmes is largely the same as in 2006 (Table 7.2). This policy area is not highly prioritised: half of the countries give it medium priority and nine low priority (Table 7.3). Demonstration programmes can be general, like Portugal's DEMTEC programme, which supports pilot projects for diffusing knowledge about technologies; or they can be dedicated, like the Finnish VAMOS programme for demonstrating the potential of mobile applications for providing added value to businesses. Governments can also set an example by implementing ICT standards in their organisations, *e.g.* the shift to IPv6 in public administrations (see the section on standards).

Technology diffusion to individuals and households

The number of policies and programmes which seek to increase diffusion of ICTs to individuals and households has increased continuously since 2004, at the same pace as policies for diffusion to businesses (Table 7.2). Both areas are highly prioritised (Table 7.3).

Overall uptake of ICTs, *e.g.* computer literacy and broadband, is increasing in OECD countries, but differences in income, education and gender are creating new kinds of "digital use divides" (see Chapter 4). Consequently, the focus has generally shifted from promotion of overall ICT penetration at home, work, schools and public access points (although programmes to foster public Internet access points are still being formulated, *e.g.* Poland's Ikonka project) towards inclusion of hard-to-reach groups (*e.g.* the European Commission's e-inclusion campaign) and the development of digital products and services.

Effective policies typically focus on promoting both the supply and demand sides of technology uptake by individuals. Spain's *Ciudades Digitales* (Digital Cities) programme, for instance, stimulates the development and provision of public electronic services, particularly in small municipalities. To encourage demand, the government offered credits for computer equipment and broadband subscriptions at zero interest rates which amounted to EUR 700 million in 2007.

Government online, government as model user

All responding countries use the Internet for internal and external communication as well as to provide public services, but the level of implementation varies. Only a few countries indicate a widespread shift towards integrated information management and user-focused e-government (*e.g.* Canada, Japan, Korea, New Zealand, Norway). Many countries still replicate existing service procedures online, so that the potential for using the Internet and ICTs to link e-government activities with wider public-sector changes remains unexploited (see also OECD, 2007c, 2008a).

The number of recent initiatives is large even though governments have long used the Internet to enable activities such as filing of forms, tax declarations, business registration, or social security services. Particular emphasis on this policy area is set in the Czech Republic, Hungary, Poland and the Slovak Republic, where e-government activities are regarded an integral and sometimes pivotal element of overall information society strategies. On the other hand, Australia, Austria, Canada and Finland, which have long led e-government developments, reported no significant recent policy measures in this area.

Many countries continue to focus on e-government activities as part of an overall transformation of the public sector, *e.g.* increased availability and transparency through one-stop shops on the Internet or improved inter-organisational collaboration and co-ordination of service delivery and delivery channels. Canada and Norway, for example, have with notable success shifted from government-centric to citizen-centric approaches, *e.g.* by measuring user satisfaction and conducting e-government audits. Japan and Korea have formulated policies to further government usages of ICTs for citizen services, improved business processes, back-office integration of government systems, ICT training of civil servants, and reliability and security of government services.

Some countries cite programmes to improve e-government access on a technological level: Italy initiated the *Italia Utile* (Useful Italy) portal, which provides services to citizen via digital terrestrial television; in Norway citizens can file income tax returns via short-messages service (SMS); and non-OECD member Singapore also provides a range of government services via SMS.

Government programmes to promote or encourage e-procurement and e-invoicing

The number of policies to promote e-procurement and e-invoicing by business has increased since the question was first asked in 2006; in the 2008 survey 22 countries cited such measures (Table 7.2). Apart from technology diffusion, these programmes help increase efficiency and transparency of public procurement. While advantages of e-invoicing are typically recognised, the Slovak Republic, for its part, leaves this to businesses.

Public e-procurement and electronic tendering help to promote uptake of e-procurement and other e-business transactions in the private sector. In recent years, a growing number of OECD governments have shifted towards e-procurement of tenders or are in the process of doing so, *e.g.* Belgium, the Czech Republic, Japan, the Slovak Republic. Where e-procurement has long been in place, policies aim to improve their effectiveness. The Korean government, for example, established an Internet-based call centre, installed customer-relationship management (CRM) applications, and recently launched mobile procurement solutions to encourage wider use of e-procurement. The United States set up an Integrated Acquisition Environment to consolidate information systems related to federal acquisition processes.

Denmark and Sweden have shifted towards full electronic invoicing among public authorities and the European Commission is developing a European e-invoicing

Framework (EEI) to create a legal framework and common standards for e-invoicing between business partners in the context of the Single Euro Payments Area, due by 2010.

RFID programmes

Countries were first asked in the current survey to provide information about RFID programmes and 14 responses were received (Table 7.2). Japan, Korea and the Netherlands give RFID high priority and Canada, the Czech Republic, Germany, Portugal and Spain give it medium priority. The priority has increased in Korea, Mexico and Portugal. However, most countries still regard it as low priority area and Sweden, for its part, prefers little public intervention in the development of the technology (see also OECD, 2008b, 2008c).

Given the very recent expansion of RFID applications, policies in this area mostly focus on creating national centres of excellence and online information portals, sponsoring pilot projects and R&D programmes, promoting best practices, and exploring privacy concerns and frequency issues (see Box 7.6). A number of governments have singled out RFID as an important area of research in their current ICT R&D programmes (*e.g.* Germany's ICT 2020).

Box 7.6. **Supporting RFID applications**

Korea's government is pursuing various initiatives to support RFID uptake: Songdo, Incheon, will be a geographic cluster for R&D and business co-operation on RFID. The government has promoted RFID pilot projects in various sectors, including procurement, defence and environment, which have led to guidelines for organisations and companies planning to adopt RFID-based services.

In **Mexico** the government has applied RFID technology in the health sector for patient cards. The Ministry of the Economy's PROSOFT fund aims to improve the competitiveness of the country's software industry through support for the development of RFID-related applications.

Singapore's National RFID Centre operates a central Internet portal where results from deployment trials and pilot projects are publicly available. The website lists best practices by different industry sectors and provides contacts to a network of national RFID experts and businesses. The centre focuses on applications across industry supply chains, provides funding to pilot projects, establishes networks of experts, conducts training for companies wishing to apply RFID technologies, and demonstrates and promotes R&D results from its network of research institutes.

Switzerland: A number of Swiss institutions have initiatives to discuss different aspects of RFID deployment, mostly in the context of pervasive computing. The Risk Dialogue Foundation developed a guide for responsible use of pervasive computing in co-operation between industry, academia and the public sector.

Source: Responses to the OECD IT Outlook Policy Questionnaire 2008.

ICT skills and employment

Widespread development of ICT skills is crucial as ICTs have become an integral part of professional and personal life in information economies. However, many OECD countries face shortages of highly skilled labour and research personnel for the ICT sector despite weakening labour markets. In this survey, more countries than in 2006 indicated having specific policies in place (Table 7.2) and the more gave it high priority as well. Only Sweden attributes low priority to this policy area.

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OECD countries clearly focus on policies to promote overall IT education and industry-based/on-the-job training. Foreign workers, international sourcing and improving labour market information typically attract considerably less attention.

