Information and Communications Technologies

OECD Information Technology Outlook

OECD PUBLISHING

2006

Information and Communications Technologies

OECD Information Technology Outlook

2006

OECD

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of 30 democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.

This work is published on the responsibility of the Secretary-General of the OECD. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Organisation or of the governments of its member countries.

Also available in French under the title:
Perspectives des technologies de l'information de l'OCDE
2006

Foreword

The OECD Information Technology Outlook 2006 *has been prepared by the OECD under the guidance of the OECD Committee for Information, Computer and Communications Policy (ICCP), and in particular its Working Party on the Information Economy. It is the eighth 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, emerging applications in selected areas of information technology and a review of IT policies and new policy directions. The 2006 edition builds on the 2004 edition to extend the economic and policy analysis.*

The first four 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 development of ICT-enabled international sourcing, with particular reference to India, and the development of the information technology industry and the Internet in China. The next chapter provides an overview of the rapid rise of digital content and increasing online delivery of content in a range of industries; it is followed by a review of developments in the demand and supply of ICT skills and the impact of distance working and international sourcing on employment. The last two chapters examine recent IT applications that will be important in the medium term and provide an overview of IT policy developments and priorities in OECD countries. National information technology policy profiles are posted on the OECD Web site to enable their widespread diffusion (www.oecd.org/sti/information-economy).

The IT Outlook 2006 *was drafted by Graham Vickery, Desirée van Welsum, Sacha Wunsch-Vincent and Xavier Reif of the OECD's Information, Computer and Communications Policy Division and John Houghton, Elizabeth Muller and Verena Weber (consultants), with contributions from Michael Engman and Karine Perset (consultants). It benefited from review and valuable contributions from delegates to the ICCP Committee's Working Party on the Information Economy at its December 2005 and June 2006 meetings, under the chairmanship of Jean-Jacques Sahel (United Kingdom), 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.*

This book has...

StatLinks

A service from OECD Publishing that delivers Excel™ files from the printed page!

Look for the StatLinks at the bottom right-hand corner of the tables or graphs in this book. To download the matching Excel™ spreadsheet, just type the link into your internet browser, starting with the ***http://dx.doi.org*** prefix.
If you're reading the PDF e-book edition, and your pc is connected to the Internet, simply click on the link. You'll find StatLinks appearing in more OECD books.

Table of Contents

Figures

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

ISBN 92-64-02643-6
OECD Information Technology Outlook 2006

Information Technology Outlook 2006 Highlights

ICTs continue to grow strongly, with very rapid growth outside the OECD area

Growth in the ICT sector and investment in ICTs are advancing solidly…

Worldwide, the ICT sector is expected to grow at 6% in 2006, with growth more balanced across the OECD area than at the time of the 2004 *Outlook* when the United States led the recovery from the slump. With improved macroeconomic performance, aggregate investment is now increasing across the OECD area and ICT is a significant and growing share of this investment. Some ICT segments are very dynamic (Internet-related investment, portable and consumer applications), with the major share of venture capital continuing to flow into ICTs. Merger and acquisition (M&A) activity is high. Overall the prospects for continuing balanced and sustained growth at a relatively high rate are good, but a return to the unsustainable annual rates of 20-30% growth of the late 1990s is unlikely.

… with spending on ICTs increasing most rapidly in certain emerging non-OECD economies.

IT spending, ICT market data and forecasts confirm expectations of moderately strong and widespread growth worldwide in 2006. With the emergence of new growth economies, world ICT spending was up 5.6% a year over 2000-05 in current USD. OECD spending was up 4.2% and the OECD world market share dropped from 89% in 2000 to 83% in 2006. ICT spending is increasing most rapidly in certain emerging non-OECD economies. China's 2005 ICT spending is estimated at USD 118 billion, following growth of 22% a year in current USD since 2000. In addition to China, nine non-OECD countries had the top spending growth rates over the 2000-05 period, including Russia (25% a year) and India (23%). Indonesia, South Africa and OECD eastern European countries were in the next group of high-growth countries. Dynamic growth in these economies is reflected in their growing shares of world trade, direct investment and M&As.

As the ICT industry reshapes itself to adjust to changes in technologies, delivery mechanisms and markets…

The ICT industry contributes over 9% of total business value added and employs 14.5 million people directly in OECD countries, but it is adjusting to growth rates below those of the 1990s. As many ICT products become commodities, very rapid growth is confined to new and niche goods and services and to emerging geographical markets. Open source (the "Linux effect"), online delivery of IT services (the "Google" effect) and new digital products are also disrupting how technology is developed and delivered. Widespread restructuring is expected to continue in IT services, telecommunications and digital content as industries and firms adapt to changing technologies and markets.

… emerging Asian countries are rapidly becoming leading producers of equipment, software and services.

The top ICT firms have recovered strongly and revenues are now over 20% above the 2000 figures; profits are up strongly, following the sharp downturn in revenues and large losses in 2001-02. However, their employment is still flat. Equipment producers from elsewhere in Asia have emerged strongly – particularly electronics manufacturers from Chinese Taipei – as Japanese electronics conglomerates have slipped in the revenue rankings. Firms from China and India play increasingly important roles in ICT goods and IT services, respectively. Semiconductors are a key intermediate input into ICT equipment and a leading indicator of ICT market trends, and their sales have also grown particularly rapidly in Asia, although world growth is likely to slow somewhat in 2006 from the rapid pace of 2004-05.

To meet these challenges the industry's R&D performance remains dynamic.

ICT R&D is a major driver of growth and change in the sector itself and more broadly. R&D performance is dynamic despite some signs of slowdown. R&D expenditures increased by the equivalent of 0.1 percentage point of GDP over the last decade to over 0.4% according to official R&D data for 19 OECD countries. They have increased particularly for electronic components and software and IT services. The top ICT firms have become more R&D-intensive, with large expenditures in electronics and components and communications equipment.

Global restructuring of ICT production and services

As firms seek new export locations and markets, they increasingly look to rapidly growing developing countries…

Eastern European and non-OECD developing countries play a significant and increasing role as both producers and growth markets for ICT. This new wave of globalisation is largely driven by efficiency-seeking competition as firms take advantage of cost differences

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

and the rapid development of production capabilities in developing economies and they are now increasingly seeking a market presence in economies that are growing faster than those of the OECD area.

… with clear impacts on international trade in goods and services.

Following the strong recovery in 2003-04, ICT goods trade settled back to steady growth in 2005 and is expected to grow at around the same rate as manufacturing trade in 2006. However, rapidly increasing commodity prices, coupled with ongoing price declines for ICT equipment, disguise the solid performance of ICT goods trade (in volume) in 2005 and 2006. In 2004, OECD exports of ICT goods reached a new peak in current USD, driven by growth in electronic components, audio and video and other ICT-related equipment. OECD imports also achieved a new high, driven by growth in communication, audio and video equipment. However, at 13.2%, the share of ICT goods in total goods trade is only a little above that of 1996. Computer and information services trade has been more dynamic in value terms. Ireland is by far the leading OECD exporter of these ICT services and software goods, with combined exports of over USD 20 billion in 2004.

There is a new wave of ICT globalisation, as manufacturing and services FDI shifts strongly to developing countries, increasingly in higher value activities.

The direction of trade and foreign direct investment has undergone a major change as ICT manufacturing and, to a lesser extent, services activities shift to non-OECD countries, with China, India and a number of eastern European countries joining countries such as Korea and Ireland as major ICT producers and exporters. To date, these new actors have focused on relatively low-value process and assembly and services activities for export. However, international investment trends suggest that this may be changing as higher value manufacturing and services functions move offshore and as markets develop in these countries.

Worldwide FDI flows increased in 2004 and grew even more strongly in 2005, recovering from the depressed levels of 2002 and 2003. The outlook for 2006 is generally positive. Mergers and acquisitions are a major component of FDI, and they have also risen sharply: the value of cross-border deals in which the ICT sector was the target was up 47% in 2005, and around 20% of all cross-border M&As have targeted the ICT sector. The first half of 2006 saw intense M&A activity, the strongest in current USD terms since the dot.com boom. The outlook for the medium term is good, although there are concerns about sustainability if company balance sheets deteriorate and as interest rates rise.

Globalisation of ICT-enabled services

The supply of ICT-enabled services is globalising rapidly…

Rapid technological advances in ICTs have increased the tradability of services and make it possible to provide from remote locations many ICT-enabled services that do not require face-to-face contact. Although OECD countries still account for most services activities and services trade, growth is very rapid in many non-OECD countries. India and China already account for around 6.5% of exports and almost 5% of imports of computer and information services and other business services. Some eastern European and Baltic countries are also increasing their share in ICT-enabled services supply and they are often growing most rapidly.

…and firms from OECD and non-OECD countries increasingly compete in the global services market.

The widespread development of ICT infrastructure and enabling business frameworks makes it clear that there is great scope for increasing the supply of services from and to emerging countries. This is a two-way process. Services firms from these countries, especially India, are adopting global business models and services operations, establishing a presence in OECD countries and increasingly competing with firms from OECD countries. But as these countries' domestic demand grows and they open their markets to international competition, services firms from OECD countries are also expanding activities in their markets.

Emerging economies are working to build their capacity to provide IT and software services and improve the quality of service.

Countries that are building up their international services supply are also actively pursuing strategies to improve domestic capabilities and the competitiveness of their IT and software services suppliers. Firms and countries developing international services sourcing activities are aware that their future development and growth depend on the quality of services supplied, and information security and privacy, for example, are attracting greater attention. Finally, most countries have seen adjustment to international sourcing as part of more general adjustment policies.

China: A new competitor and engine of growth

China is a foremost location for assembling and exporting ICT goods. It is rapidly developing technically more complex domestic ICT production and export capacity and is investing abroad.

China has developed rapidly by hosting foreign ICT firms or third-party contract manufacturers to undertake final ICT product assembly, a strategy different from that of other major Asian ICT producers. It overtook the United States as the biggest exporter of ICT goods in 2004, and its ICT exports continued strongly in early 2006. Exports from China are mainly computer and related equipment which depend significantly on imports of electronic components, increasingly from other Asian countries. Export-oriented ICT manufacturing, coupled with a rapidly developing Chinese domestic market, has resulted in high levels of inward investment. In 2005 ICT-related FDI inflows into China were worth around

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

USD 21 billion. Value added per employee of foreign affiliates in the ICT sector has risen steadily, and technically more complex activities, such as design and testing and R&D, are increasingly shifted to China.

The challenge for China's ICT industry is to produce increasingly higher value-added products and services and integrate ICTs into domestic value chains.

Chinese ICT firms are rapidly developing their production and export capacities despite their relatively limited size and technological know-how, and they are investing overseas to obtain technology, brands and distribution channels. Despite the rapid growth of its capabilities, the ICT industry must make the transition from low-cost manufacturing to higher value-added goods and services. More generally, Chinese firms need to integrate ICTs into their value chains. The government is focusing on accelerating structural change in the domestic information industry, the creation of national ICT firms and the improvement of domestic innovative capabilities, and fostering Chinese ICT-related standards.

China's domestic market for ICT goods is growing rapidly, but domestic users remain a small minority of the population.

On the demand side, China is the sixth largest ICT market and about two and a half times that of India, but in 2005 its market was still only about one-tenth that of the United States. China is already the world's largest mobile phone market, and the second largest PC market, with penetration in urban households roughly doubling every two years between 1997 and 2003. These trends are likely to accelerate in the run-up to the 2008 Olympic Games. However, there remains a striking urban-rural digital divide.

At the end of 2005, China had 64.3 million broadband and 111 million Internet users. More than half and sometimes up to three-quarters of Chinese firms surveyed use the Internet and e-commerce has grown rapidly. Nonetheless, only about 4% of the Chinese population are broadband users, only 8% are Internet users and e-commerce is comparatively less developed than in OECD countries.

Digital content creation, distribution and access

Digital content drives growth in all areas of the ICT industry, challenging established value chains and leading to new business models.

Digital content is now an important driver of the ICT industry. Technological innovation and new consumer demand are leading to new or more direct forms of creative supply, new distribution methods and potentially improved access. Research results, for example, are becoming more directly accessible, and digital content is pervading many sectors, with applications that may prove more significant than those for entertainment.

Content industries are migrating to commercial digital content applications, with varying degrees of success. The games, music, scientific publishing and mobile content industries have very specific and different characteristics, but digital content is the major driver of growth for all. New types of content have developed (*e.g.* online games) or are displacing traditional entertainment (*e.g.* television). The development of digital content has challenged established non-digital value chains. New digital value chains are increasingly complex and diverse; for example in downstream distribution, both disintermediation and re-intermediation have occurred, with new value chain participants entering as new intermediaries or to supply infrastructure services. New business models are being tested, including subscription (games) and pay-per-use (music). Advertising is becoming less important in some areas (mobile TV) and more important in others (search). As numbers of simultaneous peer-to-peer users rise, trials of commercial applications for this large user base are under way.

Advances in mobile services and content protection encourage development, but payment systems, interoperability and compatibility are needed.

Continuous technological improvements in networks, software and hardware, including mobile and wireless services and content protection and delivery systems, have made possible the development of more advanced digital content. Greater co-operation is a significant challenge as production of digital content requires agreement among content developers, device manufacturers and distributors. Successful implementation will require suitable and cost-efficient infrastructure services, including payment systems and content protection technologies. Content interoperability and compatibility issues also need to be resolved.

Consumer demographics, income and new uses will structure the growth and shape of digital content industries. For users, there is more, and more diverse, content available on line than off line, and innovative new products provide customised services with greater interactivity. Increasing numbers of users are also becoming digital content creators, although it is unclear whether this will be a lasting phenomenon or an ephemeral fashion. Governments can develop general enabling factors for the creation and use of digital content, maintain a supportive business environment and are major producers and users of digital content.

ICT skills for employment and competitiveness

The workplace increasingly requires workers with various levels of ICT skills…

ICT skills are increasingly a workplace requirement. Up to 5% of total employment is in ICT specialist occupations and around 20% in ICT-using occupations. ICT specialist job definitions appear to be evolving, requiring some combination of ICT specialist skills with other skills, *e.g.* business or marketing. ICT skills are supplied in different ways for different populations. Basic skills needs are increasingly filled “naturally” through diffusion of ICTs and the use of ICTs in schools and at the workplace. Efforts are being made to improve the

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

access of older workers to ICT skills through training programmes. Because ICT specialist skills needs are likely to change rapidly as technology changes, the formal education system may offer less flexibility for adapting curricula than private-sector schemes, usually set up as multi-stakeholder partnerships.

…and ICTs are changing job recruitment, via the Internet, and the workplace, through distance work.

Internet recruitment and distance work are driven by the broad diffusion of ICTs. Internet recruitment is gaining in importance but despite its potential to date seems fairly limited; its impact on the functioning and clearing of the labour market needs further evaluation. Teleworking has gained in importance, with more people now working remotely at least some of the time.

ICT-enabled offshoring may potentially affect up to 20% of employment, with managerial and professional occupations less affected than clerical ones.

Rapid technological developments in ICTs and ongoing liberalisation of trade and investment in services mean that many teleworking services can now be provided anywhere. Analysis suggests that up to 20% of employment is potentially affected by ICT-enabled offshoring. Potentially affected clerical occupations that can be codified are also likely to be affected by digitisation and automation, and their share in total employment is likely to decline, while the share of potentially affected managers, professionals and engineers appears likely to remain stable or increase. This does not mean that these jobs will necessarily be offshored but that around 20% of all employed workers carry out the kinds of tasks and functions that could potentially be carried out from any geographic location. ICT-enabled globalisation of services of course also means that countries may gain jobs in these functional areas. Given the sheer size of service-supplying countries such as India and China, they are unlikely to suffer, at least for any length of time, from a shortage of workers with ICT skills and tertiary education. Indeed there would seem to be scope for important further increases in these workers.

Looking to the future: Emerging technology applications

Many new technology applications may have major economic and social impacts. RFID and ubiquitous sensor technologies are finding commercial application…

Many new ICT applications have significant potential and may well have strong economic and social impacts in the near future; ICTs also play a fundamental role in the interlinking and convergence of different technologies. Among these emerging technologies are ubiquitous networks, which make it possible to follow persons and objects and provide real-time tracking, storing and processing of information. Applications of enabling network technologies such as radio frequency identification (RFID) and other sensor technologies are increasingly affordable, investment is rising and applications are moving into commercial use. Location-based services use a variety of position-determining technologies to follow the location of objects and users. The two most common applications are navigation and asset tracking.

Internet users are finding new ways to use this communication medium.

Natural disaster prevention and warning technologies (*e.g.* tsunami early warning systems) are becoming more important for preventing disasters that result in large economic losses (USD 170 billion in 2005). Participative web (Web 2.0) refers to the active participation of Internet users in creating content, customising the Internet and developing applications for a broad variety of fields. Blogs are one of the most popular forms, with around 50 million in mid-2006. In Asia, the number is disproportional to the general use of the Internet.

Convergence of nanotechnology, biotechnology and information technology holds promise in health care and robotics.

In another area, the convergence of nanotechnology, biotechnology and information technology is likely to provide major opportunities and challenges. Convergence in applications such as health care and robotics is leading OECD countries increasingly to assess the potential impact. Neurotechnology, for example, is the growing application of electronics and engineering to the human nervous system.

The interaction of technological opportunities, commercial development, and social acceptance determine which innovations and applications become widespread.

The increasing complexity of these new applications and the uncertainty surrounding their development paths makes it difficult to project their impact on the economy and society. The tendency towards greater interconnectedness and tracking of persons and objects, for example, allows fast reactions (*e.g.* in the field of disaster prevention and management) but can raise privacy concerns and even significantly transform social structures. Developments in the areas mentioned are still in their infancy, but offer a window onto changes that are on the horizon. However, the interaction of technological opportunities, commercial development, social acceptance and use will ultimately determine which innovations and applications become widespread and have positive economic and social impacts.

Rising to new challenges: ICT policies in a time of strong growth and expanding opportunities

National ICT strategies are becoming better integrated with economic development policies, more targeted and growth-supporting.

ICTs are increasingly recognised as a source of innovation and economic growth, and national ICT strategies have pushed towards further integration of IT and economic development policies to meet emerging challenges. To maximise policy effectiveness, countries are increasingly co-ordinating policy both vertically, through the layers of government, and horizontally, across ministries and agencies, to achieve more coherent and effective cross-ministry and agency planning and improve delivery of more targeted policies and programmes. As countries have achieved higher levels of basic ICT access, skills and content, the focus has shifted to deepening these achievements through broadband, more advanced skills and more sophisticated content.

Reflecting these priorities, the focus is on R&D and innovation, technology diffusion, ICT skills, digital content, IPRs and broadband to enable and underpin growth.

The overall shift in policy priorities reflects these changes. There is a more specific focus on co-ordination and policy setting, with higher priority given to strengthening R&D, innovation and government applications (increasingly ICT-specific), increasing diffusion and use of ICT (especially in terms of broadband and online government), raising ICT skills and employment (especially ICT education), expanding digital content and applying intellectual property rights and promoting trust on line. The development of this policy framework and trends in policy priorities provide important general policy lessons for OECD and non-OECD countries alike.

Changing ICT policy priorities

Policy areas which are most widespread, with **high** and/or *increasing* priority

R&D programmes
Government development projects
Innovation networks and clusters
Technology diffusion to business
Government on-line
ICT skills and employment
Digital content
Competition in ICT markets
Intellectual property rights
Broadband
Promoting trust on-line

But more attention should be given to assessment and comparable evaluations of IT policies

Assessment and evaluation remain important weaknesses in most countries. Despite the emphasis on broadband rollout, for example, few countries report evaluation of broadband policies. Techniques for evaluating the effectiveness of IT policy need to be shared and improved. In particular, until there is more coherence of evaluation methodologies across governments, it will be difficult to compare assessments from one country to another.

ISBN 92-64-02643-6
OECD Information Technology Outlook 2006

Chapter 1

The IT Industry: Recent Developments and Outlook

The overall outlook for the information and communications technology (ICT) sector, ICT investment and ICT markets has improved, with more balanced growth across the OECD area and dynamic growth in the rest of the world. Led by ICT services and software, the top ICT firms are growing strongly, and the semiconductor industry has shown strong growth and its market is growing very rapidly in Asia. Growth in ICT markets is likely to be accompanied by major restructuring of the supply side. Both open source (the "Linux effect") and online delivery of IT services (the "Google" effect) are changing how technology is developed and delivered, and continuing merger and acquisition activity and restructuring are expected in IT services, telecommunications and digital content although current high M&A levels are probably not sustainable. ICT markets in China, India and Central and Eastern Europe are expected to grow strongly as they install the basic network and computing infrastructures to increase competitiveness.

Introduction

The outlook for the information and communication technology (ICT) sector, ICT investment and ICT markets has continued to improve, with more balanced growth, since the last *Information Technology Outlook*. Overall macroeconomic prospects for OECD countries have slowly emerged from the trough of 2001-02 underpinning ICT performance. Real GDP growth has increased consistently and is becoming better balanced across the three major OECD economic zones. The very large gap between the United States and the other major zones has diminished. The euro area and Japan are forecast to grow at 2.2% and 2.8% respectively in 2006, and the euro area will maintain growth at 2.1% and Japan will grow somewhat more slowly at 2.2% in 2007. Growth in the United States is forecast at 3.6% in 2006 and 3.1% in 2007. Smaller OECD economies (Australia, Canada, Ireland, Korea, Mexico) and eastern European OECD countries (Czech Republic, Hungary, Poland, Slovak Republic) are all projected to have growth rates well above total OECD in 2006-07 (OECD, 2006).

Aggregate investment has also picked up steam in recent years. Because of the accelerator effect, it declined more than GDP during the downturn and is now growing more rapidly than GDP during the upturn. Real gross fixed capital formation grew by 5.5% in 2004 across the OECD zone and by 5.3% in 2005, with business investment (non-residential private gross fixed investment) somewhat more robust, particularly in the United States, and in Japan in 2005 and now picking up in Europe. Investment growth was considerably above the average in the United States from 2004, but in Europe low GDP growth has restrained gross fixed capital formation. However in 2006-07 it is projected to strengthen considerably in Europe with stronger GDP growth, and slow somewhat in Japan and the United States while still remaining well above GDP growth. ICT investment (including software) is a significant and rising share of total investment and is increasingly correlated with overall capital formation. It is therefore unlikely to achieve the rapid growth of the 1990s, although some segments are very dynamic (Internet and digital content, some mobile and consumer applications).

There are however continuing risks to the global economy in terms of current account imbalances across OECD countries and between OECD countries and non-OECD countries, particularly China. The current account balance for all OECD countries went from –1.1% of GDP in 2003 to –1.8% in 2005, with a particularly marked imbalance for the United States (–6.4% of GDP in 2005) and these imbalances are projected to persist. The euro area balance declined to –0.2% of GDP in 2005 (but the surplus rose in Germany to 4.2% of GDP in 2005 and is projected to grow) and that of Japan remained approximately level (a surplus of 3.6% of GDP and projected to grow). General government financial balances are also a cause for macroeconomic policy concern, with the total OECD financial balance slowly declining to –2.7% of nominal GDP in 2005 from –4% in 2003, and remaining high in the United States (–3.8% of GDP) and Japan (–5.2% of GDP), but somewhat less so in the euro area (–2.4% of GDP). However, unemployment rates continue to decline slowly from 2002-04 peaks with stronger economic growth across all major regions.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

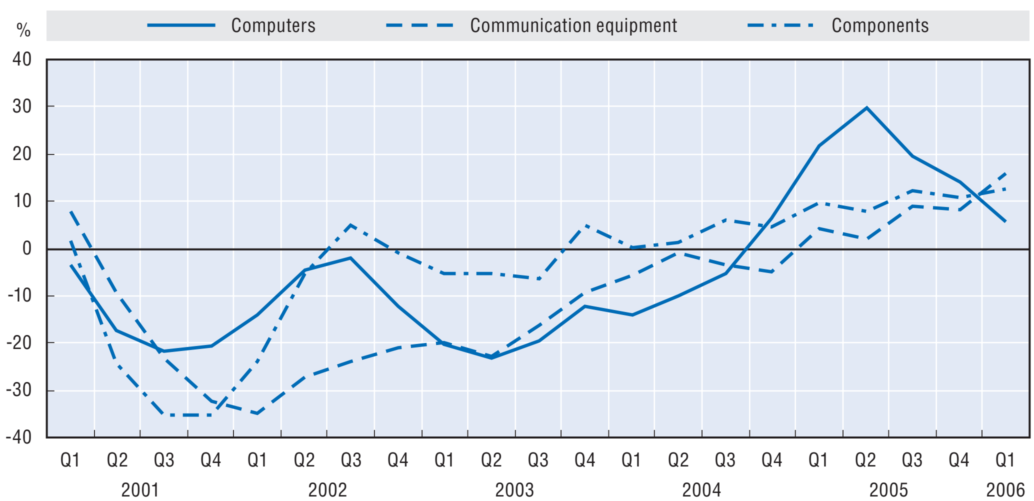
Recent developments in ICT supply

Recent growth in short-term ICT indicators parallels macroeconomic performance and aggregate investment behaviour, but shows more pronounced cyclical behaviour than GDP. Production and markets have been robust in the United States and more subdued until recently in Japan and in Europe, although ICT export performance has been generally strong, particularly in 2004 (see Chapter 2), and other Asian countries have grown very rapidly (see Chapters 2-4). Recent data on ICT goods production in the United States (an indicator of physical investment) show improving year-on-year performance from the third quarter of 2003 in all goods segments, with components leading the way, although annual growth, while still positive, slowed in computers during 2005 and early 2006 (Figure 1.1). This follows the dramatic slump from the first quarter of 2001 in all segments, although domestic markets are also increasingly supplied from foreign sources.