Promoting IT education

Promotion of IT education is seen as essential to achieving the long-term objectives of information economies/societies. Around 80% of respondents pointed to policy programmes in this area, a share similar to the 2006 survey. Policies geared towards the reduction of "digital divides" and an increase in the supply of highly skilled labour and researchers include broadening and deepening primary/secondary education in this area, reviewing and updating advanced education curricula, and tackling structural challenges.

Primary and secondary education. Promoting IT in primary and secondary education comprises two interlinked dimensions: *i)* ICTs in the curriculum and *ii)* ICTs in the classroom. A number of countries specifically include ICT skills in school curricula, sometimes as part of the natural sciences. Norway's strategy, An Information Society for All, for example, has developed a school curriculum that makes the ability to use digital tools one of the five basic skills to be obtained through primary and secondary education.

Greater focus, however, is set on the provision of ICT education through technology diffusion in classrooms and skills training for teachers. New Zealand's Digital Strategy aims to have e-learning activities applied across subjects by 2010 and provides teachers' fellowships for making effective use of these technologies in classrooms. The target of Spain's *Avanza* is to supply all state schools with broadband access and multimedia applications by 2008 along with the corresponding teacher education. Switzerland's *Schule im Netz* (School on the Net) programme provided ICT training for teachers over a six-year period and its impact was recently evaluated. Furthermore, the Swiss Education Server has since 2001 published a monthly newsletter on ICTs in education. The US National Science Foundation (NSF) recommends addressing changes in education due to the Internet and ICTs, *e.g.* by integrating virtual worlds for guided inquiry and experimentation.

Advanced education. Reaping the economic and social potential of ICTs depends on a highly skilled workforce in various disciplines. Many OECD countries have been under pressure to find immediate solutions to short- and medium-term skill shortages and mismatches in the ICT sector. A number of structural challenges are being addressed to increase the appeal of ICT-related professions and some governments are tackling low female ICT-related participation rates in ICT businesses and the research community, and among students (Box 7.7; see also OECD, 2007a).

Learners with special needs. National policies to increase the ICT skills of other under-represented or structurally disadvantaged groups target:

- The long-term unemployed – the Slovak Republic's "National eInclusion Strategy" aims to address the particular needs of the unemployed and those with low levels of education.
- The elderly – Switzerland's "Swisscom Help Points" train the elderly in the practical use of mobile phones and the Internet.
- Persons with disabilities – Hungary's "e-Accessibility" programme aims to promote ICT education and the uptake of telework for the disabled.

Box 7.7. **Increasing the appeal of ICT-related professions**

OECD governments are looking for effective ways to stimulate the supply of highly skilled professionals in science, technology, engineering and mathematics (STEM), including ICTs. A sustainable supply of skilled labour is crucial to realising the socio-economic objectives of information economy strategies. To deal with shortages, governments are increasing efforts to raise the appeal of ICT-related professions and research paths to young people and especially to women, a structurally underrepresented group.

Australia's government-commissioned report "Building Australian ICT Skills" identified an outmoded perception of ICT careers and a lack of understanding in schools and communities about the diversity of professional opportunities in the sector. According to the report, there is an urgent need to address this issue among young people and among those who influence future career choices, *i.e.* parents, teachers, career advisers.

As part of **Germany**'s High-Tech Strategy, the government aims to increase the share of women in ICT-related professions and research. For long-term impact, the government is co-sponsoring an annual Girls' Day on which pupils learn about various professions and university subjects; the ICT industry is one of the focus areas.

Ireland runs the Discover Sensors project in around 200 schools to enable "real science" learning in the classroom and sharing these experiences over the Internet. The government also co-sponsors projects such as ChooseIT, an Internet portal to promote ICT-related professions, and Women in Technology and Science, which provides professional role models to female students in scientific disciplines.

In the **United States**, recent reports by the National Science Foundation highlight the importance of diversifying the skills profiles of ICT-related studies in order to increase their appeal, *e.g.* through training in management and marketing. The NSF sees this as important to support "adaptive leaders" who can develop and implement complex engineering applications to achieve the socio-economic objectives of the information economy.

Sources: Australian Department of Communications, Information Technology and the Arts, 2006, "Building Australian ICT Skills", Commonwealth of Australia; German Federal Ministry of Education and Research, 2007, "ICT 2020. Research for Innovations", BMBF, Bonn; Ireland Discover Science and Engineering (DSE), *www.discover-science.ie*; United States National Science Board, 2007, "A National Action Plan for Addressing the Critical Needs of the US Science, Technology, Engineering, and Mathematics Education System", National Science Foundation, Arlington, VA; United States National Science Board, 2007, "Moving Forward to Improve Engineering Education", NSF, Arlington, VA.

While these individual activities and programmes are important, they need to be integrated into overall policies to increase the supply of ICT-skilled labour and to extend their reach.

Industry-based and on-the-job training

A majority of governments cite on-the-job and industry-based training initiatives, but less than programmes to promote IT education overall. Responses primarily focus on two key groups: *i)* training civil servants and *ii)* encouraging management to integrate skill formation more effectively in their overall strategies. Governments see IT-related training in the civil service as essential to diffuse knowledge about ICT applications as well as to modernise work processes.[3] Most OECD countries are funding ICT training to enhance civil servants' skills profiles, *e.g.* the European Computer Driving Licence or its international version in countries such as Australia and the United States.

Governments typically lend support to professional bodies and industry associations for apprenticeship programmes and national awareness campaigns. They also support industry-tertiary education partnerships that aim to increase the supply and skill sets of highly skilled personnel.

Business leaders are sometimes targeted as part of a "top-down" approach to the diffusion of ICT skills in companies. Singapore's CXO programme, for instance, provides assistance for firm-wide technology uptake to increase employees' ICT skills but also to expand the amount of workforce available, *e.g.* through telework.

Foreign workers

Many OECD governments emphasise an insufficient supply of highly skilled workers for ICT industries and research, but only a handful cited recent policy initiatives to attract foreign workers (*i.e.* "bringing workers to the work") although many explored this option during the skill shortages of the late 1990s and early 2000s. For instance, the Danish government recently proposed amendments to its Green Card scheme in order to attract qualified foreign workers into the ICT sector and Germany's High-Tech Strategy underlines the importance of foreign ICT specialists and scientists as a way to satisfy domestic demand for skills. Most countries address shortages in the sector through policies targeting technology jobs and academic research more generally.

International sourcing

Policies for international sourcing of ICTs skills and services (*i.e.* "sending work to the workers") do not feature high on government agendas. Most countries indicate that it is not a separate policy but part of more general economic adjustment policies.

Improving labour market information

Connecting job seekers with job offers is greatly facilitated by the Internet, and governments and/or national labour market institutions have long-established Internet portals that provide job search and advisory services. The European Job Mobility Portal (EURES), for instance, facilitates the dissemination of information on national labour markets, living and working conditions, employment opportunities, etc., across Europe. ICT-specific labour market information is typically part of national labour market information services, *e.g.* Skills Australia or the United States Department of Labor's Industries at a Glance portal.

Digital content

Digital content is an increasingly pervasive aspect of socio-economic developments, and creative industries and activities are regarded as strategic in information economies (see Chapter 5 for a discussion of selected digital content industries). In this survey, 27 out of 29 responding countries reported specific initiatives for digital content, a continuation in importance from 2006 and a considerable increase from 2004, when just over half of responding countries had such initiatives (Table 7.2). Whereas in previous years policies concentrated on general digital content development, initiatives for the creation or reuse of government content have gained in importance: in 2008 over 70% of respondents had policies in place compared to less than half in 2006.

General digital content development

A wide range of direct and indirect government measures affect digital content development (see Box 7.8). For example, policies in Canada, Denmark and the United Kingdom target domestic games and interactive media developers. They are often co-ordinated with general business incentives, *e.g.* funds for SMEs or ICT R&D and innovation policies, *e.g.* initiatives geared towards developing mobile entertainment, semantic web and participative web technologies. Korea accentuates the importance of the digital content industries as part of its ICT growth strategies (u-IT 839 Strategy).

Box 7.8. **Policies for digital content development**

OECD governments recognise that market participants create digital content and establish new business models. But governments have a role in developing "enabling factors" for the creation and use of digital content, in taking measures to support cultural diversity and local content-related entrepreneurship, and in removing unnecessary regulatory barriers and other impediments across previously separate policy areas. To enhance development, distribution and use of digital content, OECD countries endorsed a set of digital content policy principles, based on extensive analysis of digital broadband content industries and policies (OECD, 2008d). The following are examples of digital content policies from the current survey:

Canada's Digital Information Strategy is being developed by Library and Archives Canada. Through a multi-stakeholder approach (content developers and consumers, academic institutions), it is supposed to reflect values such as bilingualism, multiculturalism, inclusiveness, and equity in digital content provision and development. Also, the Canada New Media Fund supports the Canadian interactive media industry through various funding initiatives.

The **European Commission** initiated the European Charter for the Development and the Take-up of Film Online, which was adopted by a number of business representatives in 2006. It aims to increase the number of digital video-on-demand services available to consumers and addresses film and content industries, Internet service providers, and telecommunications companies.

Ireland established the Digital Hub centre of excellence, which aims to support digital media businesses. It provides facilities for start-ups and established digital content businesses, as well as research companies and individuals. The centre offers training in various areas of digital content development, conducted jointly with private-sector companies.

New Zealand launched a Digital Content Strategy in 2007. The initiative includes an incubator to promote 3D graphics development businesses as well as programmes to identify digital standards, promote digital content creation and its public dissemination. It also includes a periodic survey on digital content uptake by New Zealand Internet users.

Source: Responses to the OECD IT Outlook Policy Questionnaire 2008; OECD, 2008, "OECD Policy Guidance for Digital Content", OECD, Paris, *www.oecd.org/dataoecd/20/54/40895797.pdf*.

A growing trend is to harness the potential of digital content for integrating linguistic and cultural minorities. Ethnically heterogeneous countries such as Canada and New Zealand mention policies aimed at promoting cultural diversity through digital content initiatives. Other countries use digital content technologies to preserve and promote cultural assets, to protect their national heritage and to enable intercultural exchange, *e.g.*

digitisation and translation of a variety of Japanese cultural resources into English, French, Chinese and Korean.

Public sector information and content

The number of OECD countries with policies that facilitate access and commercial reuse of public-sector information has increased from 11 to 23 since 2006 (*i.e.* from 44 to 77% of responding countries). This is partly due to national implementation of the European Commission's directive on the reuse of public sector information (PSI) in EU member states, but the increasing significance of the public sector as provider and channel of digital broadband content is not geographically limited. The recent OECD Council Recommendation on Public Sector Information will further this development by providing overarching economic principles for establishment, implementation and review of PSI policies (see Box 7.9; OECD, 2008e).

While many initiatives concentrate on access and commercial use of information (*e.g.* weather information, statistical databases), some are shifting the focus towards Internet portals which allow end-users (typically freely) access to and use of content, *e.g.* geospatial information and educational and cultural content.

The ICT business environment

Policies to facilitate competition in the ICT business environment are an important part of national strategies of information economies, but compared with previous years and other policy areas, they have received less attention (Table 7.2), although this may change with the current economic downturn. This is partly a result of the perceived effectiveness of pro-competition and competitiveness policies enacted earlier. Most respondents attribute continued priority to each of the four sub-areas and no country indicated decreased priority (Table 7.3). Moreover, countries have general cross-sector policies to provide a competitive and attractive environment for business operations and investments, which also cover the ICT sector.

Competition in ICT markets

The number of countries citing specific new policies on competition in the ICT sector was smaller than in previous years, pointing to the continuation of comprehensive policies enacted earlier. The focus in 2008 is on measures to increase effective competition and to improve market and policy monitoring. Korea and Japan, for example, highlight recent policies to ensure competition in the telecommunications sector, including the facilitation of investments in fixed-mobile convergence and Internet Protocol (IP)-based networks (see the section on enhancing the infrastructure and OECD, 2007b).

Intellectual property rights

The share of countries with recent policies on intellectual property rights (IPRs) has fallen since 2006, with less than half of respondents indicating recent policy measures. This change is also reflected in the allocation of priorities. Whereas the majority of countries indicated increased priority in 2006, only the Czech Republic, Finland, Germany, Korea, Mexico, and Singapore did in this survey. Software piracy is the primary focus of IPR-related policies, and Korea and Japan cite recent policies to improve enforcement of IPR protection. Governments often refer to co-operation with international organisations, notably the World Intellectual Property Organization (WIPO).

Box 7.9. **Public sector information and content**

The OECD Council has issued a set of principles to provide a framework for the wider and more effective use of public sector information (PSI). The principles aim to increase returns on public investments in public sector information and promote more efficient distribution of this information by providing principles on openness, access and transparent conditions on reuse, quality and integrity, new technologies and long-term preservation, pricing, competition and copyright issues, international reuse and best practices (see OECD, 2008e). While these principles underpin current and future policies, the following are examples of policies cited in the current survey:

In **Germany,** Bonn, Mainz, Muenster and Nuremberg have set up a map tool and an Internet portal to create new services based on public geographic and spatial data. The cities are also developing new ways of accessing public information such as environmental data on water quality, noise levels or constructions plans.

In **Korea** the national Knowledge Portal provides access to various public-sector databases, which are also available for search through the popular Internet portals Naver and Daum. Uptake by businesses is exploited through dedicated programmes of the Korean Agency for Digital Opportunity and Promotion (KADO).

In the **Netherlands** the SURFnet/Kennisnet project aims to produce innovative applications and services to allow educational institutions to make optimal use of ICTs, *e.g.* streaming video of educational content from the Dutch public broadcast archives.

The **New Zealand** Geospatial Strategy is designed to improve access to public geospatial information. It provides a framework for the development and management of geospatial resources and aims to ensure compatibility of data collected by different agencies.

Poland's Ministry of Culture and National Heritage is supporting the digitisation of multimedia assets in museums as well as the national library. The Polish Film Institute initiated a programme to finance the digitisation of the national film archives in order to facilitate preservation and public access.

The government of **Switzerland** is defining an overall preservation policy for Swiss cultural goods, which includes digitised and digital content. The country is also involved in the EU's Digital Libraries Initiative.

Turkey's Information Society Strategy affirms that policies for commercial and non-commercial (re)use of public-sector information will be enacted in line with existing EU legislation.