The subdued European market for ICT goods is partly captured by export data for Ireland, whose ICT goods exports are mainly due to foreign firms using the country as an export platform to serve the European market, and their performance is a leading indicator of the European ICT market. The relative performance of these exports largely reflects European demand for ICT goods but also their relative prices and import competition from other, mainly east European and Asian, sources. The share of ICT goods (computer and communications equipment) in Ireland's total exports peaked around the end of 2000, and then declined before picking up slowly from mid-2005, driven by strengthening European investment and demand (Figure 1.2). On the other hand, Ireland's exports of computer and information services have been booming over the last few years, showing the global shift towards greater ICT-related services trade and Ireland's role in expanding IT services markets (see Chapter 2).

Figure 1.1. **Quarterly shipments of ICT goods by segment, United States, 2001Q1-2006Q1**

Year-on-year growth, percentages

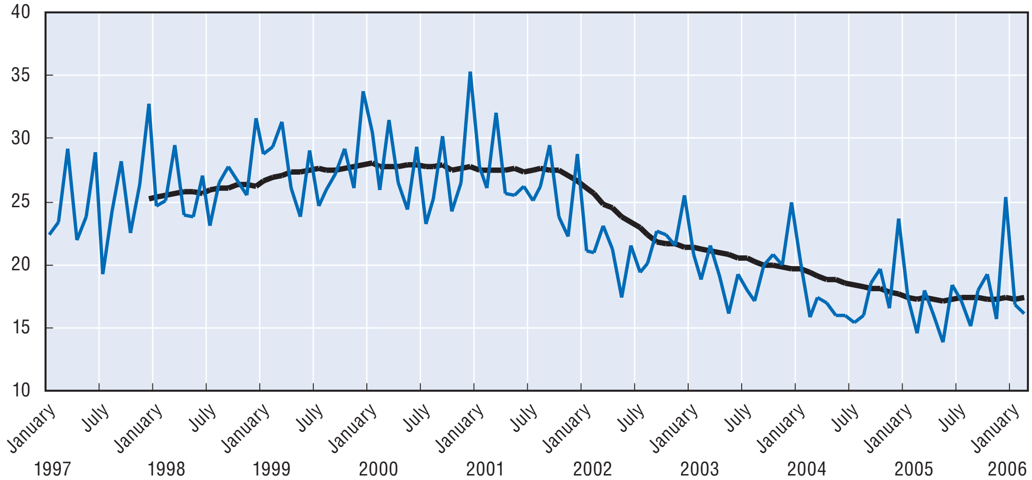


Source: OECD, based on US Bureau of the Census, Manufacturer's Shipments, Inventories and Orders (M3) survey, April 2006. *www.census.gov/indicator/www/m3/.*

StatLink: http://dx.doi.org/10.1787/845440756123

Figure 1.2. **Monthly exports of ICT goods (NACE 30+32), Ireland, January 1997-February 2006**

Percentage of total exports and 12-month moving average



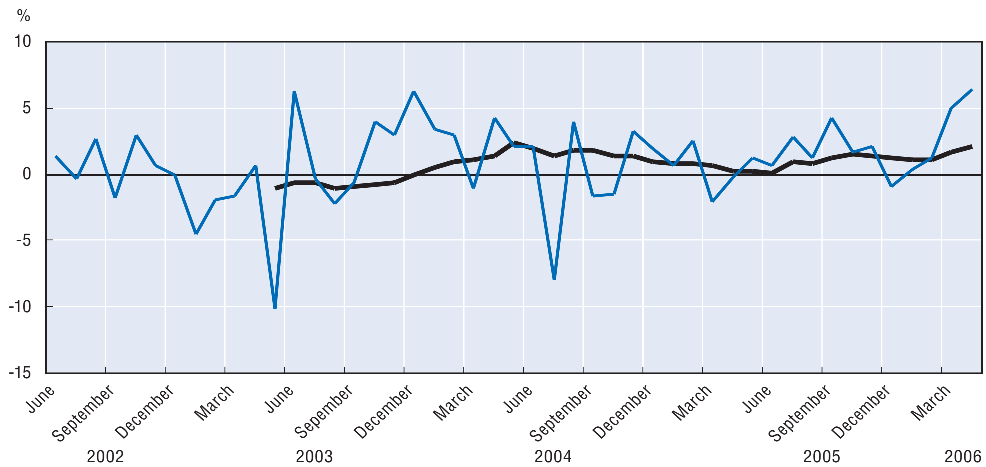
Source: Central Statistics Office (CSO) Ireland, TSAM-Trade: Imports and Exports by Section/Division (Monthly), June 2006. Available at: *www.eirestat.cso.ie/TSAMvarlist.htm.*

StatLink: http://dx.doi.org/10.1787/241766180474

Japan's subdued domestic market for investment in ICT over the last few years is evident from the performance of its IT services industries. Their output is largely for domestic use, and IT services industry sales are a better indicator of domestic ICT demand than goods production, which is strongly oriented towards export. After growing at around 10-15% a year, demand declined sharply from mid-2002 and has remained sluggish, reflecting slow growth of the domestic market (Figure 1.3). The slowly strengthening upturn from mid-2005 reflects the increase in business investment, in the context of the relatively low growth of the total Japanese ICT market in 2005 and 2006 (see the section on ICT markets below).

Figure 1.3. **Growth of monthly sales by IT services industries, Japan, June 2002-April 2006**

Year-on-year variation and 12-month moving average



Source: Japan Information Technology Services Industry Association (JISA), METI Monthly Survey on IT Services Market, June 2006, *www.jisa.or.jp.*

StatLink: http://dx.doi.org/10.1787/877033416015

Outlook

Forecasts from private sources confirm the picture painted by macroeconomic projections and official monthly data. The IT market and spending outlook is for moderate worldwide growth of 5-6% in 2006 (in USD terms, lower when currency-adjusted), slightly down from 2005, but stronger than earlier projections (IDC, 2006a; Gartner, 2005a, 2006; see also the section on ICT markets below). Although these growth rates would be viewed very positively in many industries, the ICT industry is adjusting to more moderate growth after growing 20-30% a year in the 1990s. As many ICT products have become commoditised, rapid growth is now confined to new, niche and replacement products and software and IT services. For example, rapid growth in portable PC sales has underpinned overall PC sales growth, particularly in Europe, mobile telephone handsets with new features have replaced older models, IPTV and other distribution models are starting to transform media distribution, and increased globalisation of IT services has driven services growth (IDC, 2006a, 2006b, 2006c, 2006d; Gartner, 2006). In emerging markets, particularly in Asia (especially in India and China), high growth is expected to continue for all IT spending, and offshoring has been a particularly dynamic aspect of IT services globalisation (see Chapters 3 and 4).

For 2006, somewhat slower growth is projected for ICT as a whole, but the first quarter was considerably stronger than expected in segments such as portable PCs and mobile telephone handsets. PCs are expected to show about a 10% growth in volume, but flat revenue growth as average prices fall 10% a year. Revenue for semiconductors should increase somewhat from 2005 to around 10% in 2006 (see below). Much higher growth is expected in Linux servers, storage (consumer demand for digital music, films and photographs) and business/consumer items such as personal digital assistants and new portable consumer products and displays (Gartner, 2005b). Software and IT services are also projected to see moderate growth, with major shifts in how software is delivered and used. Internet media are enjoying a return to favour with the rapid increase in broadband networks and subscriptions (*Financial Times*, 2006).

In OECD countries growth in ICT markets is likely to be accompanied by major restructuring of the supply side. Both open source (the "Linux effect") and online delivery of IT services (the "Google" effect) are disrupting how technology is developed and delivered (Gartner, 2005c; IDC, 2005). Relatively high merger and acquisition activity and associated restructuring are expected to continue in IT services, telecommunications and digital content (see Chapter 2) as these industries adapt to changing technological opportunities, although current high M&A activities are probably not sustainable. On the other hand, growth in ICT markets is expected to be well over 10% in China, India and Central and Eastern Europe as they install the basic network and computing infrastructures to increase their competitiveness.

Top ICT firms

The performance of the top ICT firms (see Box 1.1) in recent years shows broad recovery from the sharp downturn that started in 2000 through 2002. Software, services and IT equipment firms have grown consistently, but conditions were much more challenging for communication equipment firms. Among the larger firms, revenue and employment held up well, but profitability dipped before growing broadly again from 2003. At national level, Japanese electronics conglomerates have slipped in the revenue rankings, while equipment producers from elsewhere in Asia have emerged strongly and software and services firms from India are growing rapidly. Electronics manufacturers from Chinese Taipei have been among the fastest growing, although firms with significant production activities in mainland China (*e.g.* Hon Hai Precision) have done much better than others (*e.g.* EliteGroup Computer Systems).

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

Sources used to identify the top 250 ICT firms include *Business Week*'s Information Technology 100, various Forbes company listings and other Internet listings. Once candidates for a top 250 listing were identified, details were sourced from the latest annual reports, Securities Exchange Commission 10K and 20F forms, directly from company financial reports and from Reuter's MultexInvestor. Details for private firms were sourced from the Forbes listing of the largest private firms or directly from company Web sites.

ICT activities are those that "process, deliver and display information electronically". ICT industries 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 and components; *iii*) IT equipment and systems; *iv*) IT services; *v*) software; and *vi*) telecommunication services. Broadcasting, media and content are excluded. Because many firms operate in more than one market segment, where possible firms are classified according to their official industry classification (primary SIC). Otherwise, they are classified according to their main ICT-related activity on the basis of revenue. In some cases a firm's primary SIC does not fully reflect its activities (*e.g.* IBM, which now derives the majority of its revenues from services and software). However, primary SIC classifications are followed for consistency. Where conglomerates have substantial ICT-related activities they are classified according to their major activities, principally electronics and components (*e.g.* Siemens). Others, with minority ICT-related activities (*e.g.* Hutchison Whampoa) are excluded. Nevertheless, a consistent and workable framework has been established.

The top 250 ICT firms are ranked by total revenue in the most recent financial year ending during 2005 or on the basis of the most recent four quarters to October 2005, with historical data drawn from company annual reporting. In each case, company name, country, industry, revenue, employment, R&D expenditure and net income are recorded. Income data are reported using generally accepted accounting principles (GAAP) where possible. Time series data reflect current reporting and restatements of historical data. The country base is the place of company registration.

Top 250 ICT firms

In 2005, the top 250 ICT firms had total revenues of USD 3 000 billion, some USD 570 billion more than in 2000 (in current USD for the same panel). Average revenue was USD 12 billion, with growth of 4% a year since 2000. The top 250 ICT firms employ some 10 million people worldwide, near the levels of employment recorded during the boom year of 2000. R&D expenditure held up well during the downturn and grown subsequently, with those reporting R&D expenditure spending a total of around USD 135 billion or 6.3% of revenue in 2005 (Figure 1.4).

Figure 1.4. **Top 250 ICT firms' performance trends, 2000-05**

Current USD, index 2000 = 100

Note: Averages for those reporting, preliminary 2005 data based on financial year reported in 2005 or most recent four quarters.

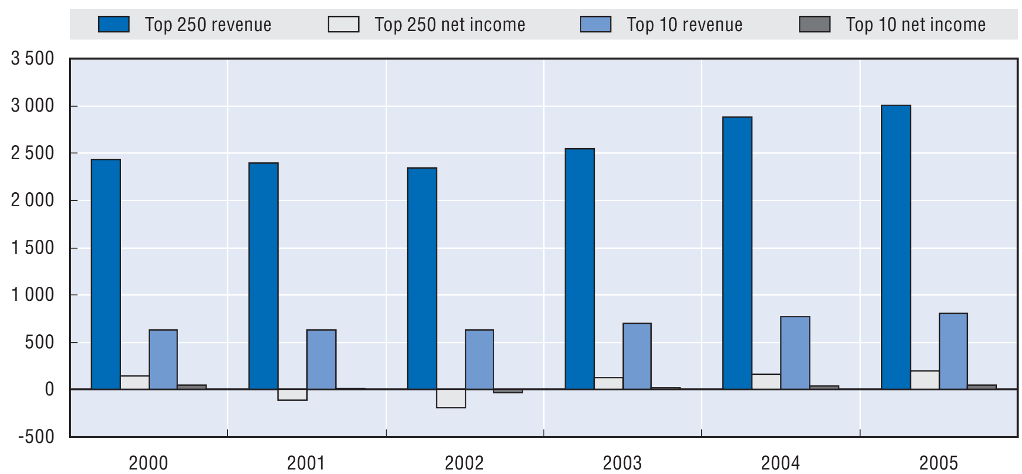
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/840327770178

While revenues held relatively stable during the downturn and have risen strongly since, net income fell dramatically in 2001 and 2002. Aggregate net income declined from a USD 144 billion net profit in 2000 to a net loss of USD 192 billion in 2002. The following year marked a return to profitability, with aggregate net profit of USD 131 billion in 2003 and USD 197 billion in 2005 (Figure 1.5). Higher-ranking firms performed better than lower-ranking ones, with the top 10 recording somewhat higher revenue growth overall and proportionally lower losses in 2001-02.

Figure 1.5. **Top ICT firms' total revenue and income trends, 2000-05**

USD billions, current prices



Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.

Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/615768156244

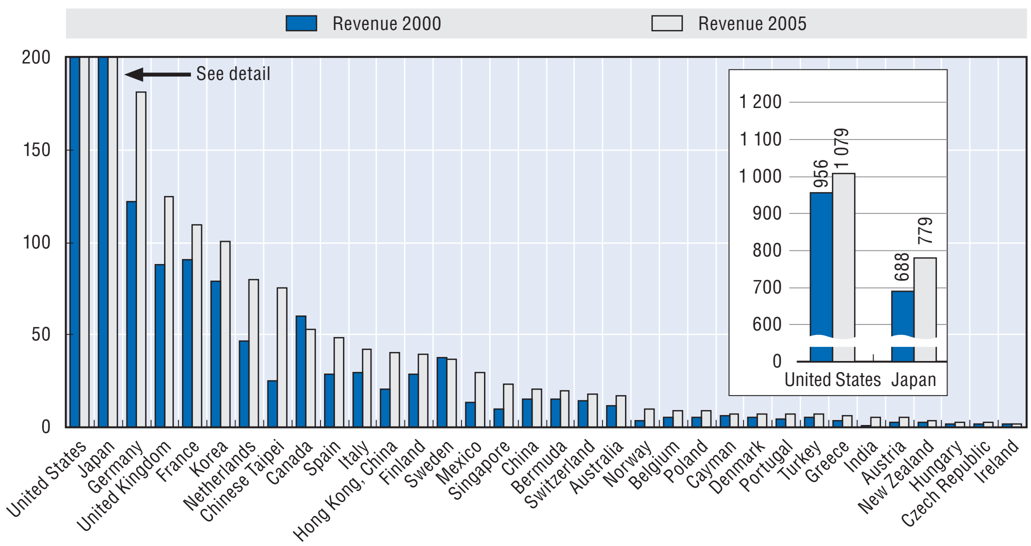
The top 100 ICT firms accounted for around 84% of the top 250 revenues in 2005, the top 50 for 67% and the top 10 for 27%. These shares have been relatively stable since 2000, suggesting little change in industry concentration despite high M&A activity. Shares of employment were also similar, with the top 100 accounting for 80% of top 250 employment in 2005, the top 50 for 64% and the top 10 for 26%. Of the firms reporting R&D expenditure, those in the top 100 spent an average of 6% of revenue on R&D, while those in the top 50 and the top 10 spent an average of 5.7%. Thus, lower-ranked firms have been spending a somewhat higher share of revenue on R&D; this may be because of specialisation in some sectors and the diversification of large conglomerate operations in others. Nevertheless, the higher-ranking firms have performed somewhat better than those lower in the rankings, with average revenues realised by the top 10 increasing by 5% a year between 2000 and 2005 and those of the top 250 by 4% a year. The higher-ranking firms have also increased R&D spending and employment faster, although their net income growth has been slower.

Top 250 ICT firms by economy

In 2005, the top 250 ICT firms reported 34 countries as bases (*i.e.* the country in which the firm is registered). The United States accounted for 46%, followed by the EU25 with 19%. There are signs of a shift towards Asia, with fewer US-based firms in the top 250 in 2005 than in 2001, and more firms from China, Hong Kong (China), India, Korea, Singapore and Chinese Taipei (Figure 1.6).

Figure 1.6. **Top 250 ICT firms' revenue by economy of registration**

USD billions, current prices



Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/824036708834

Regionally, firms based in the Americas accounted for 39% of the top 250 revenues in 2005 (USD 1 188 billion), 39% of total employment and 53% of overall net profit; firms based in the Asia-Pacific region accounted for 36% of revenue (USD 1 066 billion), 37% of employment and 28% of net profit; firms based in Europe accounted for 25% of top

250 revenue (USD 749 billion), 25% of employment and 18% of the net profit (see Table 1.A2.1). Firms based in the United States accounted for 36% of top 250 revenue in 2005, 34% of total employment and 49% of overall net profit (USD 97 billion).

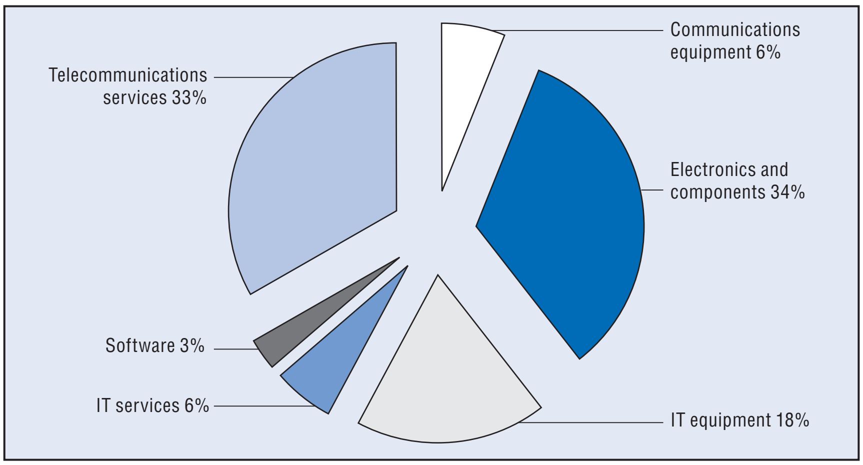
Firm performance has varied across countries. Regionally, revenues have grown faster over the last five years in Europe (7.2% a year) than elsewhere (4.6% a year in the Asia-Pacific and 2.5% a year in the Americas). Top 250 firm revenues declined in Canada and Sweden between 2000 and 2005 but increased by more than 20% a year in India, Chinese Taipei and Norway. Firms based in Finland, Sweden, Switzerland, the Netherlands, Korea and India accounted for a larger than average share of R&D expenditures. Differences in performance reflect the sectoral composition of firms, levels of specialisation and roles in global production systems, with performance often firm-specific.

Top 250 ICT firms by sector

In 2005, 80 of the top 250 firms were electronics and components manufacturers, 69 were telecommunication services providers, 40 were IT equipment and systems producers, 31 were IT services providers, 16 were communication equipment and systems producers, and 14 software publishers (Figure 1.7). Electronics and components firms and telecommunication services firms, each with about USD 1 000 billion, accounted for the largest shares of top 250 revenues (Figure 1.7 and Table 1.A2.2). IT equipment firms accounted for 18% of top 250 revenues, IT services and communications equipment firms each accounted for around 6% of top 250 revenues, and software firms accounted for just 3%. Average revenue was highest among telecommunication services firms, at USD 14.5 billion in 2005. IT equipment firms averaged revenues of USD 13.7 billion, electronics and components firms USD 12.6 billion, and communications equipment firms USD 11.3 billion. Software and services firms are on average smaller, with average revenues of USD 6.4 billion and USD 5.6 billion, respectively.

Figure 1.7. **Top 250 ICT firm revenue shares by sector, 2005**

Percentages



Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

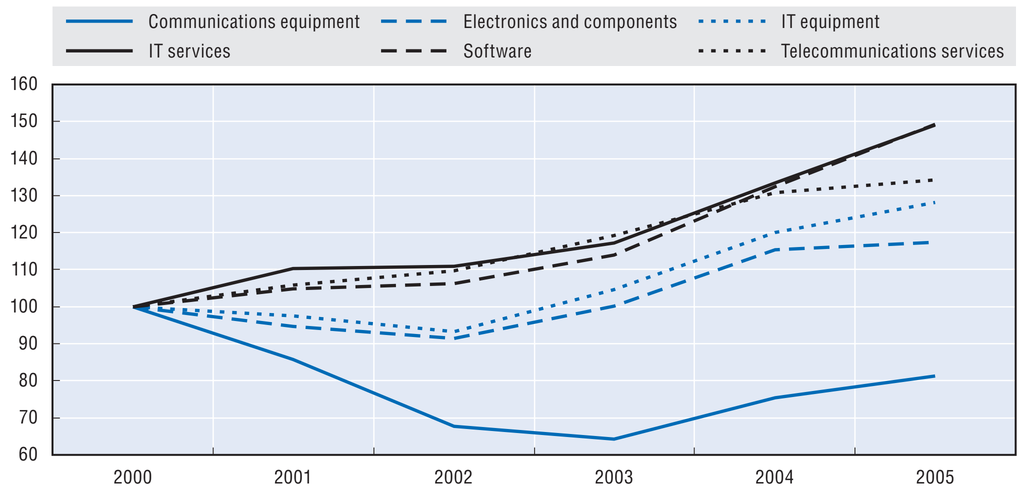
StatLink: http://dx.doi.org/10.1787/350131873778

The main cyclical feature of the last five years has been the collapse and recovery in communication infrastructure investment and its impacts on communications equipment firms. The infrastructure investment collapse and valuation write-downs in telecommunications services firms led to a dramatic fall-off in demand for communication equipment and to a lesser extent IT equipment. The downturn in telecommunications investment and ripple effects through the rest of the ICT sector is one of the main factors in the ICT downturn and subsequent recovery (Figure 1.8 and 1.9).

Revenue growth has been strongest in the software and IT services sector, each of which increased revenues by more than 8% a year between 2000 and 2005 (Figure 1.8). Telecommunications services firms' revenues increased at a steady 6% a year over the period, while IT equipment and electronics and component firms have seen revenues recover and return to growth after 2003. Firms in the communication equipment sector have suffered declines, with revenues falling by 36% between 2000 and 2003; they are still well down on their peak levels of 2000 and this has driven recent consolidation of the sector, for example the Alcatel-Lucent merger announced in April 2006.

Figure 1.8. **Top 250 ICT firm revenue trends by sector, 2000-05**

USD current prices, index 2000 = 100



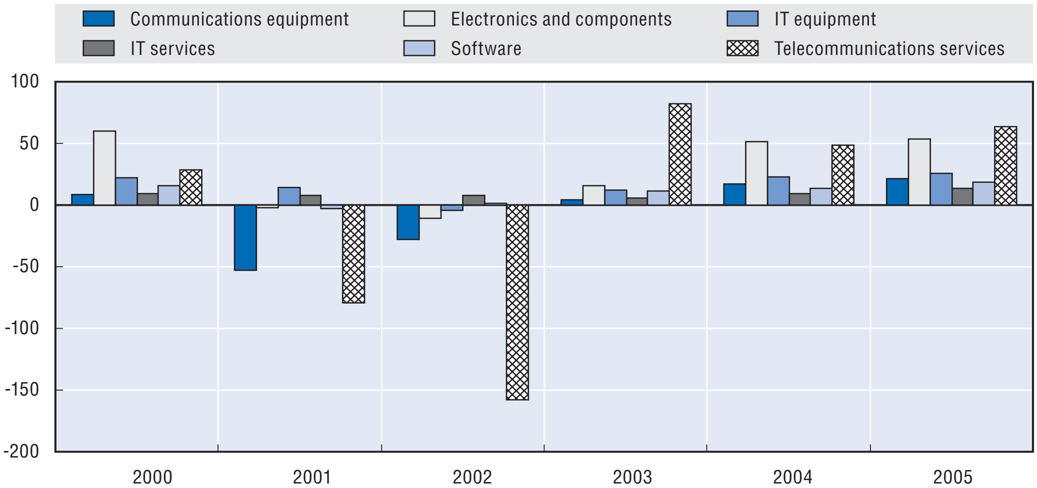
Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/450640248023

IT services alone remained profitable every year between 2000 and 2005; the top 250 firms in the telecommunications services, communications equipment and electronics and components sectors all experienced substantial losses (Figure 1.9). Nevertheless, profitability has returned to all sectors, with only the electronics and components sector yet to recover to the net income levels of 2000. Employment has grown relatively strongly in the IT services and software sectors. It has also increased in IT equipment and systems, which includes substantial services and software activities. Telecommunications services and communication equipment have experienced declines in employment, by 1% and 12% a year, respectively, between 2000 and 2005.