The **United States** created Geospatial One-Stop (GOS), a portal to improve access to geospatial information by public entities and the general public. The aim is also to stimulate commercial development of geospatial tools and to reduce technology risk for data users by providing consistent and compatible access to information.

Source: Responses to the OECD IT Outlook Policy Questionnaire 2008; OECD, 2008, "OECD Recommendation of the Council for Enhanced Access and More Effective Use of Public Sector Information", OECD, Paris, C(2008)36, *www.oecd.org/dataoecd/0/27/40826024.pdf.*

Trade and foreign direct investment

Policies to promote trade and foreign direct investment (FDI) play a moderately important direct role in ICT policies. The main focus is on promoting ICT exports and seeking export opportunities, including the establishment of liaison offices abroad, participation in international fairs, and free trade agreements (see below). Specific measures include Internet portals and agencies to promote FDI, some of a general nature,

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but with a dedicated focus on ICTs (*e.g.* IDA Ireland). An important part of the work of these agencies is to provide foreign investors information about investment aid and subsidies, local partners, pilot projects, R&D facilities, geographic technology/ICT clusters, cash grants and tax benefits and to support domestic ICT firms to find business partners abroad.

International co-operation

Half of the respondents cite recent policies to promote international co-operation in ICTs, including:

- Encouraging investment through developing cross-country standards, *e.g.* on RFID spectrum use and harmonisation in Canada and the United States, or pilot projects on cross-border recognition and interoperability of national electronic ID systems in some EU member states.
- Establishment of free-trade agreements (FTAs) on a bilateral or regional level, *e.g.* Singapore with Australia, Japan, Korea and the United States.
- Partnerships and co-operation initiatives, *e.g.* Mexico-Korea IT co-operation centre (ITCC-MEXCOR).
- A number of countries mentioned co-operation with international organisations, *e.g.* the International Telecommunication Union (ITU) in the area of telecommunication standards.

Enhancing the infrastructure

OECD governments acknowledge that attaining the socio-economic objectives of information economies requires rapid and reliable infrastructures. Virtually all countries cite policies to promote broadband roll-out and use (Table 7.2). Policies in the areas of electronic settlement/payment and standards have historically been less common, but the share of countries attributing high priority to these areas has increased from the previous survey (Table 7.3). A few countries indicated decreased priority, which is partly due to the effectiveness of policies enacted earlier.

Broadband

Broadband policies have been commonplace since 2006, and, as broadband uptake expands, the focus turns increasingly to the inclusion of structurally disadvantaged user groups (see Box 7.10). With regard to priority, 21 out of 27 responding countries gave broadband policy high priority. Nine countries gave it increased importance (Australia, Austria, Belgium, Greece, Mexico, New Zealand, the Slovak Republic, Spain, Singapore). With the exception of Australia, Belgium and the non-OECD member Singapore, these countries lag the OECD average on broadband penetration suggesting that focused broadband policies are seen as a way of increasing broadband coverage and use.

Besides the general promotion of broadband uptake, policies aim to bridge access divides between urban and rural areas, *e.g.* in Greece, Japan, Korea, Spain, and the United States (US Department of Agriculture Rural Development Broadband Programme). Australia and Canada have programmes to facilitate the inclusion of indigenous communities, although programme funding is sometimes relatively small compared to overall broadband action plans. Korea, Singapore and other countries that already have high penetration rates focus on the promotion of ultra high-speed (gigabit) networks, *e.g.* via fibre-to-the-home (FTTH), and wireless broadband access technologies.

Box 7.10. **Monitoring the Recommendation of the OECD Council on Broadband Development**

The Recommendation on Broadband Development provides policy principles to expand broadband infrastructure, promote efficient and innovative supply, and encourage effective use of broadband services. The 2008 OECD monitoring exercise shows that the development and use of broadband has flourished in most OECD countries, but that there are substantial differences among them and that there are continuing and new issues to be addressed. Competition among service providers varies between countries and between rural and urban areas. Access prices remain high in some markets and users may have a very limited choice of providers, and while the number of rural connections has increased, their quality varies. Differences remain in the uptake of broadband in businesses, households and schools, and attention needs to be paid to access and use by SMEs and disadvantaged groups.

Broadband applications and use are expanding, but many services remain experimental. Faster upstream bandwidth is more important as demand for content increases, and advanced mobile broadband services have yet to develop in most OECD countries. OECD firms and governments are only beginning to realise the full potential of advanced applications and the use of broadband in health, e-government services, education, telework, environment, energy and transport systems (intelligent transport systems, smart buildings, monitoring networks) is still in its infancy.

The monitoring exercise shows that new broadband-related security threats are emerging, and that there are new or more pronounced consumer and privacy issues developing with "always-on" broadband connections and the development of the participative web, all of which warrant continued policy attention. Continuing investments in R&D for broadband infrastructure, applications and content are necessary, and devising balanced regulatory frameworks, especially in fields such as intellectual property rights, will be a continuing challenge for governments.

A few countries have undertaken broadband policy evaluations that enable policies to be designed and implemented in a more effective and accountable manner. These need expanding. Overall the monitoring exercise identifies ongoing and emerging policy issues to be tackled to further broadband development, roll-out and innovative use.

Source: OECD, 2008, "Broadband Growth and Policies in OECD Countries", OECD, Paris, *www.oecd.org/dataoecd/32/57/40629067.pdf*.

A few countries indicate programmes to develop broadband applications as a way to increase uptake. By 2010, Korea plans to provide access to broadband convergence networks (BcN) which integrate a wide array of services to 20 million users, half of whom are expected to access them via wireless network devices. Moreover, national broadband plans often refer to domestic R&D and innovation activities, including research into advanced broadband technologies, development of applications as well as broadband networks as facilitators of scientific research (see section on fostering ICT R&D and innovation).

Electronic settlement/payment

The share of countries mentioning electronic settlement and payment policies is smaller than in previous years. This is to a large degree a result of the widespread establishment of these technologies in many countries, as indicated by the large number of "continued" priorities. All countries with decreased (Austria, the Czech Republic) and low priority (Belgium, Finland, the Netherlands, Sweden) are EU member states, some of which refer to EC directives and harmonisation of national legislation in this area.

The public sector plays an important role as model user. Finland, for instance, is using banking technologies for electronic payments and revenue collection. Italy promotes uptake across the public sector through an electronic public administration payments system (SIPA), which integrates a wide range of electronic budget execution, assignment and monitoring functions. However, OECD countries have adopted no single electronic payment standard. Proprietary standards compete and not all payment methods are equally accepted across countries.

Standards

As many respondents have policies on ICT standards as on electronic payment/ settlement, but more give it high priority. Policies regarding standards often include model use by the public sector to spur technology diffusion to businesses, *e.g.* open standards for information exchange (Box 7.11). Some countries mention the objective of developing national standards that will then be internationally adopted (*e.g.* Korea) and most refer to co-ordination activities with international standardisation institutions, *e.g.* the International Telecommunication Union and the International Organisation for Standardization.

Some public authorities are encouraging widespread uptake or enabling in preparation for Internet Protocol version 6 (IPv6) in order to avoid problems related to the rapidly diminishing supply of IPv4-based Internet addresses (see OECD, 2008f). Japan, for instance, established an IPv6 Promotion Council in 2001 and is often regarded as a leader in the transition process, for example through the engagement of companies such as NTT. Other countries have followed, *e.g.* in 2005 the US federal government set June 2008 as the date by which the network infrastructures of all public administration agencies should be IPv6-capable; but no official evaluation of the achievement of that goal is as yet available. The European Commission recently proposed a set of actions to facilitate widespread transition by 2010, *e.g.* through public procurement.

Box 7.11. **Open standards for information exchange**

Belgium and the **Netherlands** have policies to promote the use of OpenDocument formats (ODF) for all information exchange within the public administration. Belgium recently commissioned a study to analyse the impact of ODF on communications in the public administration.

Denmark: The National IT and Telecom Agency developed an open source application (*NemHandel*) for the exchange of e-business documents, *e.g.* electronic invoices, via the Internet. The application is freely available and can be incorporated in commercial products.

Source: Responses to the OECD IT Outlook Policy Questionnaire 2008.

Promoting trust online

Promoting trust online is not covered by the survey responses in Table 7.2, but governments indicated their priorities as shown in Table 7.3. The security of information systems remains a high policy priority in most responding countries and governments continue efforts in this area. As Internet penetration and uptake by individuals is growing rapidly, consumer protection and privacy are becoming a high priority in around half of respondent countries. Governments are, for instance, taking steps to protect consumers by preventing Internet-related identity theft and related fraud (Box 7.12).

Box 7.12. **Online identity theft**

Consumers benefit from more choice and easier ways to purchase goods and services on the Internet, but despite growth rates of around 25% per year, business-to-consumer online transactions are still low, in particular across borders. In a 2008 OECD report, identity theft is identified as one of the main reasons for such limited success (OECD, 2008g). According to the US Federal Trade Commission, in 2006, for the sixth consecutive year, identity theft topped the list of consumer complaints, accounting for over one-third of fraud cases filed with the agency.

Governments have taken steps to implement more effective schemes for fighting ID theft. In addition to preventive consumer education, actions that stakeholders can take to protect identity online include: *i)* the concept should be consistently defined domestically and internationally to ensure effective co-operation on enforcement; *ii)* governments should consider making ID theft a specific offence – this is currently the case in only a few countries; *iii)* statistics to measure ID theft are mostly not comparable across countries or even authorities in the same country; *iv)* related legislation such as security breach notification schemes should require companies holding personal data to inform their customers of any risk or security breach affecting their data; *v)* sanctions should be increased to discourage fraudsters from evading regulatory compliance by locating in countries in which identity theft is not or is poorly regulated.

Source: OECD, 2008, "OECD Policy Guidance on Online Identity Theft", OECD, Paris, DSTI/CP(2007)12/FINAL.

Policy assessment and evaluation

OECD countries clearly acknowledge the importance of evaluation in formulating (and reformulating) policy goals and related instruments, but coherence in national evaluations and international comparability of results remain issues to be resolved. The share of countries reporting systematic and regular assessments of ICT policies has increased to over 90% in 2008 from just over half in 2004 (Table 7.2). The increase is particularly high in the area of broadband policies where policy assessment has become commonplace. Evaluation and monitoring of RFID programmes are still low, but are likely to increase as governments develop specific RFID policies.

Overall programme evaluation

Programme evaluation is part of most countries' policy-making process, and this includes ICT policies. Out of 30 respondents, 26 mentioned individual programme evaluations. Evaluation procedures typically consist of *ex ante* and *ex post* evaluations of programme impact and administrative procedures. Korea, for instance, carries out evaluations of ICT programmes as well as of the "informatisation" of government authorities. The Mexican government assesses the impact of its PROSOFT programme on employment along with the evaluation of application and grant approval procedures.

Evaluation is becoming more widespread and systematic and some countries actively promote methodologies that are applicable to multiple policy areas (*e.g.* Austria's Platform Research and Technology Policy Evaluation, the United Kingdom's ROAME system). However, many evaluations still focus on particular policies rather than a coherent evaluation of national ICT policy as a whole. Improved evaluation of policies, including co-ordination among various agencies, ministries and the private sector, is especially needed as countries increasingly promote ICTs as a way to tackle wider socio-economic challenges, *e.g.* ageing populations, climate change.

Evaluation standards and procedures differ among countries, making international comparisons of programme outcomes, their effectiveness and the promotion of best practices difficult. There are attempts to create cross-country benchmarking tools, but they need to be extended. The European Commission, for instance, carries out periodic benchmarking and evaluation exercises of ICT use in various areas, *e.g.* health care, the public sector, and individuals and households (see Box 7.13 on evaluation of its ICT R&D support).

Box 7.13. **Evaluation of ICT R&D in the European Commission's 6th Framework Programme**

The Framework Programme, currently in its 7th edition (FP7), is a multi-year funding programme for R&D sponsored by the European Commission. ICT-related research has been a major pillar in recent FPs: Between 2003 and 2006 the European Commission granted some EUR 4 billion for ICT-related research projects and the funding mechanisms as well as their outcome have been evaluated.

In general, the evaluation concludes that support for ICT-related R&D under FP6 was well managed and effective. It highlights the successful promotion of pan-European public-private partnerships and research networks, *e.g.* through joint technology initiatives (JTIs) in areas such as embedded systems. Also, the goal of 15% participation of SMEs has been exceeded at 20%. The report credits FP6 with reinforcing European co-ordination and emphasises that European cross-border infrastructures are benefiting from FP funding, *e.g.* by improving standards for and interoperability of national e-government and e-health systems.

The evaluation highlights some shortcomings, many of which echo general observations of the European R&D landscape, especially in international comparisons. It suggests a lack of flexibility in administration procedures and proposes measures such as granting small amounts of "seed funding" to proposals that have not yet been fully evaluated. The bigger theme of improving Europe's research and innovation "eco-system" requires wider-ranging, systemic changes that are not necessarily specific to ICT-related R&D, such as increased availability of venture capital and better incentives for the commercialisation of R&D. The report also highlights a lack of rules for (pre-commercial) procurement of innovative goods and services by public authorities.

Source: European Commission, 2008, "Information Society Research and Innovation: Delivering results with sustained impact", Evaluation of the effectiveness of Information Society Research in the 6th Framework Programme 2003-2006, May, *http://ec.europa.eu/dgs/information_society/evaluation/data/pdf/fp6_ict_expost/ist-fp6_panel_report.pdf*. See also Chapter 3.

Assessment of broadband uptake and use

Assessments of broadband uptake have increased in number since 2006 and OECD governments collect numerous statistics on the progress of broadband strategies. EU members in conjunction with Eurostat have implemented surveys compatible with the OECD model surveys for ICT Access and Use by Households and Individuals and ICT Use by Businesses. Other countries are using variations of one or both surveys, *e.g.* Australia, Canada, Japan, Korea, Mexico, New Zealand and Switzerland. The *OECD Broadband Portal* (*www.oecd.org/sti/ict/broadband*) provides a range of internationally comparable broadband-related statistics, but comparable metrics are not always available in some areas, such as indicators on broadband coverage, usage of fixed broadband subscriptions and high-speed mobile data usage (see also Chapter 4).