Figure 1.9. **Top 250 ICT firms, trends in net income by sector, 2000-05**

USD billions, current prices



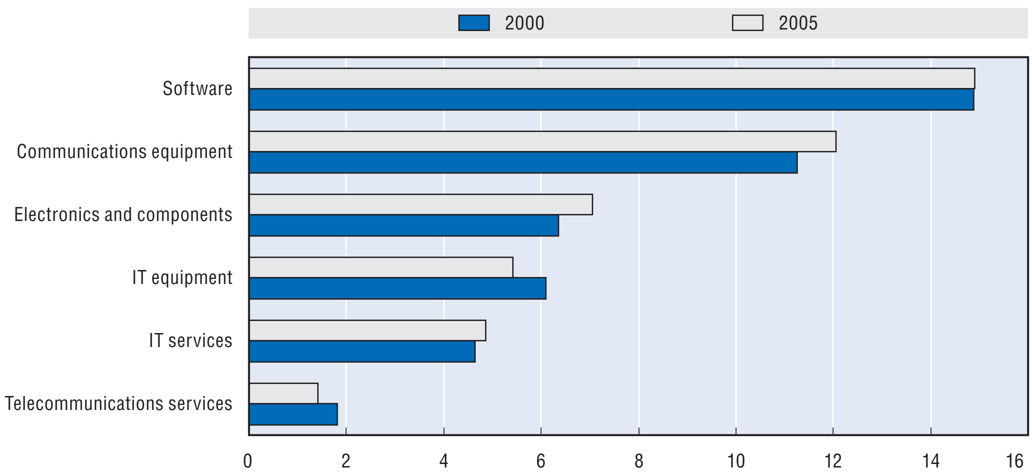
Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/632815753763

R&D expenditures of the top 250 ICT firm are concentrated in electronics and components firms (49% of the total in 2005), while IT equipment and systems firms account for 20% and communications equipment firms for 16% (Figure 1.10). However, over the period 2000-2005 software firms were the most R&D-intensive, and reported software and IT services R&D expenditures increased more rapidly over the period.

Figure 1.10. **Top 250 ICT firm R&D intensity by sector, 2000-05**

R&D spending as a share of revenue, percentage



Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/046860058833

Individual firm performance

There have been numerous entries into and exits from the top 250 since it was first compiled in 2001 (see OECD, 2002). New entrants are the result of such forces as deregulation and privatisation in telecommunications, spin-offs and organic growth. Chief among the new entrants are telecommunications and IT services firms (*e.g.* China Mobile, China Unicom, Singtel, Google, Yahoo!, Wipro and Infosys). Spin-offs include Benq, Palm and Infineon Technologies. A number of those exiting have been taken over (Compaq by Hewlett Packard, C-MAC Industries by Solectron, SCI Systems by Sanmina, and Peoplesoft by Oracle). Others have simply dropped below the revenue cut-off line (ACT Manufacturing, ASM International, Ciena, Cirrus Logic and Iomega).

Among the top 250 firms, revenues increased for 193 and declined for 53. Seven of the top 250 had growth in excess of 40% a year (Google, Research In Motion, Nextel Partners, UTStarcom, Lite-on Technology, Infosys and Hon Hai Precision). Of the 36 firms whose revenues increased by more than 20% a year between 2000 and 2005, 12 were based in the United States and seven in Chinese Taipei, three in Canada and two in the United Kingdom and in India. Two were in the top 50 (Hon Hai Precision and Vodafone) and 11 in the top 100. Fourteen of these fastest-growing firms were in telecommunication services, nine were in the IT equipment and systems sector, five in IT services, four in communications equipment, three in electronics and two in software.

Among the top 250 ICT firms, employment increased for 125 and decreased for 112 over the period 2000-05. There is no obvious sectoral pattern, with individual firms in all sectors doing well while others did poorly. Almost 100 of the top 250 ICT firms do not report R&D expenditures, but among those that do, eight spent more than 20% of revenue on R&D in 2004-05 (six in the electronics and components sector and two in the software sector). No fewer than 51 firms reported R&D spending in excess of 10% of revenues.

Top 50 ICT firms

In terms of 2005 revenues, the largest ICT firms are: NTT, IBM, Siemens, Hewlett-Packard, Hitachi, Matsushita Electric, Verizon, Deutsche Telekom and Sony (Table 1.A2.3). At the tail of the top 50, eleven firms earned revenues of less than USD 20 billion (Tech Data, MCI-Worldcom, Ericsson, Accenture, Emerson Electric, Ricoh, Telstra, Sumitomo Electric, Hon Hai Precision, Flextronics and Xerox). In terms of employment by the top 50, Siemens, Hitachi, Matsushita, IBM and China Telecom employ more than 250 000, and 26 employ fewer than 100 000.

Eleven of the top 50 ICT firms, most notably Hon Hai Precision and Vodafone, enjoyed double-digit revenue growth between 2000 and 2005; only ten experienced revenue declines. Double-digit employment growth was experienced by Hon Hai Precision, Vodafone, China Telecom, China Mobile and Hewlett-Packard (the last as a result of Compaq acquisition) and another five experienced double-digit declines. Profitability was also mixed. In 2005, 31 of the top 50 ICT firms made a net profit of USD 1 billion or more, with eleven (Microsoft, Verizon, France Telecom, Intel, IBM, Philips, Samsung, NTT, China Mobile, Cisco Systems and Telecom Italia/Olivetti) making more than USD 5 billion. Just five of the top 50 (Vodafone, MCI-Worldcom, Sanyo, Sprint-Nextel and EDS) were reporting a net loss for 2005.

While a number of ICT firms cut R&D budgets to control costs during difficult times, others saw the need to maintain and even increase expenditure in order to innovate in the

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

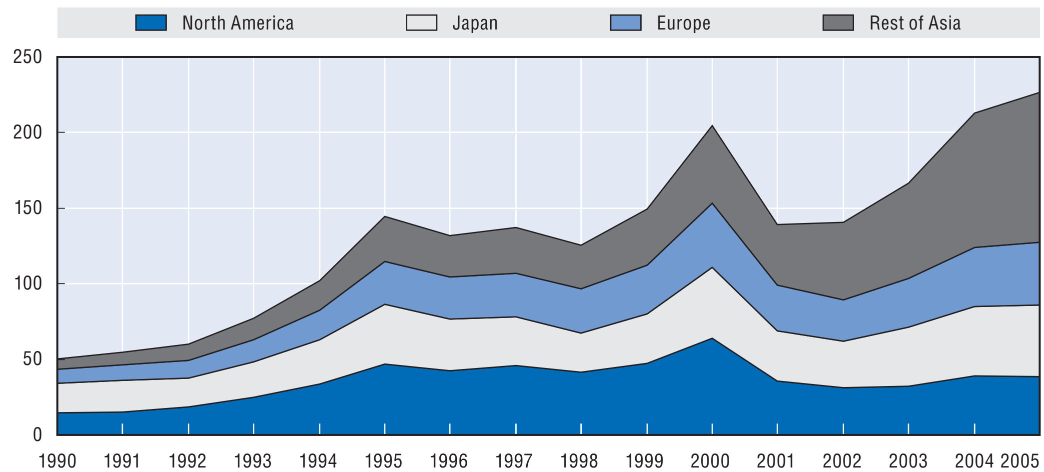
years ahead. Overall, 12 of the top 50 ICT firms reduced R&D expenditure between 2000 and 2005, and six significantly increased R&D spending (by 10% a year or more). R&D expenditure data are unavailable for 15 of the top 50 ICT firms. Of the remainder, nine spent more than USD 4 billion on R&D in 2004-05 and Microsoft, Siemens, IBM, Matsushita and Philips each spent more than USD 5 billion. Among the top 50, firms reporting R&D expenditure spent an average of 5.7% of 2005 revenues. However, R&D intensity varied considerably, with five of top 50 firms investing between 10% and 20% of revenue in R&D (Microsoft, 15.5%; Ericsson, 14.5%; Intel, 13.2%; Cisco Systems, 13%; Nokia, 12.2%), and some rather low levels.

Semiconductors

Semiconductors are a key intermediate input into ICT equipment, and a leading indicator of ICT market trends; production is highly cyclical, dropping sharply during a downturn and recovering quickly in an upturn. 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 in 2001, with sales down by 32% to less than USD 140 billion. Since then, sales have rebounded to reach an estimated new peak of USD 227 billion in 2005 (Figure 1.11) and are expected to be somewhat stronger in 2006 (Dataquest, 2006).

Figure 1.11. **Worldwide semiconductor market by region, 1990-2005**

USD billions, current prices



Note: 2005 data are forecast (October 2005).
Source: World Semiconductor Trade Statistics (WSTS).

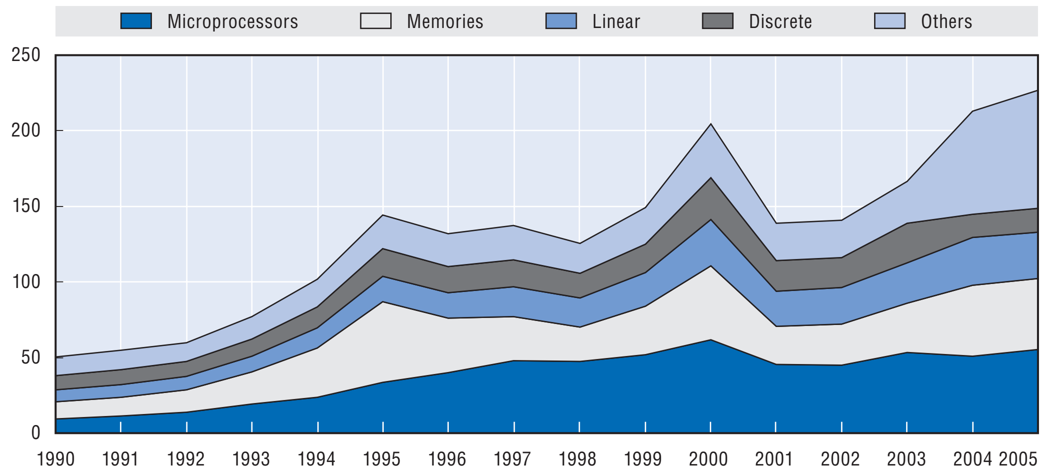
StatLink: http://dx.doi.org/10.1787/480556777335

Asia is now the leading market for semiconductors. By 2005, Asia accounted for almost 44% of worldwide sales, Japan for 21%, Europe for 18% and North America for just 17% (Figure 1.11). All regions participated in the boom of 2000, with markets in Japan and the rest of Asia growing somewhat faster than those in Europe and North America. The downturn in 2001 was felt most severely in North America, with a drop of more than 44%; Japan and Europe had declines of around 30% and the rest of Asia 20%. Asia led the recovery in 2002, growing by more than 28%; all other regions continued to decline. Data for 2003-05 reveal an uneven return to growth, with the Asian market (excluding Japan) growing by 26% a year and slower growth in Europe (13%), Japan (10%) and North America (9%).

Over 1990-2005, sales of microprocessors, memories and other specialist devices (*e.g.* opto-electronics) have increased most rapidly, while sales of other devices have experienced below-average growth (Figure 1.12). The downturn as well as the recovery have affected all product groups.

Figure 1.12. **Worldwide semiconductor market by segment, 1990-2005**

USD billions, current prices



Note: 2005 data are forecast (October 2005).
Source: World Semiconductor Trade Statistics (WSTS).

StatLink: http://dx.doi.org/10.1787/221623810564

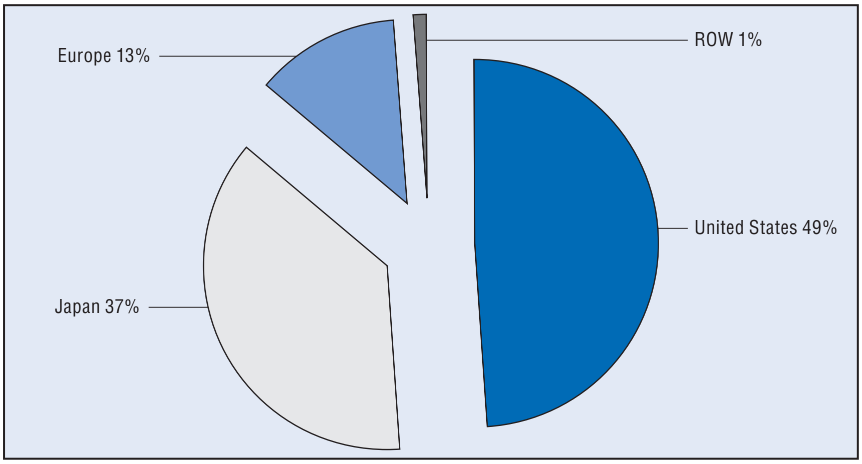
Demand for semiconductor production equipment reflects projections of semiconductor capacity utilisation and demand, and is an indication of semiconductor firms' expectations regarding future sales. Although demand was strong in some consumer electronics segments, semiconductor capital equipment spending declined in 2005, following strong growth in 2004. In late 2005, capital equipment expenditure was forecast to decline by around 12% in 2005 (to USD 33 billion), with wafer fabrication equipment declining by 9.5% (to USD 25 billion), packaging and assembly equipment by 15% (to USD 4 billion) and automated testing equipment by 21% (to USD 3.8 billion). All but wafer fabrication equipment are expected to recover during 2006, and strong growth is predicted for all segments in 2007 and 2008 (Gartner, 2005d). Key drivers are expected to be end user demand for cellular phones, personal computers, digital televisions and cameras (SIA, 2005a).

US-based manufacturers account for around 50% of worldwide semiconductor manufacturing equipment sales, Japanese manufacturers for 37%, and European manufacturers for 12% (Figure 1.13). China plays an increasingly important role as a market for semiconductor equipment, accounting for more than 30% of European semiconductor capital equipment manufacturers' sales in 2004 (The Information Network, 2005). The US Semiconductor Industry Association recently noted that "there is no question that a major migration of chip manufacturing activities toward Asia is under way. More than two-thirds of all the state-of-the-art chip making facilities now under construction are being built in Asia" (SIA, 2005b).

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Figure 1.13. **Worldwide market share of front-end semiconductor equipment manufacturers, 2004**

Percentages



Source: The Information Network, October 2005.

StatLink: http://dx.doi.org/10.1787/624330025611

Renewed growth in many ICT and related electronics equipment markets has led to a return to growth in semiconductor sales, with sales in 2004, 2005 and 2006 exceeding the previous peak of 2000. Asian markets for semiconductors are growing faster than others as electronics equipment assembly activities in Asia play an increasingly important role in global production. Semiconductor fabrication is therefore relocating to be closer to these growth markets.

Structural change in the ICT sector

Value added and employment

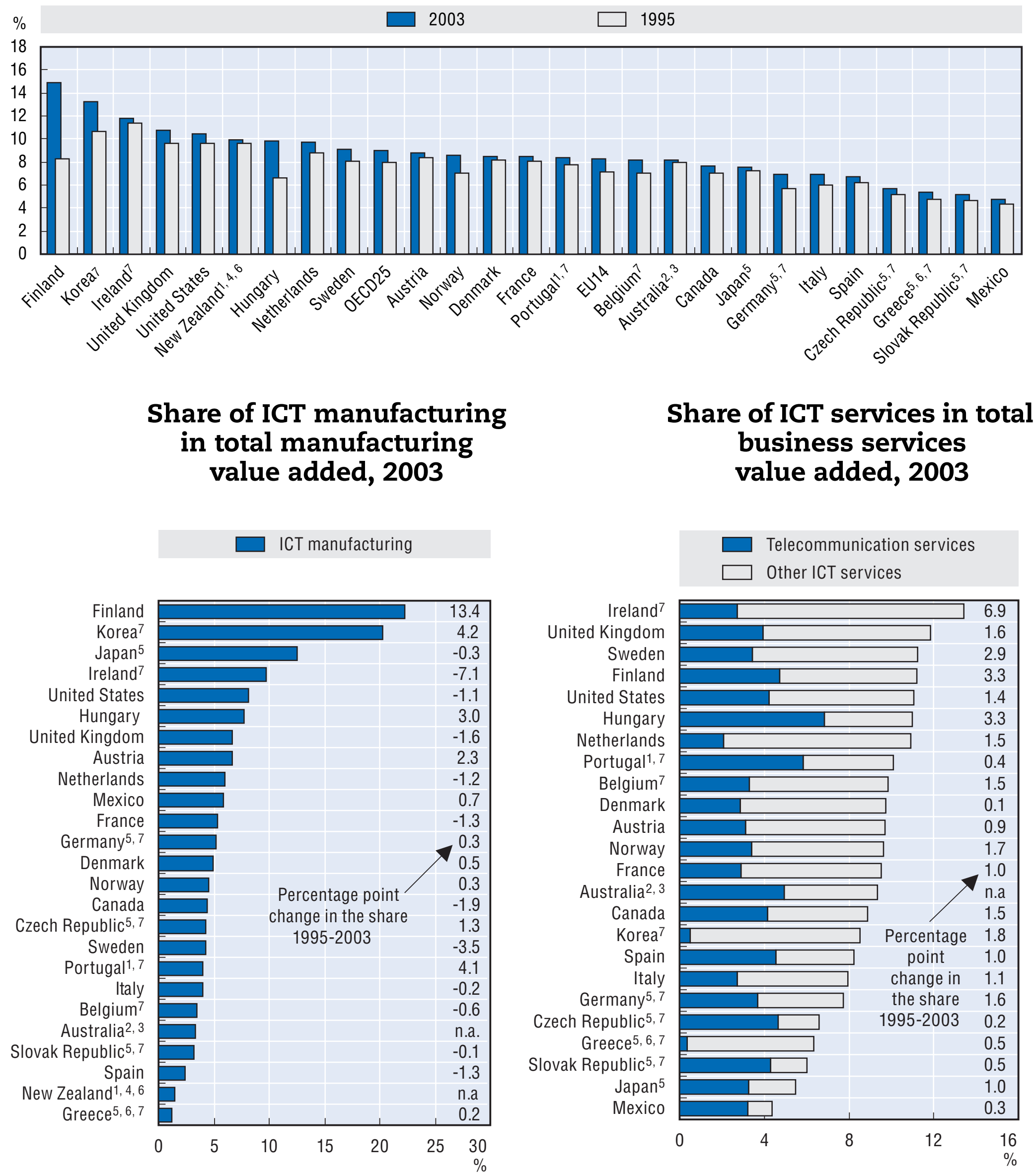
Long-term prospects are good for sustained growth in the ICT sector. New goods and services will drive demand from businesses, households and governments; replacement ICT investment will help boost demand; and IT services are underpinned both by the expanding use of software and the increasing recourse to outsourcing IT services and ICT-enabled services. This section analyses the ICT supply side (value added and employment) across the economy, using official data and OECD definitions of the ICT sector.[1]

Value added

Value added in the ICT sector increased as a share of business sector value added in all OECD countries over the period 1995-2003, in spite of the downturn in the early 2000s. The share of the ICT sector in total business value added was over 9% in 2003 (after peaking at close to 10% in 2000), up from 8% in 1995. Following the decline in 2001 and 2002, most countries stabilised or increased their ICT value added shares in 2003, with the recovery strongest in Korea and Ireland. The rising share of the ICT sector in total value added was strongest in Finland (6.7 percentage points), Hungary (3.2 percentage points) and Korea (2.5 percentage points). In 2003, the ICT sector accounted for 15% of total business sector value added in Finland, 13% in Korea and 12% in Ireland (Figure 1.14).

Figure 1.14. **Share of ICT valued added in business sector value added, 1995 and 2003**

Percentages



1. 1996 instead of 1995.
2. 1998 instead of 1995.
3. 2000 instead of 2003.
4. 2001 instead of 2003.
5. ICT wholesale (5150) is not available.
6. Telecommunication services (642) included Postal services.
7. Rental of ICT goods (7123) is not available.

Source: OECD estimates, based on national sources; STAN and National Accounts databases, March 2006.

StatLink: http://dx.doi.org/10.1787/878500233257

ICT services account for more than two-thirds of overall ICT sector value added in most OECD countries, and over 1995-2003 most have seen strong and sustained growth in ICT services, particularly communications services and software (Figure 1.14). In some countries value added in ICT manufacturing as a share of total manufacturing is well above the OECD average; the share is 22% in Finland and 20% in Korea. It is also above average in Japan and to a lesser extent in Mexico.

There are strong parallels between the shares of ICT in value added (in both manufacturing and services) and relative trade performances as specialisation in the ICT sector reflects the relative strengths of national firms and national factor endowments (see Chapter 2). Finland, Korea, Japan, Ireland, the United States and Hungary (in decreasing order) all have high ICT manufacturing value added shares, relatively strong export performance and positive revealed comparative advantages in ICT goods exports. Ireland also has a high share of value added in computer and related software services, which is reflected in its role as the leading exporter of computer and information services (see Chapter 2).

Employment

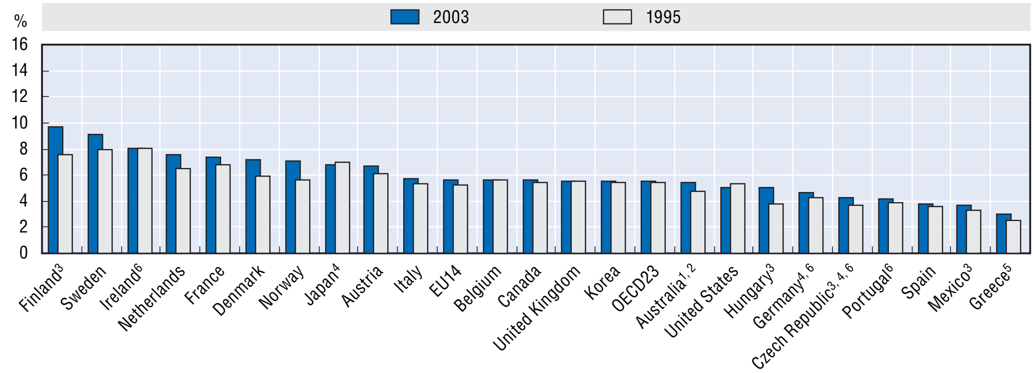
In 2003 more than 14.5 million people were employed in the ICT sector in OECD countries, or more than 5.5% of total OECD business sector employment. Over 1995-2003, ICT sector employment increased by almost 8% (over 1 million people), but in most countries it remained approximately stable. Five million were employed in manufacturing and 9.5 million in services; the share of ICT manufacturing in manufacturing employment was 7.2% and the share of ICT services in services 4.9% as ICT manufacturing tends to be more labour-intensive than ICT services as a whole. Countries with the largest relative employment increases were Finland, Norway, Denmark, Sweden, Hungary and the Netherlands. The share of ICT employment in total manufacturing is high in Korea, Ireland, Japan, Mexico and Finland, and the share in services is highest in Sweden, Finland, Denmark and France (Figure 1.15).

Overall, Japan and Europe tend to have more labour-intensive ICT industries, and Korea and the United States less labour-intensive ones (see the relative rankings in Figures 1.14 and 1.15). This probably reflects differences in services structures, with higher productivity per employee in services in Korea and the United States and lower productivity in Japan and Europe. It may also reflect in part more advanced offshoring practices in the United States which increase efficiency in services.

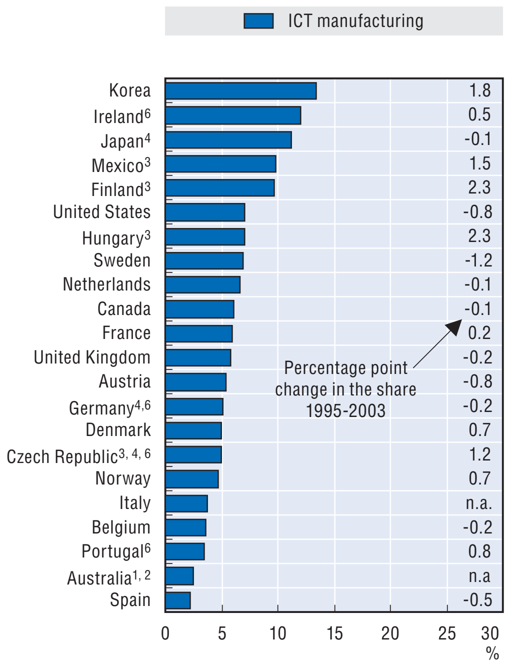
Countries with high revealed comparative advantages in ICT goods exports (Korea, Hungary, Ireland, Japan, Mexico, the Netherlands and Finland, see Chapter 2) have a range of production structures and strategies, illustrated by their manufacturing value added/ employment ratios (in current USD). For Finland and Japan the ratios are high and point to innovative and capital-intensive manufacturing activities, while those for Korea and the Netherlands are somewhat lower and suggest that factors other than simple ICT manufacturing productivity drive export performance. Ireland's position contrasts strongly with those of Hungary and Mexico, although all are assembly platforms for exports by international ICT firms. Ireland has a very high ratio, which is related 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 in their export performance (see Chapter 2 on Ireland's exceptional software and computer and IT services trade).

Figure 1.15. **Share of ICT employment in business sector employment, 1995 and 2003**

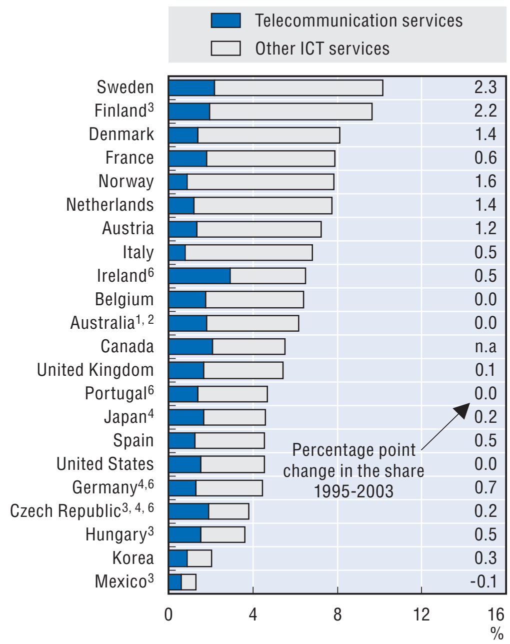
Percentages



Share of ICT manufacturing in total manufacturing employment, 2003



Share of ICT services in total business services employment, 2003



1. 1998 instead of 1995.
2. 2000 instead of 2003.
3. Based on employees figures.
4. ICT wholesale (5150) is not available.
5. Telecommunication services (642) includes Postal services.
6. Rental of ICT goods (7123) is not available.

Source: OECD estimates, based on national sources; STAN and National Accounts databases, March 2006.

StatLink: http://dx.doi.org/10.1787/453161448788

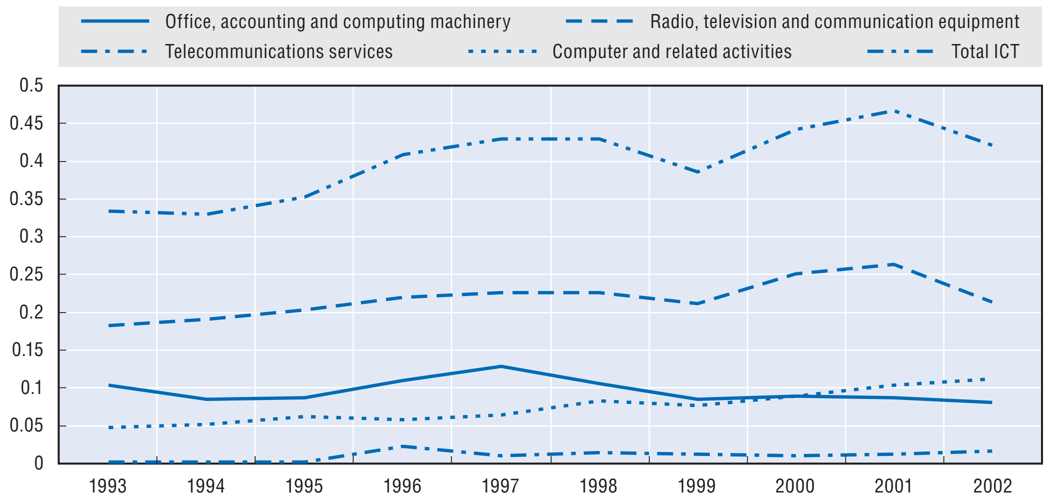
Industry drivers

ICT R&D

Research and development is a major driver of ICT growth and change. The ICT sector is relatively R&D-intensive and its R&D intensity has been increasing. A striking feature of the composition of R&D has been the shift away from computer hardware and towards computer and related services. This section looks at growth of ICT R&D for 1993-2003 for 19 OECD countries ("OECD-19", and 11 EU-15 countries, "EU-11") to the extent that official data are available. In some cases missing data are estimated to provide comparisons over time.

ICT R&D expenditure as a share of GDP. OECD-19 countries have increased their share of ICT R&D expenditures by the equivalent of 0.1 percentage point of GDP over the last decade, from over 0.3% in 1993 to over 0.4% in 2002 (Figure 1.16).[2] The share declined a little in 2002, but for countries for which data are available for 2003, there was an increase in Radio, television and communication equipment and in Telecommunications services, mainly driven by expenditure increases in Korea, and decreases in the other two sub-sectors. Finland, Korea and Sweden had considerably higher than average shares of ICT R&D expenditure in GDP, reflecting their relative specialisation (Figure 1.17).

Figure 1.16. **ICT R&D percentage share in GDP**



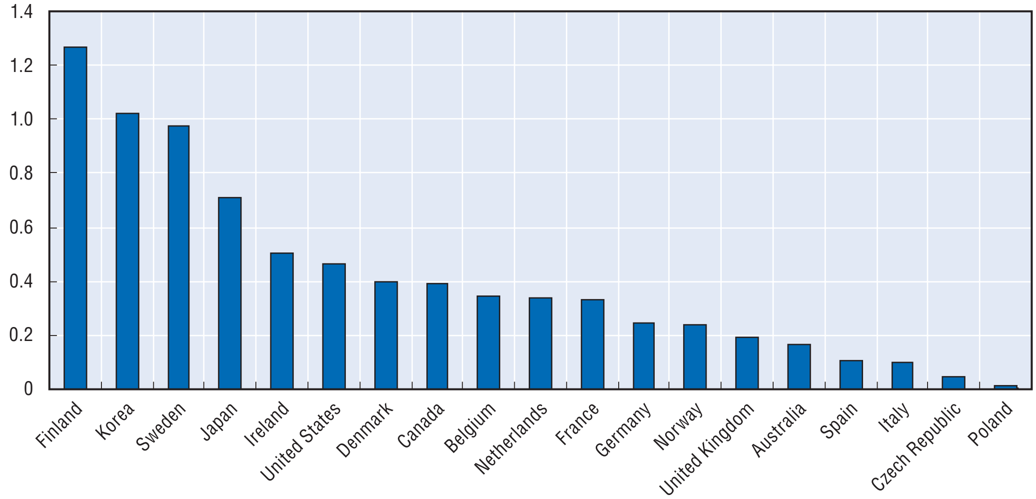
Source: OECD, ANBERD.

StatLink: http://dx.doi.org/10.1787/061041768654

In terms of absolute ICT R&D expenditures in 2002, the leaders were the United States, with 43.2% of the total, and Japan with 21.8% (shares of total expenditures for the 19 OECD countries with detailed data). In the EU15, 12 countries accounted for 22.8% of the total.

ICT R&D expenditure in total business R&D expenditure. Trends in shares of ICT R&D expenditure in total business R&D expenditure are very similar to shares in GDP. Ireland, Korea and Finland had the highest shares and the gap with other countries has widened as they have increasingly specialised in ICT R&D and the ICT industry (see above). Finland increased its share in 2003 (mainly in Radio, television and communication equipment), as did the Czech Republic (in Computer and related activities – possibly linked with inward investment in the sector). Shares declined somewhat in Sweden, Norway and Italy. In terms of source of funds, business funding represents over 90% of total business and government funding in all countries for which official data are available.

Figure 1.17. **ICT R&D percentage share in GDP by country, 2002**

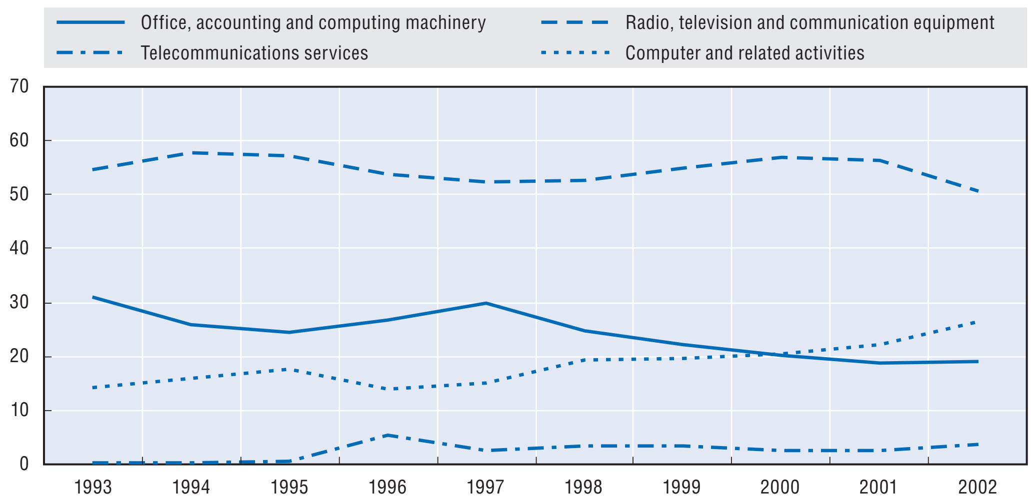


Source: OECD ANBERD.

StatLink: *http://dx.doi.org/10.1787/634770822861*

ICT sub-sector R&D expenditures. Around half of total ICT R&D is in Radio, television and communication equipment (including electronic components and semiconductors), a share that rises and falls in line with the output cycle of the semiconductor industry (see section on semiconductors) (Figure 1.18). Owing to the increasing importance of software in ICTs, there has been a significant increase in the share of Computer and related activities (service activities, which includes software and IT services) and to a lesser degree in Telecommunications services.[3] At the same time there has been a marked decrease in the share of R&D in ICT goods, particularly Office, accounting and computing machinery; since 2001 it has had a smaller share of R&D than Computer and related service activities (software and IT services) as hardware is increasingly commoditised and software gains in relative importance.

Figure 1.18. **ICT sub-sector R&D expenditures as a share of total OECD area ICT R&D**



Source: OECD, ANBERD.

StatLink: *http://dx.doi.org/10.1787/462567256388*

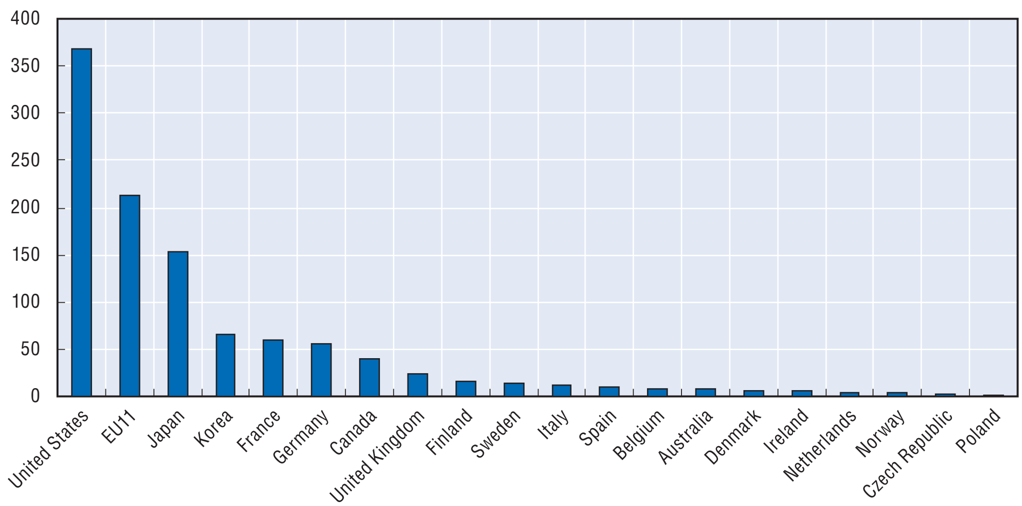
Countries tend to specialise in one sub-sector. In 2002, Finland made 90% of its ICT R&D expenditure for Radio, television and communication equipment, Sweden 86% and Korea 85%. The Netherlands (80%) and Japan (42%) emphasised Office, accounting and computing machinery. Denmark (61%), Australia (57%) and the Czech Republic (52%) focused on Computer and related services, and Poland (51%) and Spain (37%) devoted a large share of expenditure to Telecommunications services.

Type of cost. Current expenditure represents by far the largest share of R&D expenditure (current and capital expenditures), at about 88% in 2002 (simple and weighted averages), a share that is stable over time and varies little across countries.[4] Most of this expenditure goes to R&D labour costs. On average, current expenditure represents a larger share of total R&D expenditure for the ICT sector than for the total business sector, suggesting that ICT R&D is relatively labour-intensive.

Personnel. Total ICT R&D personnel in OECD-19 grew by 34% from 635 000 in 1993 to over 850 000 in 2002 (measured in full-time equivalents) and by around 45% in EU-11.[5] The United States has a wide lead in total numbers (Figure 1.19). In terms of R&D expenditures per R&D employee (calculated in PPPs), Japan, Korea and the United States all spent above average, whereas the EU11 spent below average, with Sweden a notable exception. This suggests that European ICT research could benefit from increased effort in terms of expenditure intensity.

The countries with the largest share of ICT R&D personnel in total R&D personnel are Ireland (64%), Korea (54%), Finland (52%) and Canada (52%), which also have the highest shares of ICT R&D expenditure in total R&D expenditures and (with the exception of Canada) high shares of ICT value added and comparative specialisation in ICT goods exports. Shares of personnel and expenditure are highly correlated owing to the high level of current expenditures (largely wages) in total expenditure. For an estimated 1 percentage point increase in the share of ICT R&D personnel in total R&D personnel there is a 0.8 percentage point increase in the share of R&D expenditure. Overall, ICT R&D will continue to be a major driver of ICT innovation and growth in new and improved goods and services.

Figure 1.19. **ICT R&D personnel 2002 (full time equivalents)**



Source: OECD, BERD. Missing values have been partly estimated.

StatLink: http://dx.doi.org/10.1787/846623686761

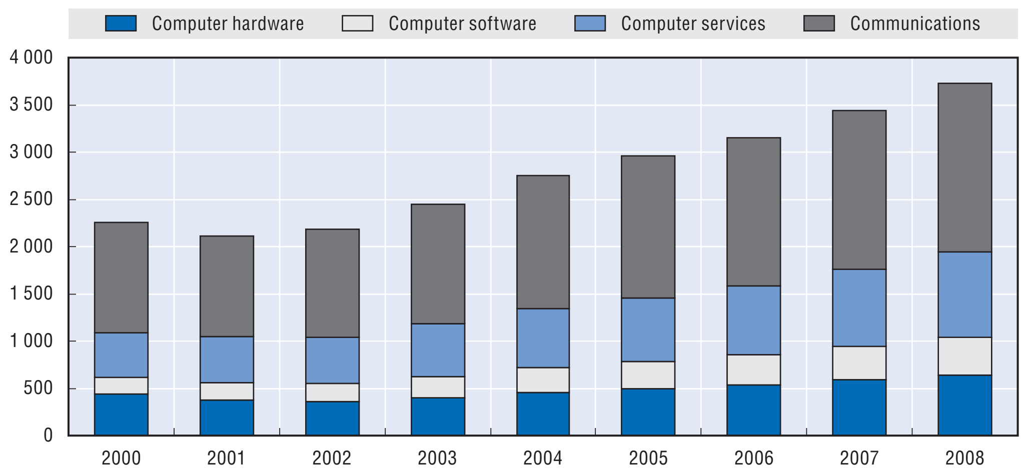
ICT markets and spending[6]

ICT market data confirm an overall trend towards renewed but slower ICT growth in the near future. Total worldwide ICT spending reached an estimated USD 2 964 billion in 2005, of which 84% (USD 2 483 billion) by OECD member countries (see Table 1.A2.5). In 2006, the share of OECD countries was 83%, down from 89% in 2000. The North American market is the largest, accounting for 40% of worldwide ICT spending in 2005 (USD 1 185 billion), western Europe accounts for 27% (USD 814 billion) and the Asia-Pacific region for 24% (USD 717 billion). With the emergence of new growth economies as markets for ICTs, worldwide ICT spending was up 5.6% a year from 2000, and OECD spending was up by a somewhat slower 4.2% a year.

Worldwide, more than half of 2005 ICT spending was on communications services and hardware, 23% was on computer services, 17% on computer hardware and 10% on software. Against continuing declines in equipment prices, software spending has increased the most rapidly since 2000 (by 10% a year), computer services spending has increased by 7.4%, communications services and hardware spending by 5.2%, and computer hardware spending by 2.3% (Figure 1.20).

Figure 1.20. **Worldwide ICT spending by market segment, 2000-08**

USD billions in current prices



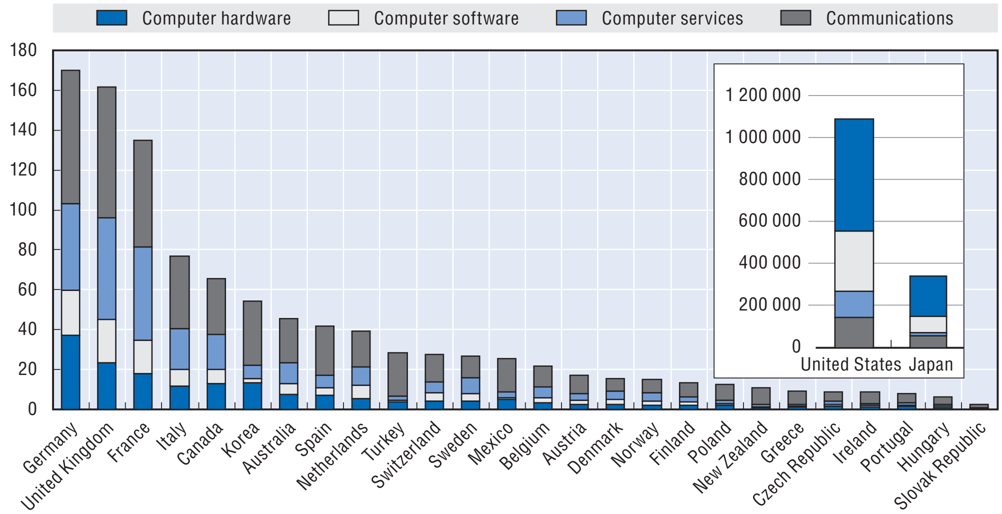
Note: Data for 2005 to 2008 are forecasts.
Source: OECD, based on data provided by WITSA.

StatLink: http://dx.doi.org/10.1787/378082664878

The United States, by far the largest national market, spent some USD 1 094 billion in 2005: USD 537 billion on communications services and hardware, USD 288 billion on computer services, USD 145 billion on computer hardware and USD 126 billion on software (Figure 1.21). Japan, the second largest spender (USD 342 billion), spent less than one-third as much as the United States. Other major markets included Germany (USD 170 billion), the United Kingdom (USD 162 billion), and France (USD 135 billion). Outside the OECD area, China was the sixth largest market in 2005 at USD 118 billion, Brazil ranked ninth (USD 62 billion), India eleventh (USD 46 billion) and Russia seventeenth (USD 27 billion).

Figure 1.21. **ICT spending by market segment, 2005**

USD billions in current prices



Source: OECD, based on data provided by WITSA.

StatLink: http://dx.doi.org/10.1787/264101825473

Among OECD member countries, the Slovak Republic, the Czech Republic, Hungary, Greece, New Zealand, Turkey, Spain and Poland all increased their ICT spending by more than 12% a year between 2000 and 2005. North American spending was subdued, and the United States (3.2% a year), Mexico (6.8%) and Canada (8.2%) were among the OECD member countries with slowest growth in ICT spending over the period. Japan was the only OECD member country with declining ICT expenditures in recent years, with spending falling from USD 400 billion in 2000 to USD 342 billion in 2005, although it is now increasing and expected to exceed USD 400 billion in 2008.

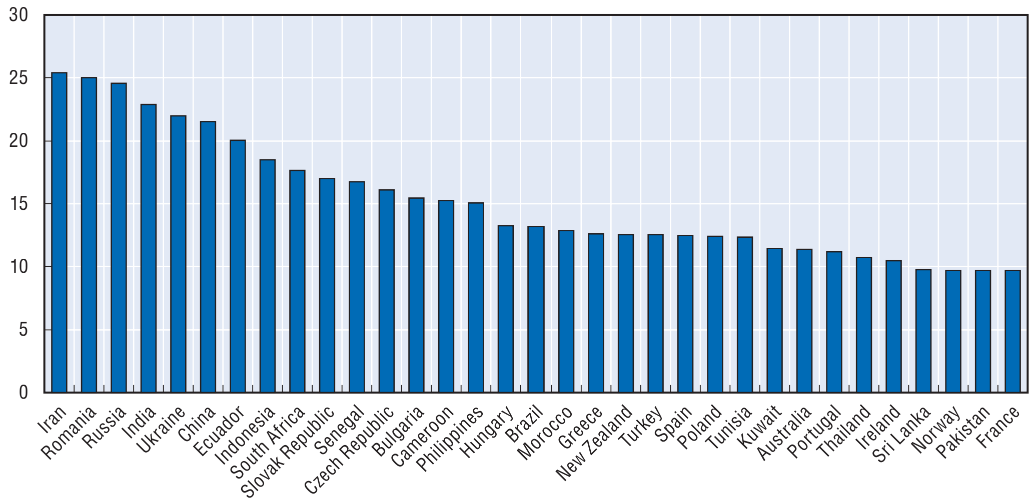
For cyclical, structural and regulatory reasons, and because levels of in-house production of software and IT services vary from country to country, there are significant differences in expenditure shares by market segment. Among OECD member countries:

- Communications services and hardware accounted for more than 60% of total 2005 ICT spending in Turkey, New Zealand, Greece, Ireland, Mexico, Poland, Hungary, the Slovak Republic and Portugal, but less than 40% in Germany, Denmark and Sweden.
- Computer hardware accounted for more than 20% of total 2005 ICT spending in Korea, Germany and Mexico, but less than 10% in New Zealand.
- Computer software accounted for more than 13% of total 2005 ICT spending in the Netherlands, Denmark, Switzerland, the United Kingdom and Germany, but less than 5% in Mexico, Turkey, Korea, New Zealand and Japan.
- Computer services accounted for more than 30% of total ICT spending in France, the United Kingdom and Sweden, but less than 10% in Greece and Turkey.

ICT spending is increasing rapidly in some emerging non-member economies (Figure 1.22 and Table 1.A2.6). China's ICT spending is estimated to have been USD 118 billion in 2005, having grown by 22% a year since 2000. ICT spending in India and Russia has increased even more rapidly over the period, with spending increasing 25% a year to USD 27 billion in Russia, and by 23% a year to USD 46 billion in India. In terms of growth in ICT spending between 2000 and 2005, Russia ranks third worldwide, India fourth, and China sixth. Their spending on computer hardware in 2005 was relatively high, at 41% of total ICT spending in China and 22% in India (OECD average 15%). However, at between 5% and 10% of total ICT spending, spending by India and China on software and services was below the OECD average, suggesting priorities for basic hardware investment, and preference for in-house services and development and, perhaps, low-cost and open source software.

Figure 1.22. **ICT spending growth, 2000-05**

Annual average growth, percentage



Source: OECD, based on data provided by WITSA.

StatLink: http://dx.doi.org/10.1787/664061085350

Conclusion

The outlook for the ICT sector, ICT investment and ICT markets has continued to improve, showing more balanced growth, since the *Information Technology Outlook 2004*. The macroeconomic outlook has improved and is more balanced across major economic zones, and investment has increased. ICT investment (including software) is a significant and growing share of total investment, and it is increasingly correlated with overall capital formation. It is unlikely to achieve the rapid growth of the 1990s, although some segments are very dynamic (Internet-related investment, portable and consumer applications).

Recent growth in short-term ICT indicators parallels macroeconomic performance and aggregate investment. Production and markets have been robust in the United States and more subdued in Europe and in Japan until recently, although export performance has tended to be strong across most countries, and growth has been rapid in other Asian countries. Forecasts from private sources and IT spending and ICT market data confirm the prospect of moderate worldwide growth of 6% in 2006, slightly down from 2005. With the emergence of new growth economies, worldwide ICT spending was up 5.6% a year over 2000-05, while OECD spending was up by a somewhat slower 4.2%, and the OECD world market share has dropped from 89% in 2000 to 83% in 2006. ICT spending is increasing most rapidly in some emerging non-member economies. China's ICT spending is estimated to have been USD 118 billion in 2005, following growth of 22% a year since 2000; and in India and Russia it has increased by 23% and 25%, respectively, in current USD.