However, only a few countries go beyond measuring the spread of broadband to effective monitoring of broadband plans (*e.g.* Finland, Korea, Japan; see Box 7.10 and OECD, 2008a). Plans rarely include mechanisms to review the performance of government initiatives.

Assessment of RFID development and applications

Only Canada and Korea indicate efforts to assess and evaluate programmes to diffuse RFID technologies. The Office of Consumer Affairs at Industry Canada issued a report on technology uptake (*e.g.* of the Electronic Product Code, an improvement to existing bar codes) which reviews policy developments, deployment, pilot projects and consumer concerns, such as privacy protection. Some countries refer to projects that evaluate the business use of RFID technologies (typically in partnership with the private sector) and indicate the need to measure actual and potential socio-economic effects by collecting effective statistics (*e.g.* Italy, Portugal, the United Kingdom).

Conclusion

This chapter outlines current policy priorities for information and communication technologies. It is based on replies to the OECD IT Outlook Policy Questionnaire 2008 and on trends since the survey was first used in the *OECD Information Technology Outlook 2002*. The top ten ranking of current priorities shows that some policies continue to be of high importance, particularly government online activities, infrastructure issues (especially broadband), technology diffusion and ICT-related skills and employment. OECD countries also report increased focus on linking ICT policies with policies for economic growth, employment and increasing welfare.

Table 7.4. **Changing ICT policy priorities, 2008**

Policies ranked by the number of countries indicating increased priority

1.	ICT skills and employment
2.	Digital content
3.	Government online/as model users
4.	ICT R&D programmes
5.	Security of information systems and networks

Source: Based on detailed responses to the OECD IT Outlook Policy Questionnaire 2008.

Some noteworthy changes and developments in ICT policy priorities are described. Table 7.4 lists five policy areas which have greater priority in 2008; they are presented in more detail in the overall ranking (Annex Table 7.A1.1):

- Policies to foster *ICT skills and employment* are receiving more attention. The focus is mainly on IT education, ranging from ICTs in primary education to life-long learning and "e-inclusion" programmes, as well as on-the-job training in the private and public sectors.
- Policies regarding *digital content* have risen greatly in prominence. They include general policies for digital content development, *e.g.* the promotion of digital content industries and digital content generation and use more generally, and especially policies aimed at the (re)use of *public sector information* which have become common over the last two years.
- *Government online* policies have always been significant, but the focus has shifted from transferring existing business processes online to using ICTs as a tool to transform those processes and increase the overall efficiency of government. Some countries, *e.g.* Central and Eastern European OECD members, emphasise the direct and indirect impact of e-government activities on the development of information societies.
- *ICT R&D* programmes have increased both in number and in priority. OECD countries aim to harness the ICT sector's innovation potential to stimulate overall national innovation in the medium and long term. Some countries with lower GDP per capita regard this as less important than measures to improve ICT uptake and use.
- While the issue of *promoting trust online* is not covered in detail by the survey, the *OECD Seoul Declaration for the Future of the Internet Economy* highlights countries' preoccupation with security-related issues, especially for consumer and user protection and for critical information systems and infrastructures.

Policies that focus exclusively on the ICT business environment have decreased in prominence, a further indication that ICT policies are now becoming less sector-specific and more a part of the mainstream economic policies that concern the economy and society as a whole, although this may change with the current economic downturn.

The shift in ICT policies in some instances also results in changes in the institutional context within which these policies are formulated and implemented. OECD countries with long-term strategies for information societies typically emphasise the role of ICTs and the Internet as key enablers of wider societal change, in some cases alongside other technologies, *e.g.* biotechnology and nanotechnology.

The survey shows that stronger links between ICT policies and government objectives, in areas such as social cohesion, the environment, health care, education and national security, can lead to two types of, often sequential, institutional developments. First, the number of ministries and agencies involved increases as the policy portfolio extends well beyond infrastructure and economic development. Second, governments formalise this diversity through co-ordination bodies that centralise the formulation and implementation of ICT policies. Most countries still follow a decentralised approach, but one-third of OECD countries have already established government-wide co-ordination institutions. Their set-ups and competencies vary, ranging from *ad hoc* committees, *e.g.* for the formulation of Iceland's recent ICT policy strategy, through advisory bodies, as in Denmark or Switzerland, to standing policy-formulating committees reporting directly to the prime minister (*e.g.* in Japan and Korea).

Apart from the need to co-ordinate diverse institutions, governments face challenges for developing and implementing future ICT policies. The increasing pervasiveness of ICTs, for example, presents governments with a trade-off: to design ICT policies to promote technology research and uptake or to channel and guide technology developments towards dealing with wider socio-economic objectives. As the current survey shows, ICT policies are often expected to produce outcomes that go beyond technology uptake and diffusion, thereby increasing the challenge to measure the socio-economic impacts of ICTs and their contribution to increasing welfare.

ICT policies have evolved to meet new priorities while continuing to focus on core activities. These policies will be tested in terms of their contributions to long-run competitiveness, growth and employment. To safeguard the future, it is crucial in light of the sharp economic downturn which began in 2008 to maintain long-term priorities and investments in research, innovation and human resources.

Notes

1. See *www.oecd.org/FutureInternet*.
2. In total, all OECD countries, plus the European Commission (EC) and non-member Singapore replied to the questionnaire in part or in full. Individual country responses are posted on the OECD Information Economy web page (*www.oecd.org/sti/information-economy*).
3. The importance of improving ICT skills and competencies among civil servants is a key challenge for the implementation of e-government according to OECD e-government country studies (available at *www.oecd.org/gov/egov*).

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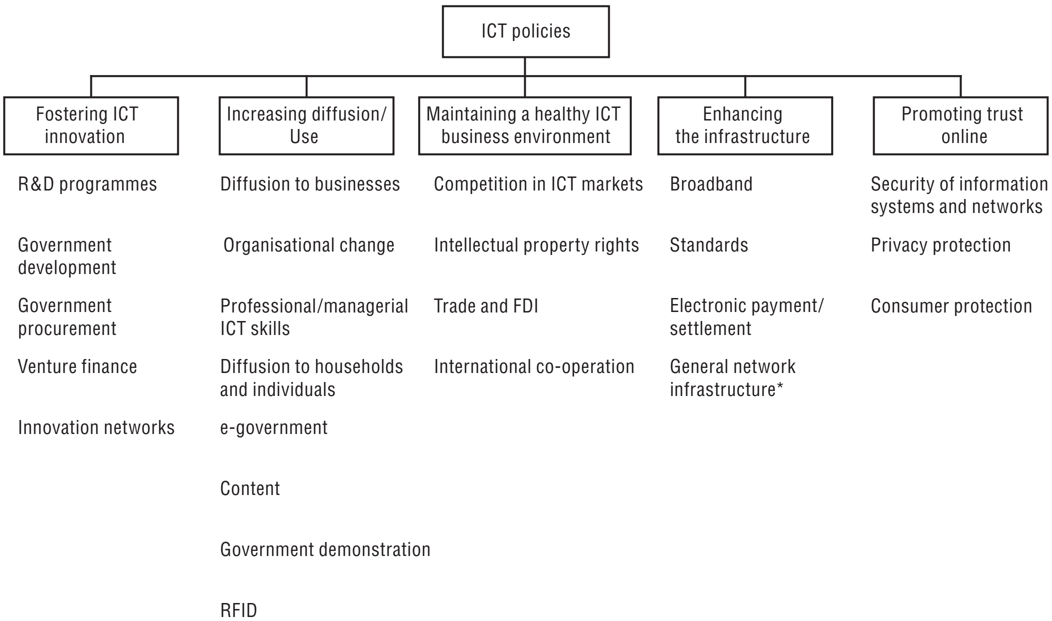
ANNEX 7.A1

Figure 7.A1.1. **ICT policy framework**



Note: Policy areas have been developed on the basis of priorities expressed in national replies, the framework developed in the series of peer reviews on ICT diffusion to business, and other completed work of the Working Party on the Information Economy. Policy areas with an asterisk (*) are examined in the *OECD Communications Outlook* and promoting trust online is not dealt with in detail.