A compilation of the leading ICT firms is used to track recent performance in the ICT sector. The top 250 ICT firms, representing well over one-half of the ICT sector, show a solid recovery from a sharp downturn. At national level, Japanese electronics conglomerates have slipped in the revenue rankings, while equipment producers from elsewhere in Asia have emerged strongly and software and services firms from India are growing rapidly. Electronics manufacturers from Chinese Taipei have been among the fastest-growing, and China and India play increasingly important roles. Semiconductors, a key intermediate input into ICT equipment, are a leading indicator of ICT market trends, and sales have been strong recently, with Asia growing particularly rapidly, although overall growth is likely to be somewhat slower in 2006 after very rapid growth from the upturn in 2003.

Although these growth rates would be viewed very positively in many industries, the ICT industry is adjusting to more moderate times following annual growth of 20-30% in the 1990s. As many ICT products become commodities, rapid growth is now in new and niche products and emerging markets. Both open source (the "Linux effect") and online delivery of IT services (the "Google" effect) are disrupting how technology is developed and delivered, and relatively high merger and acquisition activity and restructuring are expected to continue in IT services, telecommunications and digital content as industries and firms adapt to changing technological opportunities, although current high M&A levels are probably not sustainable.

Research and development is a major driver of ICT growth and change, and R&D performance has remained dynamic despite some signs of slowdown. Official R&D data for 19 OECD countries shows that their share of ICT R&D expenditures increased by the equivalent of 0.1 percentage point of GDP over the last decade, from over 0.3% in 1993 to over 0.4%. For countries for which recent official data are available, R&D expenditures for communication equipment and components and for computer and related services activities have increased, paralleling the relative shift in R&D in the top ICT firms over the period 2000-05.

Notes

1. The data in this section and in Figures 1.14 and 1.15 have been extensively revised and updated since the *Information Technology Outlook 2004* and should not be directly compared with the previous data set.
2. The "ICT" sector is defined to comprise: ISIC Rev.3 30 Office, accounting and computing machinery; 32 Radio, television and communication equipment (which includes electronic components and semiconductors); 642 Telecommunications; 72 Computer and related (service) activities. 33 Medical, precision and optical instruments are not included although they are included in the value added and employment data above, and the trade data in Chapter 2.
3. Values for Telecommunications are low, at only 3.8% of ICT R&D expenditure in the OECD area. But the sector's share is underestimated owing to missing values.
4. The standard deviation between countries is only 6.2 percentage points.
5. Data partly estimated and may underestimate the actual totals.
6. This section uses data from WITSA, *Digital Planet,* available at *www.witsa.org/digitalplanet/*.
7. IBM is classified here as a hardware firm, based on its classification in US SEC filings under "Computer and Office Equipment" (US SIC 3570), even though the major part of its activities are in IT services and software.

References

Dataquest (2006), "Semiconductor capital equipment demand to rise in 2006", 17 April.

Financial Times (2006), "Investors piling into Internet media", 7 May.

Gartner (2005a), "Market Databook June 2005 Update", Gartner Dataquest, 5 July.

Gartner (2005b), "Forecast scenarios: Semiconductors, hardware and systems, worldwide, 2004-2006 (3Q05 Update)", Gartner Group, 29 September.

Gartner (2005c), "Major forces changing the software industry, 2005 update", Gartner Group, 11 November.

Gartner (2005d), "Semiconductor Capital Equipment Sales Correction Stretches into 2006", Gartner Group, October.

Gartner (2006), "Market trends: PC forecast analysis, worldwide, 2006 update", Gartner Group, March.

IDC (2005), Press release: "IDC predicts that moderate spending growth will push IT vendors towards disruptive business models", IDC, 1 December.

IDC (2006a), Press release: "IDC sees firming conditions in worldwide IT spending, market growth will exceed 6% in 2006", IDC, 23 March.

IDC (2006b), Press release: "Globalization, standardization, and automation drive changes in the $663 billion worldwide services industry", IDC, 18 April.

IDC (2006c), Press release: "PC shipments continue double-digit expansion in the first quarter", IDC, 19 April.

IDC (2006d), Press release: "Worldwide mobile phone market exhibits strong year-over-year growth on continued strength of developing markets", IDC, 20 April.

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

OECD (2004), *OECD Information Technology Outlook 2004*, OECD, Paris.

OECD (2006), *OECD Economic Outlook No. 79*, May, OECD, Paris.

SIA (2005a), "SIA Projects 6 per cent Growth for Global Semiconductor Sales", Semiconductor Industry Association, June.

SIA (2005b), "Semiconductor Industry Sees Globalization as Growth Opportunity", Semiconductor Industry Association, July.

The Information Network (2005), "US Capture 50 per cent of Global Semiconductor Processing Equipment in 2005", TIN, October.

WSTS (2005), "WSTS Semiconductor Market Forecast", *World Semiconductor Trade Statistics*, May.

ANNEX 1.A1

ICT Firms

Top 10 firms in each sector

Large electronics and telecommunication services firms dominate the top 50 and overshadow the major players in other industry sectors. There is, for example, only one software firm in the top 50. This annex explores the activities of the top 10 firms in each ICT industry sector: communications equipment and systems, electronics and components, IT equipment and systems, IT services, software and telecommunication services (Table 1.A1.7 at the end of this annex briefly describes the activities of the top 10 firms in each of the industry sectors).

Communications equipment and systems

The top 10 communications equipment and systems firms generated combined revenues of USD 168 billion in 2005, employed a total 405 000 people and spent USD 20 billion or 12% of revenues on R&D. The composition of the top 10 is unchanged from 2003, although two firms exited the top 10 since 2001 (Marconi which fell from 8th in 2000 to 12th in 2005, and Tellabs which fell from 10th to 15th). They were replaced by Qualcomm and L-3 Communications (Table 1.A1.1).

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

USD millions in current prices and number employed

	Country	Revenue 2000	Revenue 2005	Employees 2000	Employees 2005	R&D 2000	R&D 2005	Net income 2000	Net income 2005
Nokia	Finland	27 868	38 136	58 708	56 571	2 371	4 667	3 613	4 104
Motorola	USA	32 107	33 327	147 000	68 000	3 426	3 249	1 318	2 751
Cisco Systems	USA	18 928	24 801	38 000	38 413	2 704	3 220	2 668	5 741
Ericsson	Sweden	29 866	19 020	105 129	53 638	4 577	2 750	2 300	2 857
Alcatel	France	28 815	15 118	131 598	55 718	2 610	1 929	–521	648
Nortel Networks	Canada	27 948	10 782	94 500	34 150	3 663	1 906	–2 995	–8
Lucent Technologies	USA	28 904	9 412	126 000	31 800	3 179	1 177	1 219	2 022
L-3 Communications	USA	1 910	7 733	14 000	44 200	24	72	83	444
Qualcomm	USA	3 197	5 230	6 300	7 600	340	946	622	1 998
Avaya	USA	7 732	4 682	31 000	14 900	468	389	–375	361
Total		207 274	168 242	752 235	404 990	23 362	20 305	7 931	20 917

Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/281714005513

Communications equipment firms were severely affected by the downturn and sudden slowdown in telecommunications infrastructure investment. Nevertheless, some continued to perform well, and a broader recovery is now apparent. Between 2000 and 2005, revenues fell by almost USD 40 billion, employment fell by almost 350 000 and R&D expenditures by more than USD 3 billion. Preliminary results for 2005 suggest combined net income of USD 21 billion, a marked improvement over the losses experienced in the sector in 2001 and 2002. L-3 Communications was one of the fastest-growing communications equipment and systems firms over the period, with revenues increasing by 32% a year, employment by 26% a year and net income by 25% a year. Other communications equipment and systems firms enjoying rapid growth included Research in Motion, UTStarcom and Juniper Networks. These increases reflect opportunities in security, defence-related and mobile communications markets, and the success of the Blackberry.

Electronics and components

Leading electronics firms tend to be significantly larger than are those in the communications equipment and systems sector. They also tend to be more diversified, with many conglomerates in the sector having significant non-ICT business. Intel is the exception.

The top 10 electronics and components firms generated combined revenues of USD 554 billion in 2005, employed a total of almost 2 million people, spent more than USD 37 billion or 7% of revenue on R&D, and realised an aggregate net profit of more than USD 33 billion (Table 1.A1.2). Top 10 revenues increased by more than USD 105 billion between 2000 and 2005, although employment fell by some 68 000. Total net income declined marginally to USD 33.5 billion. Nevertheless, all of the top 10 firms made a profit in 2005.

Table 1.A1.2. **Top 10 electronics and components firms**

USD millions in current prices and number employed

	Country	Revenue 2000	Revenue 2005	Employees 2000	Employees 2005	R&D 2000	R&D 2005	Net income 2000	Net income 2005
Siemens	Germany	64 405	87 677	419 000	438 000	4 425	5 979	6 528	3 563
Hitachi	Japan	72 725	83 437	323 827	347 424	3 930	3 592	154	476
Matsushita	Japan	68 711	80 543	314 267	344 733	4 881	5 719	874	536
Sony	Japan	62 046	66 176	189 700	151 400	3 660	4 640	1 131	1 514
Philips	Netherlands	34 736	61 869	219 429	161 096	2 553	5 498	8 786	7 778
Samsung	Korea	34 573	48 579	173 000	123 000	1 332	4 600	4 768	6 728
Intel	USA	33 726	36 734	86 100	91 000	3 897	4 839	10 535	8 245
Canon	Japan	25 020	33 046	86 673	109 434	1 805	..	1 244	3 307
Mitsubishi Electric	Japan	35 021	31 525	116 588	97 661	1 615	1 207	230	658
Total		448 173	553 548	1 978 332	1 910 499	29 461	37 728	34 511	33 531

Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/835162450151

Nine of the top 10 electronics and components firms increased their revenues between 2000 and 2005, with strong growth experienced by Philips, Siemens and Canon. Other electronics and components firms enjoying rapid growth included Nvidia, Sanmina (following the merger with SCI), PCS and Singapore-based Flextronics. These results reflect some consolidation, especially in contract electronics manufacturing.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

IT equipment and systems

Leading IT equipment and systems firms are also large, with seven of the top 10 in the ICT top 50. A number are also diversified, but tend to be diversified within ICTs (*i.e.* producing IT equipment, software and services). The top firm, IBM, derives a larger share of revenues from services and software than most firms in the sector, although some others also have significant services activities (*e.g.* Fujitsu, Hewlett-Packard).[1] New entrants into the IT equipment top 10 since 2001 include: Hon Hai Precision, Apple Computer and Quanta Computer. Exits include Compaq Computer, which was taken over by Hewlett-Packard, Gateway and EMC. Seagate entered the 2003 top 10 and exited the 2005 list.

In 2005 the IT equipment and systems top 10 had total revenue of USD 423 billion, employed just over 1.2 million people and spent around USD 20 billion on R&D (5% of revenue) (Table 1.A1.3). Between 2000 and 2005, top 10 total revenue increased by USD 84 billion, total employment increased by more than 160 000, and R&D expenditure increased marginally to USD 20 billion. Total net income also increased, with just Sun Microsystems making a loss in 2005.

Table 1.A1.3. **Top 10 IT equipment and systems firms**

USD millions in current prices and number employed

	Country	Revenue 2000	Revenue 2005	Employees 2000	Employees 2005	R&D 2000	R&D 2005	Net income 2000	Net income 2005
IBM	USA	85 089	96 068	316 303	330 000	5 084	5 816	8 093	8 071
Hewlett-Packard	USA	48 870	85 172	88 500	151 000	2 627	3 490	3 697	3 073
Toshiba	Japan	53 349	51 562	190 870	165 000	3 103	3 252	–305	430
Dell Computer	USA	25 265	49 205	40 000	55 200	374	463	1 666	3 043
NEC	Japan	48 343	44 876	154 787	147 753	2 924	2 545	97	627
Fujitsu	Japan	48 484	44 512	188 053	150 970	3 722	2 245	397	298
Hon Hai Precision	Chinese Taipei	2 900	16 200	9 000	166 509	..	..	..	892
Apple Computer	USA	7 983	13 931	8 568	11 695	380	534	786	1 335
Sun Microsystems	USA	15 721	11 070	43 700	31 000	1 630	1 785	1 854	–107
Quanta Computer	Chinese Taipei	2 636	10 582	..	..	..	..	253	263
Total		338 639	423 178	1 039 781	1 209 127	19 844	20 131	16 537	17 926

Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/724588868840

Among the top 10 IT equipment firms four suffered declining revenues over the five years to 2005 (Sun Microsystems, Fujitsu, NEC and Toshiba). These same firms shed jobs, while others increased employment. Hon Hai Precision is one of the faster-growing IT equipment firms, with revenues increasing from USD 2.9 billion in 2000 to more than USD 16 billion in 2004. Other IT equipment firms enjoying rapid growth include: Lite-on Technology, ASUSTek, Compal Electronics, Benq and NIDEC. It is notable that the six fastest-growing IT equipment firms are based in Chinese Taipei. Acer, the only other Chinese Taipei-based firm in the top 250 increased its revenues by 12% a year. These data reflect the ongoing globalisation of ICT manufacturing and new opportunities to develop manufacturing activities in China (see Chapters 2 and 4).

* IBM is classified here as a hardware firm, based on its classification in US SEC filings under "Computer and Office Equipment" (US SIC 3570), even though the major part of its activities are in IT services and software.

IT services

Only three of the top 10 IT services firms ranked in the ICT top 50. However, a number of the larger IT equipment and systems firms earn a significant share of their revenue from services. In 2004, IBM's services revenues amounted to USD 46 billion, which would put it at the top of the IT services list with services revenue more than double its nearest rival were revenues attributed to activities rather than firms (see Box 1.A1.1).

Box 1.A1.1. **The shift of IT business activities to services**

Few firms better illustrate the shift in the value of business activities in IT equipment and systems firms than IBM. Between 1992 and 2004, IBM's total revenue increased from USD 64.5 billion to USD 96.3 billion, at an annual average rate of 3.4%. Over the same period, IBM's services revenue increased from USD 7.4 billion to USD 46.2 billion, or by 17% a year while its hardware revenues declined, so that services and software revenues increased from around 30% of the total to over 50% (see *OECD Information Technology Outlook 2004*, Annex A, Box A.2 for discussion).

This shift has been further underscored by IBM's sale of its PC unit to Lenovo of China, and the rapid growth in global technology services and global business services as IBM extends its services activities from technology outsourcing to human resources, finance, accounting and call centres. Along with this shift IBM is also seeing emerging markets such as China and India helping to counter declines in traditional markets including Japan and Germany.

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

Top 10 IT services firms' total revenues amounted to almost USD 119 billion in 2005, up from USD 89 billion in 2000 (Table 1.A1.4). They employed some 542 000 people and earned a combined net profit of USD 5.9 billion. Their revenues increased by almost USD 30 billion between 2000 and 2005, and total employment grew by around 47 000. However, net income fell by USD 909 million (based on preliminary data). There has been relatively little change at

Table 1.A1.4. **Top 10 IT services firms**

USD millions in current prices and number employed

	Country	Revenue 2000	Revenue 2005	Employees 2000	Employees 2005	R&D 2000	R&D 2005	Net income 2000	Net income 2005
EDS	USA	18 856	20 377	122 000	117 000	..	..	1 143	–70
Tech Data	USA	16 992	19 790	10 500	8 500	..	..	128	163
Accenture	Bermuda	11 331	17 094	71 300	100 000	252	272	2 464	941
CSC	USA	9 345	14 059	68 000	79 000	..	..	403	810
First Data	USA	5 922	10 460	25 380	32 000	..	..	930	1 653
ADP	USA	6 168	8 499	41 000	44 000	460	624	841	1 055
CapGemini	France	6 359	8 323	59 549	59 324	..	..	395	–394
IAC/Interactive	USA	2 965	7 207	20 780	26 000	..	..	–148	1 387
SAIC	USA	4 000	7 187	40 000	40 000	..	..	400	409
Unisys	USA	6 885	5 772	36 900	36 400	334	283	225	–82
Total		88 822	118 769	495 409	542 224	1 046	1 179	6 780	5 871

Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/784784181153

the top of the IT services sector since 2000. IAC/Interactive, SAIC and First Data/Concord EFS are the fastest-growing firms in the top 10; only Unisys has seen revenues decline since 2000. Other IT services firms enjoying rapid growth in excess of 20% a year since 2000 include Google, Infosys, Wipro, Yahoo! and CGI.

Software

Software firms tend to be smaller than firms in other ICT sectors. Only one, Microsoft, ranks in the ICT top 50. The software top 10 earned a total of USD 84 billion in 2005, employed 200 000 people and spent more than USD 11 million on R&D (Table 1.A1.5). Microsoft is the clear leader of the group, accounting for almost 50% of total top 10 revenue in 2005, and 44% of the total revenue of all 14 software firms in the ICT top 250. Firms in the software top 10 reporting R&D expenditure spent an average of 15% of forecast 2005 revenues. Between 2000 and 2005, total employment in the software top 10 increased by almost 36 000, but net income increased only marginally (based on preliminary data).

Table 1.A1.5. **Top 10 software firms**

USD millions in current prices and number employed

	Country	Revenue 2000	Revenue 2005	Employees 2000	Employees 2005	R&D 2000	R&D 2005	Net income 2000	Net income 2005
Microsoft	USA	22 956	39 788	47 600	61 000	3 772	6 184	9 421	12 254
Oracle	USA	10 231	11 799	42 927	49 872	1 010	1 481	6 297	2 886
SAP	Germany	7 562	9 563	24 177	34 095	1 170	1 323	743	1 661
Softbank	Japan	3 927	7 737	7 219	6 865	..	..	78	–553
CA	USA	6 094	3 530	18 200	15 300	1 110	690	696	11
Electronic Arts	USA	1 420	3 129	3 500	6 100	256	633	117	504
Symantec/Veritas	USA	746	2 583	3 800	6 500	108	332	170	536
Intuit	USA	1 037	2 038	6 000	7 000	166	305	306	382
Amdocs	USA	1 118	1 918	8 400	10 600	75	132	6	282
Adobe Systems	USA	1 226	1 885	2 947	3 142	240	351	288	560
Total		56 317	83 970	164 770	200 474	7 907	11 431	18 122	18 523

Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/265123706743

Performance has been varied, with some market segments performing well (*e.g.* Internet, security and virus protection) and others performing less well. Among the software top 10, eight firms experienced revenue growth between 2000 and 2005. Rapidly growing large software firms include Symantec/Veritas (following merger), Electronic Arts, Intuit, Softbank, Microsoft and Amdocs. Only Computer Associates, Siebel and BMC experienced declining revenues.

Telecommunication services

In recent years, firms in the telecommunication services sector have experienced some of the largest losses in corporate history. Nevertheless, revenues have remained strong. Detailed analysis of the telecommunication services sector can be found in the *Communications Outlook 2005*.

In 2005, the telecommunication services top 10 firms earned revenues totalling almost USD 540 billion, with revenues increasing by USD 150 billion between 2000 and 2005 (6.7% a year) (Table 1.A1.6). However, employment declined by around 80 300 to 1.5 million. What, with hindsight, seem ambitious investments and subsequent restructuring have adversely affected profitability, with a top 10 net profit of USD 39 billion in 2000 becoming a net loss of USD 81 billion in 2002, led by significant losses at Deutsche Telekom, Vodafone and France Telecom. The subsequent recovery has seen most return to profitability. Vodafone, Deutsche Telekom, France Telecom and the merged Sprint/Nextel have enjoyed strong revenue growth since 2000, with SBC Communications the only top 10 firm to experience declining revenue.

Table 1.A1.6. **Top 10 telecommunication services firms**

USD millions in current prices and number employed

	Country	Revenue 2000	Revenue 2005	Employees 2000	Employees 2005	R&D 2000	R&D 2005	Net income 2000	Net income 2005
NTT	Japan	92 679	99 880	224 000	201 500	3 178	2 940	–603	6 563
Verizon	USA	64 707	73 217	263 552	210 000	..	..	11 797	8 705
Deutsche Telekom	Germany	37 559	71 911	205 000	244 277	642	..	5 437	4 822
France Telecom	France	30 894	58 519	188 866	206 525	530	757	4 707	8 395
Vodafone	UK	11 929	54 249	29 465	57 378	109	..	838	–25 058
Telefonica	Spain	27 306	42 864	145 730	173 554	..	569	1 693	4 531
SBC	USA	51 374	41 183	220 000	162 700	..	..	7 800	3 819
TI/Olivetti	Italy	27 516	36 277	107 171	82 397	247	168	3 231	5 380
BT	UK	28 356	33 860	132 000	102 100	552	467	2 111	3 309
Sprint/Nextel	USA	17 220	27 901	64 900	59 900	..	..	1 964	–401
Total		389 540	539 860	1 580 684	1 500 331	5 257	4 901	38 974	20 065

Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/276213774776

Table 1.A1.7. **Activity of top 10 ICT firms by sector**

Company	SIC	Activity
		Communication equipment and systems
Nokia	3663	Supplier of data, video and voice network solutions, mobile and fixed access solutions, and broadband and IP network solutions. Nokia is a leading manufacturer of mobile phones and a pioneer in digital multimedia terminals for digital TV and interactive services.
Motorola	3663	Provider of integrated communications solutions and embedded electronic solutions such as: software-enhance wireless telephone radio and satellite communications; embedded semiconductor products and embedded electronic systems.
Cisco Systems	3576	A worldwide leader in networking for the Internet. Cisco Internet Protocol-based networking solutions are the foundation of the Internet and are installed at corporations, public institutions and telecommunication companies.
Ericsson	3663	International leader in telecommunications, recognised for its advanced systems and products for wired and mobile communications in public and private networks. It also provides wireless communication and Internet-based technology.
Alcatel	3661	Provider of communications equipment including ADSL equipment, terrestrial and submarine optical networks, public switching, fixed wireless access and intelligent network
Nortel Networks	3661	Engaged in the telecommunications equipment industry, which consists of the research and the design, development, manufacture, marketing, sale, installation, financing, support and servicing of enterprise, public carrier, wireless and broadband networks.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Table 1.A1.7. **Activity of top 10 ICT firms by sector** *(cont.)*

Company	SIC	Activity
Lucent Technologies	3661	Designer, developer and manufacturer of communications systems, software and products. It sells public/private communications systems, supplies systems and software to network operators and service providers, and sells related microelectronic components.
L-3 Communications	3663	A supplier of secure communication systems and specialized communication products, including secure, high data rate systems, microwave components, avionics and ocean systems, and telemetry and space products.
Qualcomm	3663	Qualcomm developed code division multiple access (CDMA) technology that is one of the three main technologies used in digital wireless phone networks.
Avaya	3661	A provider of communications systems and software for enterprises, including businesses, government agencies and other organisations.
		Electronics and components
Siemens	4813	An electronics and engineering company that operates worldwide, delivering advanced solutions for e-business, mobile communications, manufacturing, transportation, health care, energy and lighting.
Hitachi	3570	Manufactures and markets a wide range of products, including computers, semiconductors, consumer products and power and industrial equipment. It is one of the world's leading global electronics companies.
Matsushita Electric	3600	Major producer of electronic and electric products. It offers a comprehensive range of products, systems and components for consumer, business and industrial use.
Sony	3651	Engaged in the development, manufacture and sale of various kinds of electronic equipment, instruments and devices. It is also engaged worldwide in the development, production, manufacture and distribution of recorded music in all commercial formats.
Philips Electronics	3600	Products, systems and services are delivered in the fields of lighting, consumer products, consumer electronics, domestic appliances and personal care, components, semiconductors, medical systems and business electronics.
Samsung Electronics	3600	Large diversified electronics firm, with increasing activities in digital and mobile technologies.
Intel	3674	World's largest semiconductor chip maker, supplies the computing and communications industries with chips, boards, systems and software that are integral in computers/servers and networking and communications products.
Company	SIC	Activity
Canon	3861	Designs, develops and manufactures a variety of high-tech products including business machines and systems, cameras, computers, printers, faxes, semiconductor production equipment, medical equipment, typewriters and copiers.
Mitsubishi Electric	3674	Large conglomerate electronics firm.
Sharp	..	Maker of electronic components and computer hardware and peripherals, liquid crystal displays, flash memory, integrated circuits, and laser diodes used in optical data drives. Sharp also makes cellular phones and consumer audio and video products.
		IT equipment and systems
IBM	3571	Develops, manufactures, and sells information processing products, including computers and microelectronics technology, software, networking systems, and information technology-related services operating on a worldwide basis.
Hewlett-Packard	3570	Global provider of computing and imaging solutions and services for business and home, including: Imaging and Printing, Computing Systems, Information Technology Services, and Measurement Systems.
Toshiba	3621	Toshiba is an integrated manufacturer of electrical and electronic products spanning information and communications equipment and systems, including personal computer (PC) and other computer systems, storage devices, telecommunications equipment, etc.
Dell Computer	3571	World's largest direct computer systems company. Company offers its customers a full range of computer systems, ranging from desktops to peripheral hardware; including computer software and related services.
NEC	3570	Provider of Internet solutions, dedicated to meeting the specialised needs of its customers in the key computer, network and electron device fields.

Table 1.A1.7. **Activity of top 10 ICT firms by sector** *(cont.)*

Company	SIC	Activity
Fujitsu	3570	Fujitsu is a provider of customer-focused information technology (IT) solutions for the global marketplace. Fujitsu provides IT and communications solutions designed to help customers unleash the possibilities of the Internet for their business success.
Hon Hai Precision	3571	A global leader in providing mechanical solutions. It is the largest manufacturer of connectors for use in PCs in Chinese Taipei, and a leading manufacturer of connectors and cable assemblies around the world.
Apple	3571	Designs, manufactures and markets personal computers and related personal computing and communication solutions. Recently launched i-tunes music business.
Sun Microsystems	3571	Worldwide provider of products, services and support solutions for building and maintaining network computing environments. It sells scalable computer systems, high-speed microprocessors and a complete line of related high performance software.
Quanta Computer	..	Main activities are the manufacture and sale of computer and computer components and peripherals. Other activities include manufacture and sale of cellular phones and internet appliance devices and provision of R&D services for wireless communication companies. Products include server, motherboard, LCD-Monitor, CD-ROM, CD-RW and notebook computers.
		IT services
EDS	7370	Professional services firm that applies consulting, information and technical expertise to enhance clients' business performance. Services include the management of computers, networks, information systems, business operations and related personnel.
Tech Data	5045	Provider of information technology products, logistics management and other value-added services. It distributes microcomputer hardware and software products to value-added resellers, corporate resellers, retailers, direct marketers and Internet resellers.
Accenture	8742	A provider of management and technology consulting services and solutions which help clients capitalize on their most important business and technology opportunities.
CSC	7373	One of the world leaders in the IT services industry. Its services include outsourcing, system integration and IT and management consulting and other professional services.
First Data	6199	First Data Corporation provides high-volume information processing and related services, payment instruments, card issuer services, and merchant processing services.
ADP	7374	Provides computerised transaction processing, data communication and information services, especially in payroll and human resources information management.
CapGemini Ernst and Young	..	Combined software, services and consulting business.
IAC/Interactive	4700	Operates a portfolio of brands in the online travel, retailing, ticketing, personals, media, financial services, real estate, and teleservices industries worldwide.
SAIC	7379	Science Applications International Corporation is the US's largest employee-owned research and engineering company, providing information technology, systems integration and eSolutions to commercial and government customers.
Unisys	7373	Worldwide information services and technology company, which provides services, systems and solutions that help customers apply information technology.
		Software
Microsoft	7372	Develops, manufactures, licenses and supports a wide range of software products for a multitude of computing devices , including scalable operating systems for servers.
Oracle	7372	Supplier of software for information management. Oracle develops, manufactures, markets and distributes computer software that is categorised as systems software and Internet business applications software.
SAP	7372	International developer and supplier of integrated business software designed to provide cost-effective comprehensive solutions for businesses.
Softbank	7372	Softbank is a provider of information infrastructure and distribution services to the computer industry in Japan.
Computer Associates	7372	A leading eBusiness software company. CA's solutions address all aspects of eBusiness Process Management, Information Management and Infrastructure Management.
Electronic Arts	7372	Creates, markets and distributes interactive entertainment software for a variety of hardware platforms.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Table 1.A1.7. **Activity of top 10 ICT firms by sector** *(cont.)*

Company	SIC	Activity
Symantec/Veritas	7372	Provides a variety of content and network security software for both consumers and businesses, used for functions such as virus protection, intrusion detection, and remote management. Symantec also offers services in security assessment, consulting and outsourced security management. In July 2005, Symantec acquired Veritas.
Intuit	7372	Intuit is a provider of small business, tax preparation and personal finance software products and services that simplify complex financial tasks for small businesses, consumers and accounting professionals.
Amdocs	7372	Amdocs provides software products and services known as business support systems (BSS) to major communications companies.
Adobe Systems	7372	Offers the Acrobat Reader (distributed free of charge) that displays portable document format (PDF) files on the Internet. Adobe's products also include print technology geared toward manufacturers, as well as Web design and electronic book publishing software. Adobe's Professional Services group offers implementation, training, and support.
		Telecommunication services
NTT	4813	Nippon Telegraph and Telephone Corporation (NTT) operates as a provider of fixed line and wireless voice transmission, data transmission, leased circuit, telecommunications equipment sales, systems integration, etc.
Verizon Communications	4813	Verizon companies are providers of wireline and wireless communications in the United States.
Deutsche Telekom	4813	Is a telecommunications services provider that organizes its businesses into four main divisions: T-Com, T-Mobile, T-Systems and T-Online.
France Telecom	4813	France Telecom provides consumers, businesses and other telecommunications operators with a range of services, including fixed line and mobile telecommunications, data transmission, Internet, multimedia and other value-added services.
Vodafone	4812	Vodafone Group provides a range of mobile telecommunications services, including voice and data communications. It operates in 28 countries worldwide.
Telefonica	4813	Telefonica is a telecommunications company that operates in Spanish and Portuguese speaking markets, providing a wide range of services, including fixed and mobile telephony, Internet and broadband, content, directories and applications.
SBC Communications	4813	SBC Communications provides communications services and products in the United States through its subsidiaries, including local exchange services, wireless communications, long-distance services, Internet services, telecommunications equipment and directory advertising and publishing.
Telecom Italia/Olivetti	4813	Telecom Italia is a fixed telecommunications operator, with approximately 27.1 million subscriber fixed-lines installed (including ISDN equivalent lines). Through Telecom Italia Mobile it is also a mobile telecommunications operator.
BT	4813	BT Group provides telecommunication services, principally in the United Kingdom. The Company's main services and products are fixed voice and data calls, the provision of fixed exchange lines.
Sprint Nextel	4813	The combination of Sprint and Nextel created a wireless communications giant operating a nationwide digital wireless network with more than 44 million subscribers.

Source: OECD, Compiled from company Web sites and MultexInvestor listings.

ANNEX 1.A2

Tables

Table 1.A2.1. **Countries represented in the top 250 ICT firms**

By country of registration, USD millions in current prices and percentage

	Firms	Revenue 2000	Revenue 2005	Employees 2000	Employees 2005	Net income 2000	Net income 2005	Growth (revenue)
Australia	1	11 246	16 660	50 761	42 739	2 138	3 270	8.2
Austria	1	2 942	4 975	18 301	13 307	–13	473	11.1
Belgium	2	5 481	9 047	23 769	17 967	388	2 260	10.5
Bermuda	2	14 836	19 316	84 300	103 600	–338	647	5.4
Canada	9	60 105	52 637	233 714	219 116	778	1 818	–2.6
Cayman	1	6 448	7 553	42 800	44 000	310	707	3.2
China	1	15 663	20 299	102 647	253 050	2 754	3 555	5.3
Czech Republic	1	1 482	2 344	17 322	7 743	165	249	9.6
Denmark	1	5 787	7 427	18 363	20 573	1 143	712	5.1
Finland	2	29 009	39 773	64 869	61 680	3 633	4 350	6.5
France	7	90 665	109 269	537 507	502 785	4 842	9 005	3.8
Germany	6	122 183	181 494	695 083	771 629	14 205	9 925	8.2
Greece	1	3 299	6 571	19 604	15 925	577	518	14.8
Hong Kong, China	3	20 350	40 681	80 388	137 398	3 430	6 595	14.9
Hungary	1	1 580	2 959	14 380	13 724	236	408	13.4
India	3	706	5 534	18 830	74 035	140	1 221	50.9
Ireland	1	1 806	1 978	12 606	8 306	171	51	1.8
Italy	2	29 476	42 098	112 093	90 870	2 550	4 932	7.4
Japan	39	687 601	779 291	2 502 351	2 580 929	8 050	22 164	2.5
Korea	6	78 787	100 628	284 830	160 812	4 487	11 063	5.0
Mexico	2	13 693	29 529	80 378	99 986	3 012	4 636	16.6
Netherlands	3	46 812	79 550	266 762	197 283	15 863	9 470	11.2
New Zealand	1	2 562	3 814	7 298	8 560	292	649	8.3
Norway	1	3 701	9 717	24 950	21 750	–123	689	21.3
Poland	3	5 324	8 824	70 968	38 129	375	1 177	10.6
Portugal	1	4 721	7 333	18 539	27 925	495	567	9.2
Singapore	2	10 066	23 373	95 000	111 155	2 805	2 273	18.3
Spain	2	28 641	48 160	153 317	178 213	1 693	4 568	11.0
Sweden	3	37 381	37 201	136 744	81 966	3 408	5 050	–0.1
Switzerland	3	14 436	18 210	65 903	71 740	3 409	2 612	4.8
Chinese Taipei	11	25 277	75 717	44 522	217 842	3 556	5 143	24.5
Turkey	2	5 249	7 244	74 488	58 235	978	–425	6.7
United Kingdom	10	87 748	124 592	423 771	257 504	2 227	–20 838	7.3
United States	116	956 022	1 078 733	3 642 472	3 334 688	56 807	97 099	2.4
Total	250	2 431 085	3 002 528	10 039 630	9 845 164	144 442	196 592	4.3
OECD	227	2 337 739	2 810 055	9 571 143	8 904 084	131 786	176 451	3.7

Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/430768838813

Table 1.A2.2. **Top 250 ICT firms by sector**

USD millions and percentage

Sector	Revenue 2000	Revenue 2005	Growth % 2000-05	Employees 2000	Employees 2005	Growth % 2000-05	Net income 2000	Net income 2005	% growth 2000-05
Comms equipment	222 177	180 525	–4.1	821 793	441 280	–11.7	8 753	21 396	19.6
Electronics and components	855 245	1 004 363	3.3	3 917 360	3 887 317	–0.2	60 239	53 481	–2.4
IT equipment	428 780	549 300	5.1	1 373 842	1 574 824	2.8	22 158	25 852	3.1
Services	117 077	174 397	8.3	716 067	894 967	4.6	8 962	13 474	8.5
Software	60 332	90 021	8.3	181 780	216 334	3.5	15 470	18 862	4.0
Telecommunications	747 474	1 003 922	6.1	3 028 788	2 830 442	–1.3	28 860	63 526	17.1
Total	2 431 085	3 002 528	4.3	10 039 630	9 845 164	–0.4	144 442	196 592	6.4

Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.

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

StatLink: http://dx.doi.org/10.1787/157452317872

Table 1.A2.3. **Top 50 ICT firms ranked by revenue**

USD millions in current prices and number employed

Company	Country	Industry	Revenue 2000	Revenue 2005	Employ 2000	Employ 2004-05	R&D 2000	R&D 2005	Net income 2000	Net income 2003
NTT	Japan	Telecommunications	92 679	99 880	224 000	201 500	3178	2 940	–603	6 563
IBM	USA	IT equipment	85 089	96 068	316 303	330 000	5084	5 816	8 093	8 071
Siemens	Germany	Electronics	64 405	87 677	419 000	438 000	4425	5 979	6 528	3 563
Hewlett-Packard	USA	IT equipment	48 870	85 172	88 500	151 000	2627	3 490	3 697	3 073
Hitachi	Japan	Electronics	72 725	83 437	323 827	347 424	3930	3 592	154	476
Matsushita (Panasonic)	Japan	Electronics	68 711	80 543	314 267	344 733	4881	5 719	874	536
Verizon Communications	USA	Telecommunications	64 707	73 217	263 552	210 000	..	..	11 797	8 705
Deutsche Telekom	Germany	Telecommunications	37 559	71 911	205 000	244 277	642	..	5 437	4 822
Sony	Japan	Electronics	62 046	66 176	189 700	151 400	3660	4 640	1 131	1 514
Philips Electronics	Netherlands	Electronics	34 736	61 869	219 429	161 096	2553	5 498	8 786	7 778
France Telecom	France	Telecommunications	30 894	58 519	188 866	206 525	530	757	4 707	8 395
Vodafone	UK	Telecommunications	11 929	54 249	29 465	57 378	109	..	838	–25 058
Toshiba	Japan	IT equipment	53 349	51 562	190 870	165 000	3103	3 252	–305	430
Dell Computer	USA	IT equipment	25 265	49 205	40 000	55 200	374	463	1 666	3 043
Samsung Electronics	Korea	Electronics	34 573	48 579	173 000	123 000	1332	4 600	4 768	6 728
NEC	Japan	IT equipment	48 343	44 876	154 787	147 753	2924	2 545	97	627
Fujitsu	Japan	IT equipment	48 484	44 512	188 053	150 970	3722	2 245	397	298
Telefonica	Spain	Telecommunications	27 306	42 864	145 730	173 554	..	569	1 693	4 531
SBC Communications	USA	Telecommunications	51 374	41 183	220 000	162 700	..	..	7 800	3 819
Microsoft	USA	Software	22 956	39 788	47 600	61 000	3772	6 184	9 421	12 254
Nokia	Finland	Comms equipment	27 868	38 136	58 708	56 571	2371	4 667	3 613	4 104
Intel	USA	Electronics	33 726	36 734	86 100	91 000	3897	4 839	10 535	8 245
Telecom Italia/Olivetti	Italy	Telecommunications	27 516	36 277	107 171	82 397	247	168	3 231	5 380
BT	UK	Telecommunications	28 356	33 860	132 000	102 100	552	467	2 111	3 309
Motorola	USA	Comms equipment	32 107	33 327	147 000	68 000	3426	3 249	1 318	2 751
Canon	Japan	Electronics	25 020	33 046	86 673	109 434	1805	..	1 244	3 307
Mitsubishi Electric	Japan	Electronics	35 021	31 525	116 588	97 661	1615	1 207	230	658
Sprint (Nextel)	USA	Telecommunications	17 220	27 901	64 900	59 900	..	..	1 964	–401
AT&T	USA	Telecommunications	46 850	27 668	84 800	47 600	313	..	4 669	1 622
China Mobile	Hong Kong	Telecommunications	15 249	27 272	38 345	88 127	..	..	2 978	5 840
KDDI	Japan	Telecommunications	14 159	26 990	7 361	9 000	73	101	–99	1 854
Cisco Systems	USA	Comms equipment	18 928	24 801	38 000	38 413	2704	3 220	2 668	5 741
Sharp	Japan	Electronics	17 210	23 961	49 748	46 751	1363	1 656	261	725
Sanyo Electric	Japan	Electronics	18 005	23 221	83 519	96 023	928	1 232	201	–1 603
LG Electronics	Korea	Electronics	20 085	21 054	55 000	31 614	312	1 000	356	484
3M	USA	Electronics	16 699	20 520	75 026	67 071	1101	1 158	1 782	3 080

Table 1.A2.3. **Top 50 ICT firms ranked by revenue** *(cont.)*

USD millions in current prices and number employed

Company	Country	Industry	Revenue 2000	Revenue 2005	Employ 2000	Employ 2004-05	R&D 2000	R&D 2005	Net income 2000	Net income 2003
Bell South	USA	Telecommunications	26 151	20 474	103 900	63 000	..	..	4 220	4 022
EDS	USA	Services	18 856	20 377	122 000	117 000	..	..	1 143	–70
China Telecom	China	Telecommunications	15 663	20 299	102 647	253 050	15	21	2 754	3 555
Tech Data	USA	Services	16 992	19 790	10 500	8 500	..	..	128	163
MCI (Worldcom)	USA	Telecommunications	39 344	19 522	97 600	40 000	..	..	–48 909	–3 481
Ericsson	Sweden	Comms equipment	29 866	19 020	105 129	53 638	4577	2 750	2 300	2 857
Accenture	Bermuda	Services	11 331	17 094	71 300	100 000	252	272	2 464	941
Emerson Electric	USA	Electronics	15 545	16 782	123 400	107 800	594	486	1 422	1 357
Ricoh	Japan	Electronics	12 870	16 768	67 300	75 097	591	1 020	373	768
Telstra	Australia	Telecommunications	11 246	16 660	50 761	42 739	29	21	2 138	3 270
Sumitomo Electric	Japan	Electronics	12 142	16 205	66 992	104 398	389	526	219	340
Hon Hai Precision	Taipei	IT equipment	2 900	16 200	9 000	166 509	..	..	..	892
Flextronics	Singapore	Electronics	6 959	15 908	75 000	92 000	..	..	159	340
Xerox	USA	Electronics	18 751	15 734	91 500	58 100	1064	751	–273	1 036

Note: Preliminary 2005 data are based on financial year reported in 2005 or most recent four quarters.
Source: OECD, Compiled from annual reports, SEC filings and market financials.

StatLink: http://dx.doi.org/10.1787/414420202417

Table 1.A2.4. **Share of Japan and the US in ICT sub-sector R&D expenditures, 2002**

	Japan %	US %	OECD19 USD PPP millions
Office, accounting and computing machinery	48.3	36.3	21 440
Radio, television and communication equipment	22.5	33.3	57 011
Telecommunications	n.a.	39.1	4 294
Computer and related activities	4.6	67.6	29 817
ICT total	21.8	43.2	112 563

Source: OECD ANBERD.

StatLink: http://dx.doi.org/10.1787/713650660717

Table 1.A2.5. **ICT spending, 2000-05**

USD millions, current prices

	2000	2001	2002	2003	2004	2005
Australia	26 628	24 217	26 697	34 247	40 509	45 676
Austria	11 410	11 257	11 894	14 731	16 651	16 950
Belgium	13 824	13 543	14 284	17 493	19 999	21 596
Canada	44 382	42 774	44 896	50 767	58 242	65 699
Czech Republic	4 206	4 182	5 170	6 673	7 912	8 863
Denmark	9 842	9 701	10 597	12 869	14 656	15 430
Finland	8 942	8 715	9 622	11 333	13 377	13 255
France	84 864	84 398	91 225	112 552	129 735	134 742
Germany	115 090	112 311	119 823	146 274	164 235	169 830
Greece	5 045	5 130	5 853	7 240	8 474	9 123
Hungary	3 424	3 204	3 981	5 040	5 975	6 380
Iceland	..	..	..	..	..	..
Ireland	5 383	5 440	5 553	6 536	8 230	8 848
Italy	51 130	50 563	53 132	65 033	74 467	76 654
Japan	400 971	325 278	298 071	322 150	351 707	342 174
Korea	35 006	30 894	35 852	40 547	46 751	54 443
Luxembourg	..	..	..	..	..	..
Mexico	18 268	18 247	19 489	19 891	22 683	25 364
Netherlands	25 649	26 442	28 918	34 741	38 549	39 195
New Zealand	5 919	5 529	6 393	8 005	9 589	10 703
Norway	9 458	9 009	10 083	11 518	13 020	15 035
Poland	7 022	7 552	8 696	9 663	10 973	12 619
Portugal	4 713	4 770	5 300	6 597	7 583	7 997
Slovak Republic	1 194	1 260	1 399	1 809	2 281	2 618
Spain	23 102	23 729	26 691	33 383	38 857	41 614
Sweden	17 919	17 630	18 823	23 530	26 424	26 541
Switzerland	19 286	18 766	20 762	24 129	26 766	27 453
Turkey	15 808	10 731	13 723	18 343	23 651	28 517
United Kingdom	116 790	111 230	118 168	135 594	157 261	161 581
United States	932 166	876 561	892 125	933 970	1 015 555	1 093 625
OECD total	2 017 442	1 863 062	1 907 222	2 114 657	2 354 110	2 482 523
World	2 259 190	2 111 861	2 183 248	2 444 703	2 755 660	2 963 532
OECD share	89%	88%	87%	86%	85%	84%
North America	994 816	937 581	956 510	1 004 629	1 096 479	1 184 688
Latin America	70 703	65 756	63 587	74 881	88 701	110 413
Western Europe	538 257	523 365	564 451	681 895	781 935	814 360
Eastern Europe	29 075	32 118	38 123	47 099	58 236	70 081
Asia-Pacific	593 867	517 002	520 043	583 640	671 418	716 894
RoW	32 473	36 040	40 533	52 561	58 892	67 096
IT Hardware	440 912	374 883	359 311	396 603	455 255	493 164
IT Software	178 086	187 792	194 634	226 734	262 304	288 807
IT Services	472 814	482 679	489 766	557 614	630 025	676 656
Communications	1 167 377	1 066 508	1 139 537	1 263 752	1 408 076	1 504 906

Note: .. no data.

Source: OECD, based on data provided by WITSA.

StatLink: http://dx.doi.org/10.1787/110545204168

Table 1.A2.6. **Emerging economy ICT spending by segment, 2000-2005**

USD millions in current prices

	2000	2001	2002	2003	2004	2005
IT HARDWARE						
China	12 507	16 639	20 357	27 027	39 057	47 927
Hong Kong, China	1 961	2 007	2 033	1 921	1 980	2 026
Chinese Taipei	2 767	2 892	3 362	3 605	4 148	4 391
India	2 257	2 764	3 457	5 013	7 204	10 264
Russia	1 816	2 107	2 345	2 881	3 900	4 852
Brazil	6 263	6 404	7 031	9 905	12 407	15 946
South Africa	1 661	1 707	1 698	2 503	3 457	4 024
SOFTWARE						
China	1 085	1 658	2 253	3 344	5 295	7 940
Hong Kong, China	278	318	358	373	432	492
Chinese Taipei	519	628	739	860	1 046	1 228
India	358	456	588	948	1 350	1 908
Russia	343	395	450	570	742	923
Brazil	1 602	1 698	1 787	2 469	2 877	3 566
South Africa	627	724	800	1 328	1 965	2 369
IT SERVICES						
China	851	1 389	2 155	3 591	6 203	10 006
Hong Kong, China	540	601	688	747	903	1 071
Chinese Taipei	788	929	1 073	1 226	1 478	1 731
India	1 120	1 386	1 787	2 859	3 876	5 243
Russia	891	979	1 158	1 537	2 099	2 747
Brazil	4 937	4 792	5 101	7 353	9 040	11 911
South Africa	1 293	1 351	1 486	2 440	3 632	4 408
COMMUNICATIONS						
China	29 917	32 129	37 612	41 437	47 102	51 759
Hong Kong, China	9 098	8 432	9 423	9 595	11 662	12 240
Chinese Taipei	14 200	11 069	11 977	12 570	13 247	14 367
India	12 841	12 239	14 166	16 873	23 734	29 023
Russia	6 064	7 508	9 134	11 566	14 798	18 806
Brazil	20 609	17 691	17 757	21 491	24 006	30 642
South Africa	6 896	5 845	5 772	8 947	11 709	12 825
TOTAL ICT						
China	44 359	51 815	62 376	75 400	97 658	117 632
Hong Kong, China	11 878	11 358	12 501	12 637	14 977	15 829
Chinese Taipei	18 274	15 518	17 151	18 262	19 920	21 718
India	16 575	16 844	19 997	25 692	36 164	46 438
Russia	9 114	10 989	13 088	16 554	21 539	27 327
Brazil	33 410	30 585	31 675	41 217	48 330	62 065
South Africa	10 477	9 627	9 756	15 217	20 763	23 625

Source: OECD, based on data provided by WITSA.

StatLink: http://dx.doi.org/10.1787/724303553700

ISBN 92-64-02643-6
OECD Information Technology Outlook 2006

Chapter 2

ICT Trade and Globalisation of the ICT Sector

This chapter examines recent trends in ICT trade and globalisation of the ICT sector. There is a significant global restructuring of ICT production activities, with the emergence of eastern European and non-OECD and developing countries as both ICT goods producers and new growth markets, and global shifts in ICT and ICT-enabled services production. This new wave of globalisation has largely been driven by efficiency-seeking competition, with firms taking advantage of continuing cost differences and the rapid development of goods and services production capabilities, complemented increasingly by the growth of new markets in rapidly developing eastern European and non-OECD economies, particularly China and India.

Introduction

This chapter examines recent trends in ICT trade and globalisation of the ICT sector. The sector is among the most dynamic in goods and services trade, export-oriented foreign direct investment (FDI) and cross-border mergers and acquisitions (M&A) particularly in telecommunications services. There is a significant global restructuring of ICT production activities, with the emergence of eastern European and non-OECD and developing countries as both ICT goods producers and new growth markets, and with the global relocation of ICT and ICT-enabled services production. This new wave of globalisation has largely been driven by efficiency-seeking competition in production, with firms taking advantage of continuing cost differences and the rapid development of goods and services production capabilities, and more recently by the growth of new markets in rapidly developing eastern European and non-OECD economies (*e.g.* China and India).

ICT trade

The last few years have seen a major recovery in ICT goods trade (the sum of exports and imports) following the slump from 2000, and computer and information services trade continued to grow strongly. But the pattern of trade is changing as assembly and, increasingly, higher value production activities move to rapidly developing economies in Asia and eastern Europe and ICT-related services activities are increasingly offshored. In the late 1990s, OECD merchandise trade expanded rapidly. Trade in ICT goods contributed significantly, increasing by more than 20% in 2000 and accounting for almost 17% of total merchandise trade (Figure 2.1 and Table 2.A1.1; for definitions see OECD, 2003, 2004). In 2001, growth slowed in many developed economies and demand for ICT goods declined sharply before recovering strongly in 2003-04. ICT goods trade in current values showed steady growth during 2005 and overall is expected to grow at around the same rate as manufacturing trade in 2006, but with higher growth in some segments and in trade with developing economies, particularly China. However, strong commodity prices in 2005 and 2006, coupled with ongoing price declines for ICT equipment, disguise the relative performance of ICT trade in total trade in volume terms and the extent and significance of the ICT recovery and the emergence of new production capabilities and markets.[1] In volume terms, commodity trade has not grown anything like as much as ICT goods trade and production.