Table 7.A1.1. **Ranking of ICT policy areas, 2008**

	ICT policy area	Number of countries with policy in place (out of 30)	Number of countries indicating high policy priority (out of 28)	Number of countries indicating increased policy priority (out of 28)	*Sum (max. 86)*
1	Government online, government as model users	30	23	11	*64*
2	Broadband	30	21	9	*60*
3	ICT R&D programmes	24	20	10	*54*
4	Promoting IT education[1]	27	18	12	*54*
5	Technology diffusion to businesses	28	18	8	*53*
6	Technology diffusion to individuals and households	24	18	7	*53*
7	Industry-based and on-the-job training[1]	22	18	12	*49*
8	General digital content development[1]	22	14	12	*48*
9	Public sector information and content[1]	19	14	12	*48*
10	ICT innovation support	24	13	7	*44*
11	Standards	18	16	8	*42*
12	Government development projects	20	14	5	*39*
13	Electronic settlement/payment	18	12	7	*37*
14	Competition in ICT markets	15	12	8	*35*
15	Government ICT procurement	18	8	10	*35*
16	Trade and foreign direct investment	17	11	5	*34*
17	International co-operation	15	11	6	*32*
18	Organisational change	14	6	6	*31*
19	Venture finance	19	7	9	*30*
20	Demonstration programmes	19	3	6	*28*
21	Intellectual property rights	12	7	6	*25*
22	Improving labour market information[1]	7	9	6	*22*
23	Foreign workers[1]	14	9	6	*20*
24	RFID programmes[2]	5	3	3	*20*
25	International sourcing[1]	2	9	6	*17*

StatLink http://dx.doi.org/10.1787/478117014047

1. Countries were not asked to prioritise sub-areas for ICT skills and employment and digital content. For digital content, the number of countries indicating high and increased priorities is used for both sub-areas because of the high number of policy replies received. For ICT skills and employment, only two sub-areas were treated in this way, whereas the number of countries indicating high and increased priorities for the remaining three were halved because of the comparably low number of policy replies received.
   The ranking includes only policy areas covered in both Tables 7.2 and 7.3., *i.e.* co-ordination and priority setting, promoting trust online, policy assessment and evaluation are not included.
2. New policy area in the 2008 survey.

Source: Based on detailed responses to the OECD IT Outlook Policy Questionnaire 2008.

ISBN 978-92-64-05553-7
OECD Information Technology Outlook 2008

ANNEX A

Methodology and Definitions

This annex describes the definitions and classifications adopted in Chapters 1, 2 and 3 of this edition of the OECD Information Technology Outlook. *These definitions and classifications, and the data collected on the basis of them, draw wherever possible on work by the OECD Working Party on Indicators for the Information Society (WPIIS) which seeks to improve the international comparability and collection of statistics and data on the information economy and information society.*

Chapter 1

ICT investment

ICT investment comprises information technology equipment, communications equipment and software. ICT investment is likely to be under-estimated as expenditure on ICT products is only considered as investment if it can be physically isolated. This will apply particularly to software but also to components embedded in other equipment. Furthermore, software is very often rented (licensing is very common in standard and semi-customised business software packages), and it can also can be developed on own account.

For a more detailed overview of Investment in ICT as a share of total investment see Section E.1, "Investment in ICT Equipment and Software" in *OECD Science, Technology and Industry Scoreboard 2007*, OECD, Paris.

Recent developments

Indicators are taken from the sources cited at the bottom of each graph. Refer to these sources for more details. Note that definitions of goods and services groupings vary across countries.

Semiconductor data

Data are provided by the World Semiconductor Trade Statistics (WSTS), an industry association of some 70 semiconductor manufacturers representing around 90% of the value of production. WSTS collects revenue statistics directly from its members. The data cover only the "commercial" (merchant) semiconductor market and not internal or "captive" consumption (*www.wsts.org*).

ICT sector value added and employment

To the extent possible, data on value added and employment are collected according to the official 1998 (and amended slightly in 2002) OECD industry-based definition of the ICT sector which comprises both ICT goods and services. This widely accepted definition of the ICT sector is the first step towards comparisons over time and across countries. The ISIC Rev. 3.1 classes included in the definition 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.

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- 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

- 5151 Wholesale of computers, computer peripheral equipment and software.
- 5152 Wholesale of electronic and telecommunications parts and equipment.
- 7123 Renting of office machinery and equipment (including computers).

Services: intangible

- 6420 Telecommunications
- 7200 Computer and related activities

However, the definition is not yet consistently applied and data provided by OECD countries and available in the OECD STAN database have in some cases been combined with data from other sources to estimate ICT aggregates that are compatible with national accounts totals. These data are also partly estimated for missing values. For this reason, the statistics presented here are not directly comparable with those contained in many national reports and in previous OECD publications (see *OECD Information Technology Outlook 2006*). When such data were not available, the footnotes clarify the scope for each country.

ICT markets and spending

Data on ICT markets and spending are based on data published by World Information Technology and Services Alliance (WITSA), based on research by Global Insight, Inc.

In this section the definition used for the ICT spending is based on a narrower one and it is as follows:

- **Computer hardware** includes the total value of purchased or leased computers, storage devices, memory upgrades, printers, monitors, scanners, input-output devices, terminals, other peripherals, and bundled operating systems.
- **Computer software** includes the total value of purchased or leased packaged software such as operating systems, database systems, programming tools, utilities, and applications. It excludes expenditures for internal software development and outsourced custom software development.
- **Computer services** includes the total value of outsourced services (whether domestic or offshore) such as IT consulting, computer systems integration, outsourced custom software development, outsourced World Wide web page design, network systems integration, office automation, facilities management, equipment maintenance, web hosting, computer disaster recovery, and data processing services.
- **Communications** includes the total value of voice and data communications services and equipment.

- **Communications services** include local and long distance wire-line telecommunications, wireless telecommunications, paging, satellite telecommunications, Internet access, private line services, and other data communications services.
- **Communications equipment** includes wire-line and wireless telephone handsets, legacy and IP PBXs, key systems, wired and wireless LAN equipment, WAN equipment, central office equipment, modems, multiplexers, and telephone answering machines and systems.

Chapter 2

Trade

ICT goods

A commodity-based definition of the ICT sector is used based on the CPC (Central Product Classification) and the Harmonised System (HS). See code details and broad categories of groups in "A Proposed Classification of ICT Goods", document ref. DSTI/ICCP/IIS(2003)1/REV2, available at *www.oecd.org/dataoecd/5/61/22343094.pdf*.