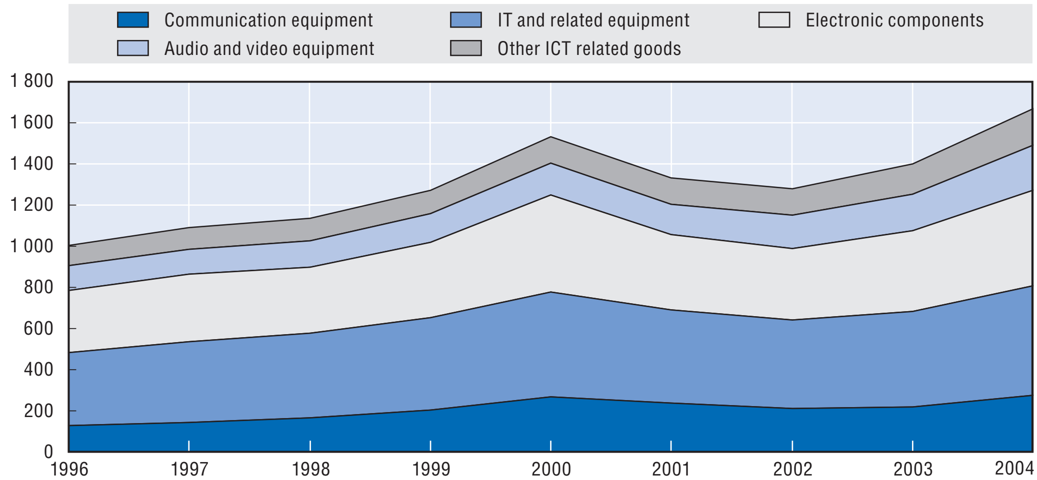
Trade in ICT goods

OECD exports of ICT goods (for a definition, see Annex A) recovered strongly to reach a new peak of USD 789 billion in 2004 (Table 2.A1.1).[2] The boom years of the late 1990s saw strong growth in exports of communication equipment, reflecting the Internet phenomenon and investment in telecommunications, but the current recovery is based on electronic components, audio and video, and other ICT-related equipment. OECD ICT goods imports exhibit a similar trend and reached a new peak of USD 880 billion in 2004, driven by growth in communication equipment, audio and video equipment (Figure 2.1).

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Figure 2.1. **OECD trade in ICT goods, 1996-2004**

USD billions, current prices



Source: OECD ITS database. The sum of exports and imports.

StatLink: http://dx.doi.org/10.1787/275325155227

In 2004, the largest OECD exporters of ICT goods after China were the United States and Japan, followed by Germany and Korea (Table 2.A1.2). Exports grew by 75% in the Slovak Republic, followed by the Czech Republic (54%), Turkey (46%) and Hungary (42%). Nine countries had a surplus on trade in ICT goods, most notably Japan and Korea. The United States had by far the largest deficit on trade in ICT goods.

Communication equipment

The Internet and the rapid expansion of mobile communications have made communication equipment the fastest-growing segment of ICT trade since 1996, with OECD exports of communication equipment doubling between 1996 and 2000 in current terms. Following a sharp contraction, exports recovered to USD 138 billion in 2004 (Table 2.A1.3; the definition of these sub-groups of ICT goods is given in Annex A). The largest exporters were Korea, Germany and the United States, with exports from Hungary, Korea, Iceland (from a very low base), the Czech Republic and Poland growing by 20% a year or more between 2001 and 2004, while exports from Ireland, Belgium, United Kingdom, Turkey and Japan declined. OECD imports of communication equipment reached a new peak of almost USD 139 billion.

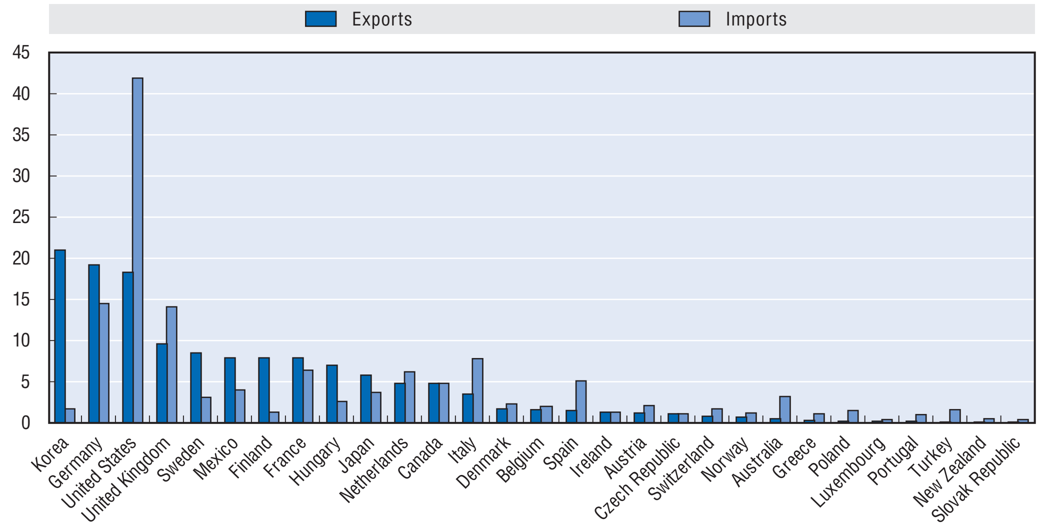
Korea enjoyed the largest surplus on trade in communication equipment during 2004 at USD 19.3 billion (Figure 2.2). Other countries with a significant surplus included a mix of established high-value manufacturing locations (Finland with a surplus of USD 6.7 billion, Sweden of USD 5.4 billion and Germany of USD 4.7 billion) and more recently emerging ICT manufacturing locations (*e.g.* Hungary USD 4.4 billion and Mexico USD 3.9 billion). The United States' deficit on trade in communication equipment was more than USD 23 billion. The United Kingdom, Italy, Spain and Australia each had a deficit in excess of USD 2.5 billion.

Computer and related equipment

Computer equipment is the largest segment of OECD ICT goods trade, accounting for around one-third of the total. Korea and Ireland continue to be major producers of computer equipment, and Mexico and eastern Europe have emerged as significant

Figure 2.2. **OECD communication equipment trade, 2004**

USD billions



Source: OECD ITS database.

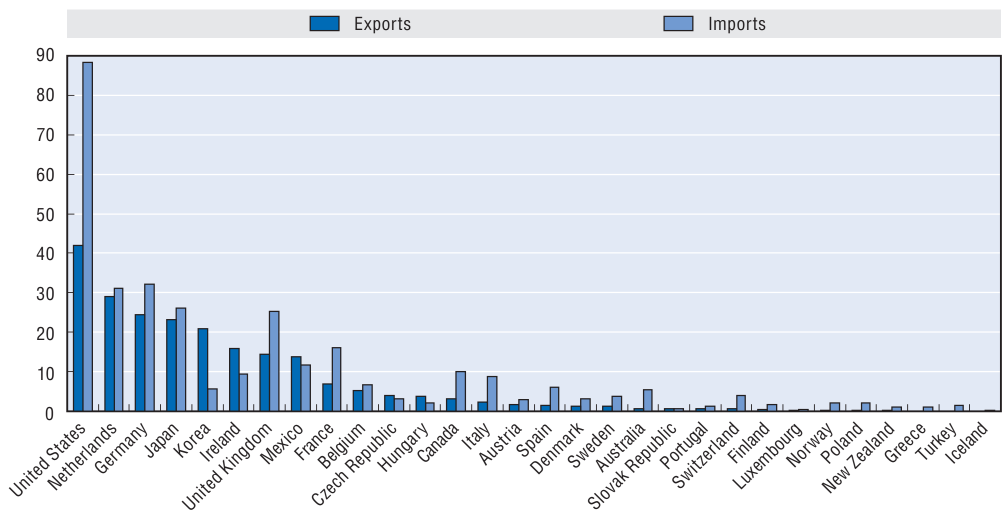
StatLink: http://dx.doi.org/10.1787/467038523847

producers. During 2004, OECD exports were USD 218 billion, almost reaching the peak of 2000 (Table 2.A1.4). The largest exporters were the United States with USD 42 billion, followed by the Netherlands, Germany, Japan and Korea. Since 2001, exports from the Slovak Republic, the Czech Republic, New Zealand, Portugal and Poland have increased by 30% a year or more. OECD imports of computer equipment reached a new all-time peak of USD 313 billion, with the United States the largest importer by far.

Korea enjoyed by far the largest surplus on trade in computer equipment during 2004, at USD 15.4 billion (Figure 2.3). Ireland, Mexico and Hungary also had much smaller but still

Figure 2.3. **OECD computer equipment trade, 2004**

USD billions



Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/486251147278

substantial surpluses. The only other OECD countries with a surplus were the Czech Republic and the Slovak Republic. The United States had a deficit of more than USD 46 billion, and the United Kingdom and France also had substantial deficits.

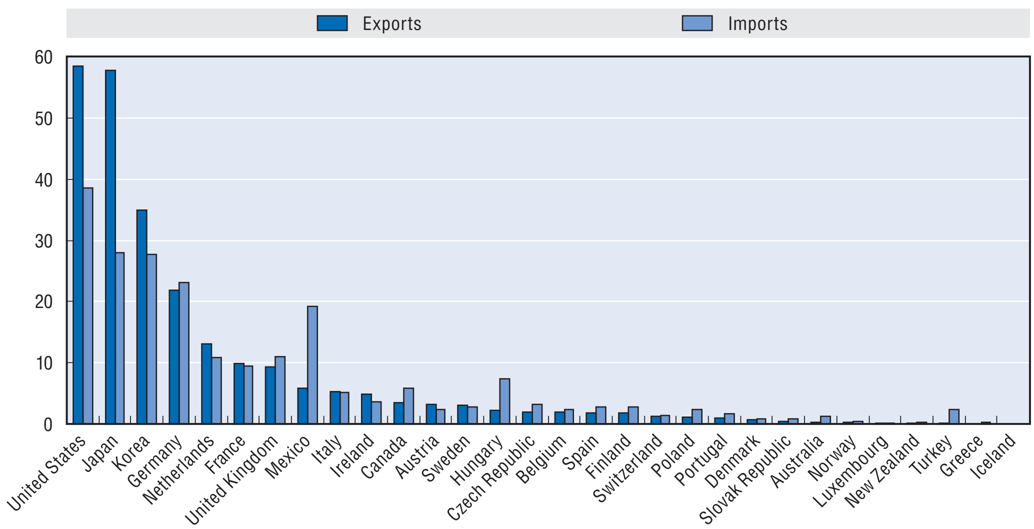
Electronic components

Electronic components account for almost 30% of ICT equipment trade, but have been one of the slowest growing segments. OECD exports of electronic components recovered during 2004 and reached a new peak of USD 247 billion (Table 2.A1.5). The largest exporters were the United States and Japan, trailed by Korea and Germany. OECD imports of components recovered to USD 218 billion. The United States was also the largest importer, followed by Japan, Korea and Germany. Imports into the Czech Republic, Hungary, Poland, the Slovak Republic and Turkey, all of which play an increasing role in ICT equipment assembly and exports, have increased by 20% a year or more since 1996.

Japan enjoyed the largest surplus on trade in components during 2004, at almost USD 30 billion (Figure 2.4). The United States also had a very large surplus. Korea, the Netherlands and Ireland, which play a substantial role in high-value electronics manufacturing also had noteworthy surpluses. Reflecting their role in assembly activities, Mexico and Hungary had the largest deficits on trade in electronic components as they imported components to assemble and export computer, communication and audio and video equipment.

Figure 2.4. **OECD electronic components trade, 2004**

USD billions



Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/818718617315

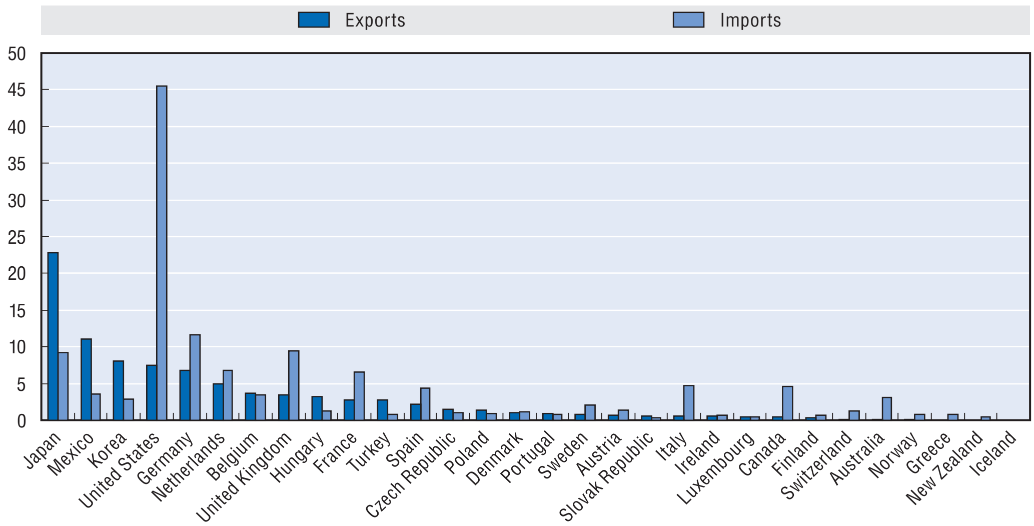
Audio and video equipment

Audio and video equipment accounts for less than 14% of ICT equipment trade. However, owing to sales of digital cameras, flat screen TVs and MP3 players, this has been one of the fastest-growing market segments in recent years. OECD exports of audio and video equipment reached USD 89 billion in 2004 (Table 2.A1.6). The largest exporters were Japan, Mexico, Korea and the United States, while exports from the Czech Republic, Hungary, Turkey and Poland recorded the fastest increases as assembly activities shift to eastern Europe. OECD imports of audio and video equipment reached almost USD 131 billion in 2004. The United States was the largest importer by far, trailed by Germany, the United Kingdom and Japan.

Japan produces a wide range of audio and video equipment and in 2004 enjoyed the largest surplus on trade at USD 13.6 billion. Mexico, Korea, Turkey and Hungary also had significant surpluses (Figure 2.5). The United States' deficit on trade in audio and video equipment was in excess of USD 38 billion, and the United Kingdom, Germany, Italy and Canada all recorded deficits of between USD 4 billion and USD 6 billion.

Figure 2.5. **OECD audio and video equipment trade, 2004**

USD billions



Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/337224723205

Software goods

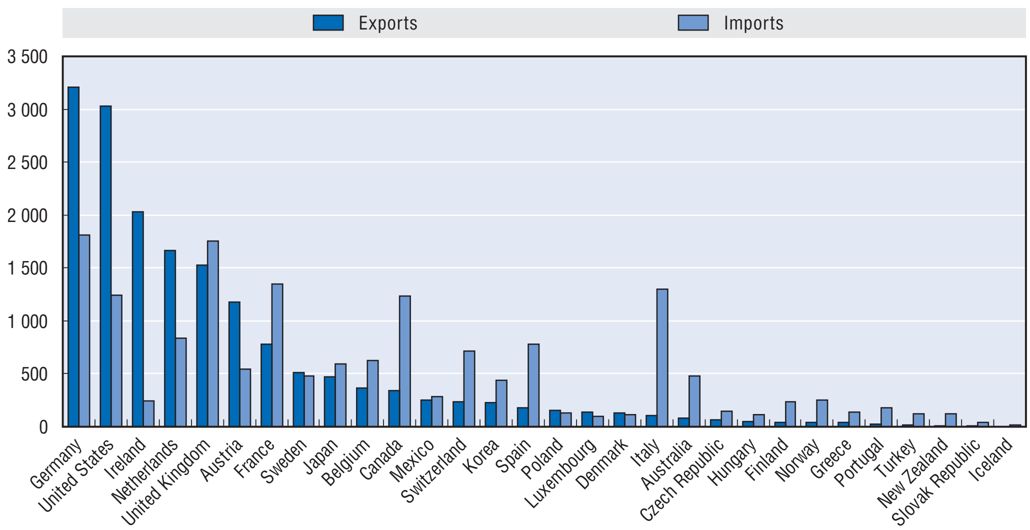
Total OECD exports of software goods (*i.e.* the media containing software, see Box 2.1) were almost USD 17 billion in 2004, and imports were USD 16.4 billion (Table 2.A1.8). Between 1996 and 2004, exports increased by 5% a year, while imports increased by 6.5% a year. In 2004, the leading exporters of software goods were Germany, the United States and Ireland. However, exports from Ireland and the United States have declined since 1996, while those from Korea, Mexico, Sweden, Austria, Portugal and Germany have grown strongly. Germany is now the leading exporter of software goods and Austria and Sweden are in the top eight exporters; all have significant surpluses, no doubt linked with the activities of their leading software and IT firms (*e.g.* SAP, see Chapter 1). Germany, the United Kingdom, France, Italy, the United States and Canada were the OECD's leading importers of software goods, each importing USD 1-2 billion. Italy, Canada, Spain and France experienced the largest deficits on trade in software goods, and the United States, Ireland and Germany recorded the largest surpluses (Figure 2.6).

Box 2.1. **Measuring software trade**

There are many problems associated with tracking software in trade statistics. 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 (equipment trade is overstated and software trade is understated). Third, trade statistics do not measure the value of copyright works sold in foreign markets. This is the "gold master" problem: only the original software product is counted in international trade, but it is then copied many times for sale in the importing country. Fourth, trade statistics do not measure the value of software transmitted electronically across borders, which accounts for a rapidly increasing share of sales, or the rise of application service providers of software (ASPs). Many of these issues (*e.g.* the treatment in balance of payments and National Accounts of royalty payments for use of intellectual property) are receiving increasing scrutiny as these payments increase in value (for Ireland, see Lucey, 2005). This section tracks trade in the physical supports (*e.g.* magnetic discs, tapes 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 goods.

Figure 2.6. **OECD software goods trade, 2004**

USD billions



Source: OECD ITS database.

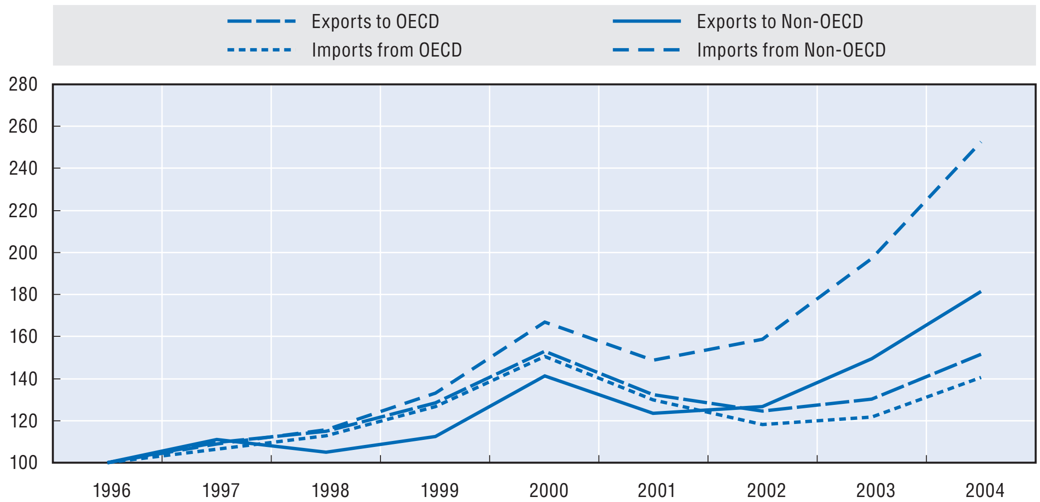
StatLink: http://dx.doi.org/10.1787/150782758630

The direction and composition of ICT goods trade

The direction and composition of trade in ICT goods show the global rationalisation of production, with rapid growth in non-OECD and eastern European countries as both producers and markets (see also WITSA, 2004). Differences in the trends during the boom years of the late 1990s and the recent recovery period are marked, with both boom and bust more pronounced for OECD countries than for non-OECD countries. Import trends in particular reveal a shift of manufacturing activity towards non-OECD countries, especially in Asia (*e.g.* China; Hong Kong, China; and Chinese Taipei). For example, imports of ICT goods into OECD countries increased 7% a year between 1996 and 2004, with growth of imports from non-OECD countries much stronger (12% a year) than that of imports from OECD countries (4% a year) (Table 2.A1.10). In the late 1990s, 70% of OECD ICT equipment imports came from other OECD countries and 30% from non-OECD countries. By 2004, the OECD share had fallen to 58% and that of non-OECD countries had risen to 42% (Figure 2.7).

Figure 2.7. **Direction of OECD ICT goods trade, 1996-2004**

USD current prices, index 1996 = 100



Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/410847705151

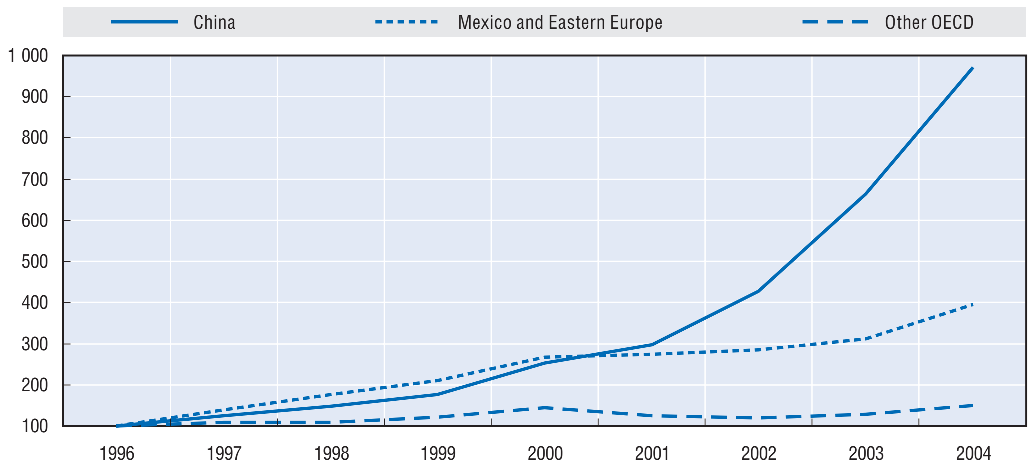
China's trade in ICT goods has continued to grow very strongly (Table 2.A1.11, see also Chapter 4). As part of global restructuring, China's ICT goods trade grew faster in the post-2000 period than in the late 1990s: China's ICT goods exports grew by 26% a year between 1996 and 2000, and by a staggering 40% a year between 2000 and 2004. China (excluding the Hong Kong and Macao Special Administrative Regions) is now the world's largest exporter of ICT goods at more than USD 180 billion in 2004, eclipsing the United States (USD 149 billion) and Japan (USD 124 billion).

The composition of China's ICT trade shows the global restructuring of the ICT sector. Computer and related equipment accounted for 46% of China's total ICT goods exports in 2004 and is the fastest growing export category. Because of China's substantial role in assembly, electronic components is the largest category of ICT goods imports and grew extremely rapidly by 38% a year from USD 7.4 billion in 1996 to USD 97 billion in 2004. Electronic components accounted for no less than 65% of all ICT goods imports into China during 2004, leading to a deficit on trade in components of USD 62 billion compared with surpluses on trade in all categories of assembled ICT equipment. A considerable share of these exports comes from the electronic manufacturing services industry which ships components into countries for low-cost assembly and then exports assembled ICT goods. The top 50 firms in this industry had reported sales of over USD 100 billion in 2005, and many have extensive operations in China and come from other Asian countries, *e.g.* Flextronics (Singapore), Hon Hai Precision (Chinese Taipei) (MMI, 2006).

There is also a shift in manufacturing activities within the OECD area, particularly towards assembly in Mexico and eastern European member countries (*i.e.* the Czech Republic, Hungary, Poland, the Slovak Republic and Turkey). Between 1996 and 2004, total OECD ICT goods trade increased by 6.5% a year, while that of Mexico and the eastern European members increased by 17.4% a year (Figure 2.8). The composition of trade for these countries is also considerably different from that of other OECD countries. In 2004, components accounted for 16% of ICT goods exports from Mexico and the eastern European members and for 43% of their imports, compared with 33% of other member countries' exports and 23% of their imports. Conversely, audio and video equipment accounted for 27% of Mexico and the eastern European members' ICT goods exports and 10% of their imports, compared with just 10% of other member countries' exports and 15% of imports.