For ICT goods, the ICT commodities list is more accurate than the industry-based sector definition used previously, which only approximates the ICT sector. For ICT goods, trade data were extracted from the joint OECD-UNSD International Trade Statistics (ITCS) database. Following the OECD proposed classification, this publication groups the detailed codes of ICT goods into five broad categories: Telecommunications equipment, Computer and related equipment, Electronic components, Audio and video equipment, and Other ICT goods.

Software goods, which are not included in the ICT goods classification listed above, were defined using the Harmonised System (HS2002) 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).

The OECD Working Party on Indicators for the Information Society (WPIIS) is developing a revised OECD ICT goods classification based on the Central Product Classification, Version 2 which will be available for use in early 2009 and will include a correspondence table to HS2007. However this revision will also narrow the scope of ICT goods and thus reduce values for ICT goods trade.

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ICT services

For ICT services, an industry-based definition was used. The two ICT services sectors correspond to the following Balance of Payments Coding System (BPM5) categories (for a full list, see *www.imf.org/external/np/sta/bopcode/topical.htm*):

- 245: communications services
- 262: computer and information services. This one includes a range of processing, bureau, consulting, development, database and other subscription services.

Trade performance indicators

Revealed comparative advantage

Revealed comparative advantage is calculated as the ratio of the share of ICT goods exports in total merchandise exports for each country to the share of OECD ICT exports in total OECD merchandise exports – *i.e.* (country ICT exports/country total exports)/(OECD ICT exports/OECD total exports).

$$RCA_i^j = \frac{\left(X_i^j / X_T^j \right)}{\left(X_i^O / X_T^O \right)}$$ 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*.

A value greater than 1 indicates a comparative advantage in ICTs, and a value of less than 1 a comparative disadvantage.

Grubel-Lloyd Index

The most widely used measure of intra-industry trade is the Grubel-Lloyd Index.

$GLI_i + [1 - |M_i - X_i| / (M_i - X_i)]$ where M_i and X_i stand for imports and exports for industry *I* respectively.

The closer the values of imports and exports, the higher the index.

ICT goods production, trade and sales

Data on production, trade and sales of ICT goods were compiled from Reed Electronics Research, *Yearbook of World Electronics Data 2006* and previous years. The six main groups that comprise ICT goods, and their corresponding Standard International Trade Classification (SITC) Revision.3 codes, are:

- 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
- Radio communications (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.

FDI flows

FDI data from the OECD *International Direct Investment Statistics Yearbook* cover the following ICT-related sectors (the corresponding ISIC Rev. 3 codes are in parentheses):

- Office machinery, computers, radio, TV and communication equipment (30, 32).
- Telecommunication services (642).

Mergers and acquisitions

Detailed analysis of cross-border M&As is based on Dealogic data (*www.dealogic.com*).

ICT sector M&As are those in which ICT sector entities, defined by primary NAICS (North American Industry Classification System), are the acquirer and/or target. The ICT sector includes the following NAICS industry groups:

- ***Manufacturing.*** *Communications equipment manufacturing*: 33421: Telephone apparatus manufacturing; 33422: Radio and television broadcasting and wireless communications equipment manufacturing; 33429: Other communications equipment manufacturing; 33431: Audio and video equipment manufacturing; *Computer and office equipment manufacturing:* 33411: Computer and peripheral equipment manufacturing; *Electronics equipment manufacturing:* 33441: Semiconductor and other electronic component manufacturing; 33451: Navigational, measuring, electro-medical, and control instruments manufacturing; 33461: Manufacturing and reproducing magnetic and optical media.
- ***IT services.*** 51121: Software publishers; 54151: Computer systems design and related services.
- ***IT wholesale.*** 42342: Office equipment merchant wholesalers; 42343: Computer and computer peripheral equipment and software merchant wholesalers; 42362: Electrical and electronic appliance, television, and radio set merchant wholesalers; 42369: Other electronic parts and equipment merchant wholesalers.
- ***Media and content.*** 51211: Motion picture and video production; 51212: motion picture and video distribution; 51213: Motion picture and video exhibition; 51219: Postproduction services and other motion picture and video industries; 51221: Record production; 51222: Integrated record production/distribution; 51223: Music publishers; 51224: Sound recording studios; 51229: Other sound recording industries; 51511: Radio broadcasting; 51512: Television broadcasting; 51521: Cable and other subscription programming; 51611: Internet publishing and broadcasting.
- ***Communication services.*** 51711: Wired telecommunications carriers; 51721: Wireless telecommunications carriers (except satellite); 51731: Telecommunications resellers; 51741: Satellite telecommunications; 51751: Cable and other program distribution; 51791: Other telecommunications; 51811: Internet service providers and web search portals; 51821: Data processing, hosting, and related services.

Chapter 3

Definitions for R&D figures follow the *Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development*, OECD, Paris.

For this chapter on R&D expenditures, the ICT sector is defined to comprise: (ISIC Rev. 3) 30 – Manufacture of office, accounting and computing machinery; 32 – Manufacture of radio, television and communication equipment and apparatus (which

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includes electronic components and semiconductors); 33 – Manufacture of medical, precision and optical instruments, watches and clocks; 642 – Telecommunications; 72 – Computer and related activities. Note that in the *OECD Information Technology Outlook 2006*, ISIC 33 was excluded.

For a more detailed overview of R&D investment see Section A: "R&D and Investment in Knowledge" in *OECD Science, Technology and Industry Scoreboard 2007*, OECD, Paris.

OECD PUBLISHING, 2, rue André-Pascal, 75775 PARIS CEDEX 16
PRINTED IN FRANCE
(93 2008 04 1 P) ISBN 978-92-64-05553-7 – No. 56417 2008

OECD Information Technology Outlook

Information technology (IT) and broadband are major drivers of research, innovation, economic growth and social change. The 2008 edition of the *OECD Information Technology Outlook* analyses recent developments in the IT goods and services industries, and suggests that the outlook is for continued long-term growth, constrained by the currently very uncertain macroeconomic environment in OECD countries but with somewhat higher growth possible elsewhere.

The industry is organised internationally. Cross-border investment, trade, and mergers and acquisitions remain high, and ICTs drive globalisation in general. The industry is rapidly restructuring with non-OECD countries, particularly China and India, as major suppliers of information and communications technology (ICT)-related goods and services. The ICT industry is the major performer of R&D; many other industries undertake ICT R&D; and ICT-related R&D drives innovation and new goods and services in many industries.

This edition analyses the impact of high-speed broadband on the economy, and areas of future impacts. The Internet is changing everyday life for 1.5 billion people worldwide, with their socio-economic standing influencing how they use the web. The dynamic growth of digital-content-based creative industries is outlined, covering user-created content, online computer and video games, film and video, music, and online advertising.

Recent trends in OECD ICT policies are analysed to assess whether they are rising to these new challenges. Highly prioritised policy areas include investing in ICT R&D and innovation, improving government online activities, spreading broadband, increasing the use of ICTs, raising ICT skills and employment, and supporting digital content development. Changing policy priorities are reviewed.

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ISBN 978-92-64-05553-7
93 2008 04 1 P

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