Figure 2.8. **ICT goods exports by region, 1996-2004**

USD current prices, index 1996 = 100



Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/465414440682

Mexico and the eastern European members had a surplus on trade in all categories of assembled ICT equipment in 2004, but a combined deficit in excess of USD 23 billion on trade in components, similar to China's pattern of trade. In contrast, the other OECD countries recorded a combined deficit on trade in all categories of assembled ICT equipment, with a surplus in excess of USD 50 billion on trade in components. These figures reflect a shift of ICT equipment assembly activities to Mexico and eastern Europe similar to that occurring beyond the OECD area in China and elsewhere in Asia. They are all important parts of the new wave of globalisation of ICT manufacturing that has emerged as a new round of efficiency-seeking assembly for export has developed.

Trade in ICT services

OECD ICT-related services trade increased from around USD 70 billion in 1996 to more than USD 175 billion in 2004, or by 13% a year (Table 2.A1.12). Over the period, OECD exports of ICT services increased by 16% a year from around USD 30 billion to USD 103 billion and imports by 9% a year from USD 35 billion to USD 72 billion.

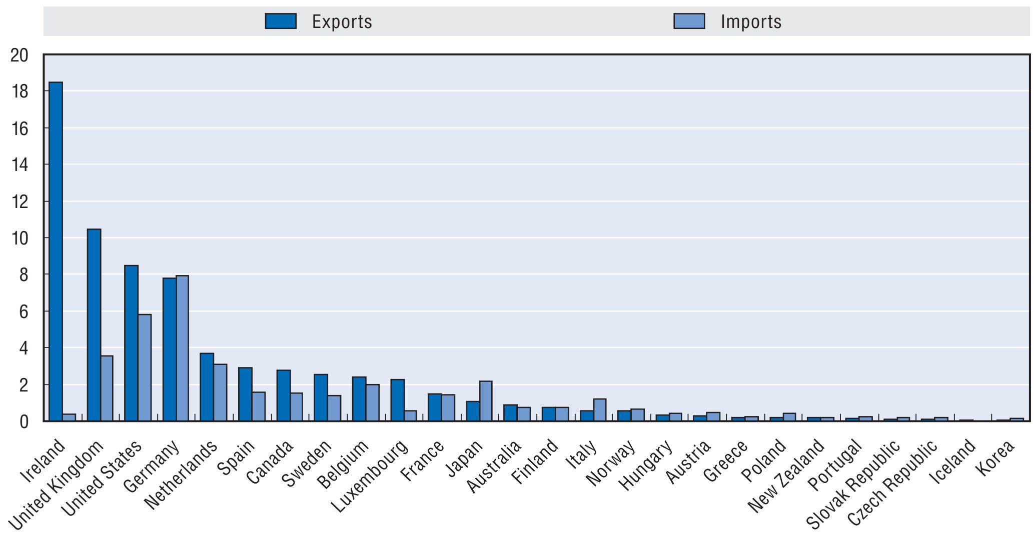
Computer and information services

Reported OECD exports of computer and information services increased by 23% a year from around USD 13 billion in 1996 to USD 69 billion in 2004 and imports increased by 15% a year from USD 12 billion to USD 37 billion (Figure 2.9 and Table 2.A1.12).[3] In 2004 Ireland was the leading exporter, followed by the United Kingdom, the United States and Germany. Germany was the largest importer, followed by the United States, the United Kingdom and the Netherlands (see also Chapter 3).

Ireland was by far the largest exporter and had by far the largest surplus on trade in computer and information services in 2004. The United Kingdom and the United States also had large surpluses. However, Ireland is unusual in that it 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 clearly a major producer and exporter of software and IT services. IT-related services exports are replacing Ireland's former leading role in ICT goods exports as global IT services and software firms use Ireland as a location to set up export operations linked with its advantageous corporate tax regime.

Figure 2.9. **Computer and information services trade, 2004**

USD billions



Source: OECD/Eurostat statistics on international trade in services.

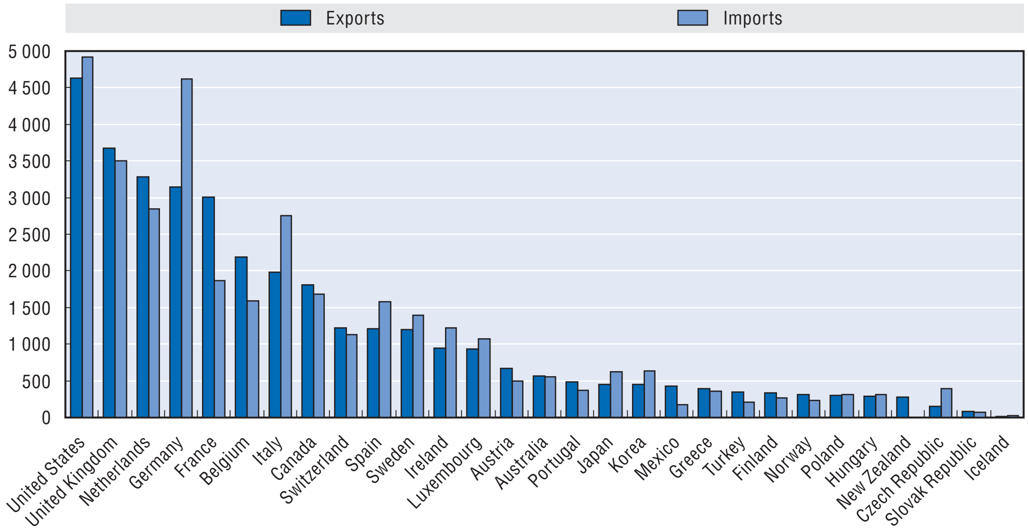
StatLink: http://dx.doi.org/10.1787/881163122436

Communication services

Communication services trade trends are difficult to read. Values are often tied to progress in the deregulation of communications in various countries and trade is often a contrary indicator of overall services trade (*i.e.* communication services imports tend to increase when other services exports increase, and *vice versa*). Reported OECD trade in communication services increased by almost 7% a year from 1996 to 2004, with exports increasing by 8.5% a year and imports by 5% a year (Figure 2.10 and Table 2.A1.12).[4] The leading exporters were the United States, the United Kingdom, the Netherlands, Germany and France. The main importers were the United States, Germany and the United Kingdom. France had the largest surplus.

Figure 2.10. **Communications services trade, 2004**

USD billions



Source: OECD/Eurostat statistics on international trade in services.

StatLink: http://dx.doi.org/10.1787/614101068220

Globalisation of the ICT sector

The world economy is highly globalised. In 2004, there were an estimated 69 727 multinational enterprises (MNEs) with some 690 391 foreign affiliates employing around 57 million people worldwide. At almost USD 19 trillion, affiliates' sales were worth twice as much as world trade. Worldwide, FDI inflows amounted to USD 695 billion in 2004 and an estimated USD 897 billion in 2005, and accounted for more than 7% of global gross fixed capital formation in 2004 (UNCTAD, 2005, 2006). The ICT sector plays a major role, both because it is itself highly globalised and because it enables the globalisation of other sectors.

Globalisation and trade

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) has transformed the overall pattern of world trade. This section analyses the level of specialisation, intra-industry and intra-firm trade to explore the nature and extent of globalisation in the ICT-producing sector.

Trade, production and sales

ICT trade is growing faster than production and sales. Between 1994 and 2004 (the most recent year for which comprehensive data are available), western European trade in electronics goods increased by 8.2% a year, while production increased by 2.8% a year and sales by 3.5% a year. Similarly, in the Americas and Asia-Pacific region trade increased by 7% a year while production of electronics goods increased by 2% a year and sales by 2.7% a year, (Table 2.1).[5] In both regions trade growth easily outstripped production, in part owing to global rationalisation of equipment production. As one indicator of globalisation, trade is generally growing faster than production. Over the period 1990-2000, worldwide merchandise exports increased 6.4% a year, while merchandise production grew by 2.5% a year (WTO 2005).

Table 2.1. **Annual growth in electronics goods production, trade and sales, 1994-2004**

Percentage

	EDP	Radio Communications	Tele-Communications	Other	Total
Western Europe					
Imports	*8.0*	*21.2*	*8.7*	*6.4*	*8.1*
Exports	*7.7*	*18.9*	*5.6*	*7.0*	*8.4*
Trade	7.9	19.9	7.0	6.7	8.2
Production	1.2	7.2	–2.4	3.4	2.8
Market Sales	4.3	6.1	–1.4	3.4	3.5
Americas and Asia-Pacific					
Imports	*8.5*	*16.5*	*7.4*	*6.8*	*8.0*
Exports	*4.5*	*15.0*	*3.1*	*6.2*	*6.2*
Trade	6.4	15.7	5.1	6.5	7.0
Production	–0.1	7.0	–2.0	2.2	2.0
Market Sales	2.5	7.0	–0.4	2.1	2.7

Note: Trade and production growth calculated as annual growth 1994 to 2004 based on current prices.
Source: Reed Electronics Research, *Yearbook of World Electronics Data*, 1994 and 2006.

StatLink: http://dx.doi.org/10.1787/735477476316

Specialisation in ICT production

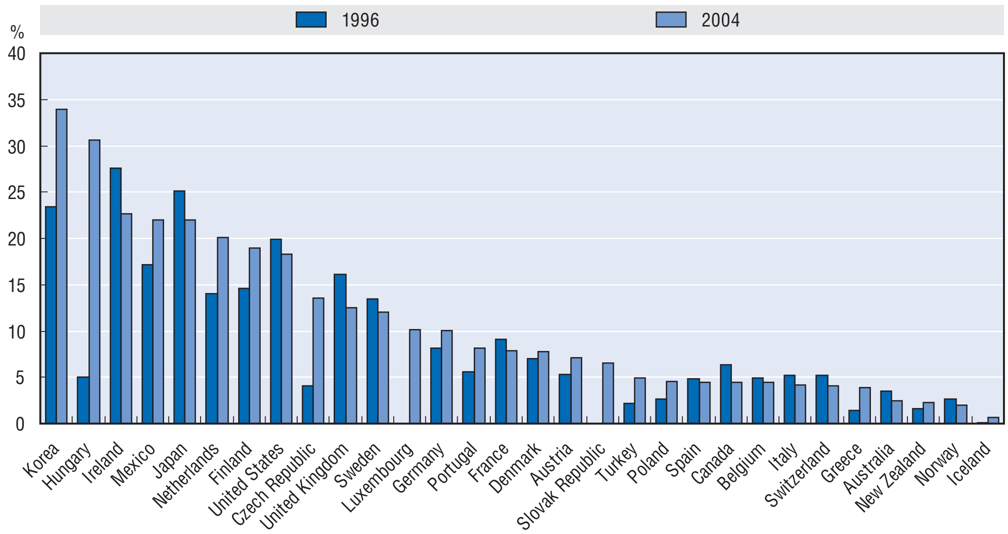
Globalisation and the international rationalisation of production might also be expected to lead to increasing specialisation, with some countries increasing their specialisation in ICT production and others specialising in other products. One indicator is the share of ICT goods in total merchandise exports, which varies significantly from country to country (Table 2.A1.13). In 2004, ICT goods accounted for 34% of Korea's merchandise exports, and between 20% and 30% of merchandise exports from Hungary, Ireland, Mexico, Japan and the Netherlands. Finland, the United States and the Czech Republic were the only other countries with a level of specialisation above the overall OECD average (Figure 2.11). Iceland, Norway, New Zealand and Australia are least specialised in the production of ICT goods for export.

In general, countries that specialise in ICT production increasingly do so, while those that do not are becoming less specialised (Figure 2.11). The share of ICTs in merchandise exports from Hungary, Czech Republic and Turkey has increased rapidly with the establishment of manufacturing facilities in eastern Europe. There has also been increasing specialisation among already relatively specialised countries (Korea, Finland and the Netherlands). The impact of the boom and bust on particular sectors (*e.g.* communication equipment), firms (*e.g.* Ericsson, Nortel and, perhaps, Marconi) and countries (*e.g.* Sweden, Ireland, the United Kingdom) is also evident. Half of the 26 OECD countries for which data are available increased their specialisation in ICT production between 1996 and 2004, while that of the other half decreased.

Revealed comparative advantage in ICT goods: Specialisation in ICT goods trade is captured in the "revealed comparative advantage" index which shows whether ICT manufacturing exports perform better or worse for a given country than the average for the total OECD area.[6] In 2004, the nine OECD countries with a comparative advantage in ICT manufacturing were, in descending order, Korea, Hungary, Ireland, Japan, Mexico, the Netherlands, Finland, the United States and the Czech Republic, with the United Kingdom slipping just below the OECD total in 2004 (Table 2.A1.14). Recent trends suggest increasing specialisation; those with an increasing advantage including a mix of countries that already had a high level of specialisation (Korea, Finland, Netherlands) and those with

Figure 2.11. **Share of ICT goods in total merchandise exports, 1996-2004**

Percentages

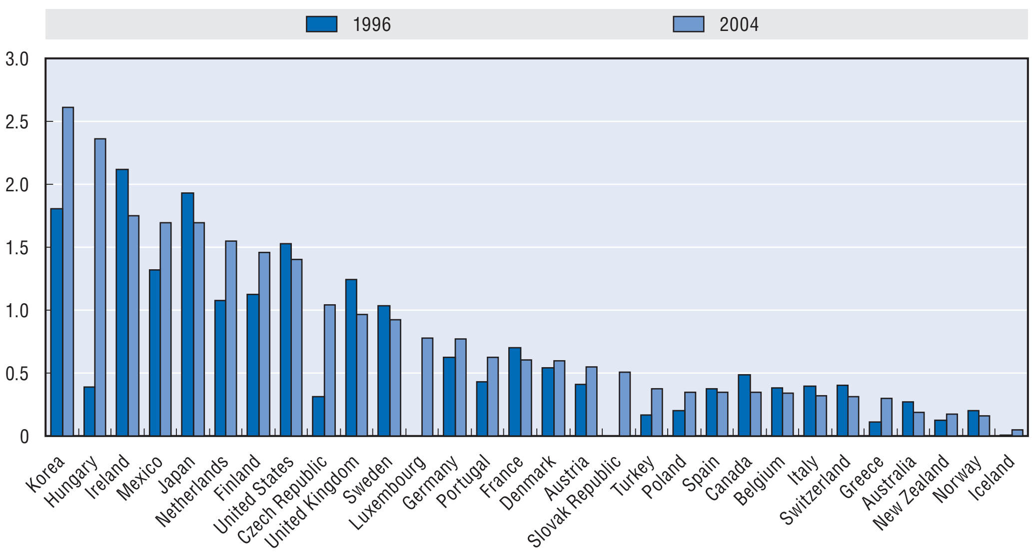


Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/252610874750

relatively recent investment in ICT manufacturing activities (Hungary, the Czech Republic, and to a certain extent Mexico). Ireland's revealed comparative advantage has declined markedly as global firm investment in Ireland shifts to services. Overall, the rapid emergence of ICT production in Korea (and elsewhere in Asia), Mexico and eastern Europe is evident, as is the continuing global rationalisation of ICT production (Figure 2.12).

Figure 2.12. **Revealed comparative advantage in ICT goods, 1996-2004**



Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/642640314042

Intra-industry trade

Developed countries increasingly trade products of the same industries.[7] This intra-industry trade tends to enhance the gains from trade through increasing specialisation in a limited number of products in particular industries. It reflects an increasingly fine-grained specialisation and global distribution of production activities.[8]

Across OECD countries, intra-industry trade accounted for almost 70% of total manufacturing trade between 1996 and 2004. Mexico, the Netherlands, Germany and the Czech Republic have relatively high levels of intra-industry trade in ICT goods. Half of the 28 OECD countries for which data are available recorded higher levels of intra-industry trade in 2004 than in 1996. Eastern European countries (the Czech Republic, Turkey, Poland and Hungary) have seen some of the most rapid increases in their ICT goods intra-industry trade index, which points to the ICT sector's increasing global specialisation and efficiency-seeking organisation.

Intra-firm trade

A large and growing share of international trade is between related firms and ICT goods and services have generally higher than average shares. The United States is among a handful of countries that report intra-firm trade in detail. In 2004, intra-firm trade accounted for 42% of total US merchandise trade – 48% of imports and 31% of exports (Department of Commerce, 2005).[9] Intra-firm trade is a particular feature of highly globalised ICT manufacturing, accounting for more than 68% of US ICT goods imports and 34% of exports, higher shares than for total goods (Table 2.2). ICT goods accounted for 15% of total US goods imports and 11% of exports, but they accounted for almost 22% of related party imports and almost 13% of related party exports.[10]

Intra-firm trade is also increasingly important in services. In 2004, affiliated trade accounted for 27% of US cross-border exports of services and 21% of cross-border imports, compared with 16% and 22%, respectively, in 1997. Again, the ICT sector appears to be relatively highly globalised, with affiliated trade accounting for 22% of US cross-border exports of computer and information services and 66% of cross-border imports in 2004, compared with 31% and 50%, respectively, in 1997 (Borga and Mann, 2002, 2004; Nephew *et al.* 2005). The global rationalisation of services production and the emergence of IT services offshoring may be one reason for the relatively high and growing share of affiliated imports of computer and information services, reflecting, in part, the extent of captive (*i.e.* in-house) offshoring of such services by US parent firms (WTO, 2005).

Foreign direct investment

Arm's-length trade is becoming a somewhat less important avenue for globalisation with the emergence of new patterns of cross-border business activity and FDI playing an increasing role, particularly in the ICT sector (Hemerling *et al.*, 2005; IMF, 2005; OECD, 2005b, 2006). Direct investment is affected by cyclical fluctuations in income and growth. On the supply side, FDI is affected by the availability of investment funds, which have been boosted by rapidly increasing profitability and stock market valuations. On the demand side, global rationalisation of production and growing overseas markets lead MNEs to invest, and strong growth in Asia and elsewhere have increased the attractiveness of international expansion. As a result, FDI flows have recovered from their depressed levels of 2002 and 2003, growing very strongly in 2004 (developing countries) and 2005 (everywhere), with a generally positive outlook despite some macroeconomic and political uncertainties (see section on M&As below and Table 2.A1.15 for details through 2004).

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Table 2.2. **US intra-firm trade in ICT goods and services, 2004**

USD millions and percentage shares

	US imports			US exports		
	Total imports	Related party trade	Share %	Total exports	Related party trade	Share %
All goods	*1 460 160*	*697 561*	*47.8*	*817 936*	*252 086*	*30.8*
Computer equipment	73 733	51 731	70.2	27 039	9 654	35.7
Communication equipment	38 733	28 106	72.5	13 530	2 108	15.6
Audio and video equipment	37 054	24 282	65.5	3 417	973	28.5
Electronic components	65 351	43 690	66.9	47 626	17 935	37.7
Magnetic and optical media	4 096	2 160	52.7	1 390	825	59.4
ICT products	218 967	149 969	68.5	93 002	31 495	33.9
ICT share of total	15.0	21.5	..	11.4	12.5	..
All services	*258 069*	*54 693*	*21.2*	*323 362*	*85 548*	*26.5*
Computer and information services	5 804	3 800	65.5	8 501	1 900	22.4
ICT share of total	2.2	6.9	..	2.6	2.2	..

Note: ICT sector based on 4-digit NAICS. ICT goods include 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, 2005.

StatLink: http://dx.doi.org/10.1787/160323018228

The shift to developing countries

A major feature of FDI flows in recent years has been the shift to developing countries. A significant share of this investment goes into the ICT sector (about one-fifth of total flows to all countries in 2005 according to M&A data below). Inflows to developing countries in recent years grew sharply, while those to developed countries slumped over the 2001-04 period before reviving in 2005. Although FDI into developing countries continued to grow strongly, estimates for 2005 show a relative change in direction towards developed countries with inflows into OECD countries reaching pre-slump 2001 levels. In 2004 flows to developing countries rose by 41% to USD 243 billion, while inflows to developed countries fell by over 6% (the major exceptions were the United States and the United Kingdom) (OECD, 2006; UNCTAD, 2005, 2006).

In 2005, preliminary data show a very sharp rise in global FDI (up 29%). FDI in developed economies grew by an estimated 38% for the year, in very large part driven by the merger of the Shell companies which drove FDI into the United Kingdom to record levels (UNCTAD, 2006). Other OECD countries (Belgium, Canada, France, Germany, Ireland, the Netherlands and the United States) also recorded high inflows. Nonetheless, FDI inflows into developing countries continued at a high rate, up 13% according to preliminary estimates. More recent OECD data show direct investment inflows into OECD countries up by 27% in 2005, with France the major outward investor and the United Kingdom and the United States the main OECD destinations.

In 2005, Asia and Oceania are still the major recipients among developing regions, with China (excluding Hong Kong) and India receiving over 7% of worldwide FDI inflows (UNCTAD, 2006). China is continuing to grow as a major destination for FDI, with a significant share in ICT-related sectors, and as an emerging source of outward investment in OECD countries (*e.g.* Lenovo's acquisition of IBM's PC manufacturing division; see Chapter 4 and OECD, 2006). FDI into Mexico's *maquila* industry also showed a return after years of decline, with total FDI into all sectors rising rapidly in 2004 (by well over 30%)

and maintained high levels in 2005 as the effects of NAFTA continued to feed through into restructured assembly activities, including ICT. There have also been significant investments in ICT-related services in India and increasing Indian investments in OECD countries (*e.g.* Tata's acquisition of Tyco Global Network, see Chapter 3).

A shift to services

The other significant trend in FDI is a shift from manufacturing towards services: telecommunications, computer and information services, and a range of IT-enabled business process services, and R&D, technical testing and design services with a strong emphasis on ICT (*e.g.* R&D related to mobile communications and semiconductor design). From 2001 through 2003, FDI flows to services were 2.8 times greater than those to manufacturing (UNCTAD, 2005). Services investments are often motivated by market access, but there is now a significant trend towards efficiency-seeking FDI which promotes global rationalisation of services production. This is particularly evident in computer and information services and in IT-enabled business process, R&D, technical testing and design services, and is a key feature of the new wave of globalisation of the ICT-producing sector.

FDI in the ICT sector

During 2004 FDI flows into electrical and electronic equipment manufacturing grew strongly, and flows into transport, storage and communication services grew steadily (UNCTAD, 2005). During the late 1990s telecommunications attracted large FDI flows, as liberalisation and privatisation coincided with the rapid development of mobile communications networks and the Internet. Between 1990 and 2002, the stock of FDI in telecommunications, transport and storage increased 16-fold from around USD 29 billion to an estimated USD 476 billion (UNCTAD, 2004). Investment activity in the telecommunications sector is now more subdued, although merger and acquisition activity has grown strongly again since 2003 and continues in 2006 (see below).

With the global rationalisation of ICT-related services production, developing countries became an increasing target of FDI inflows. There were a estimated 632 export-oriented FDI projects in IT services worldwide during 2002-03, with a further 513 call-centre projects and 139 projects related to shared services centres. Leading locations for offshored IT services in developed countries were the United Kingdom, Germany, the United States and Australia. Nevertheless, the number of IT services projects in developing countries more than doubled. Asia dominated among developing regions, accounting for 265 (42%) of the IT services projects, with India alone accounting for 118, or 19% of the worldwide total. More than half of the 500 FDI projects for call centres in 2002-03 went to developed countries, notably Canada, Ireland and the United Kingdom, but Asia accounted for 33% of call centre projects and 47% of the shared services centre projects (UNCTAD, 2004).

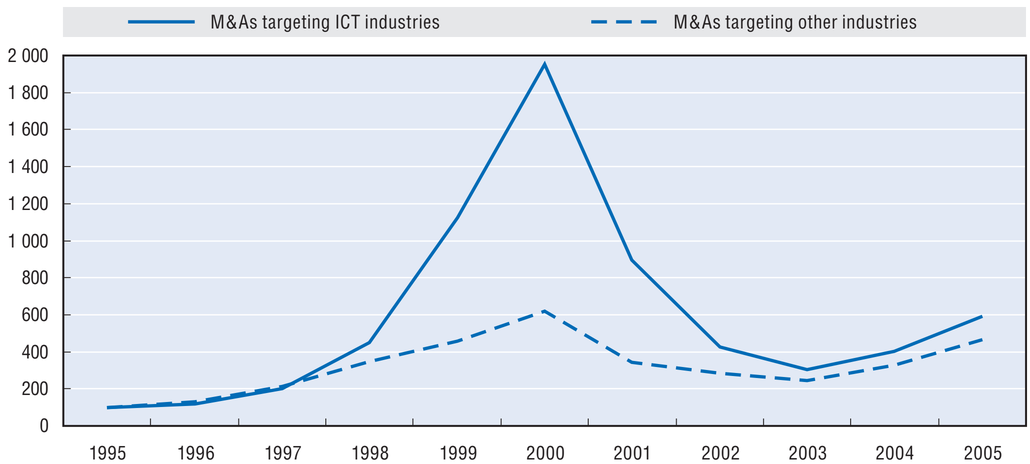
Mergers and acquisition

Cross-border mergers and acquisitions (M&As) have become the most common form of FDI and are largely driving FDI activity. They are especially important in the ICT sector, taking around 20% of all cross-border M&As. They allow faster build-up than greenfield investment and give the acquirer immediate access to existing production capabilities, business relationships and markets. M&A showed increasing levels of activity during 2004 and 2005 and this has continued in the first half of 2006 (*Financial Times*, 2006).[11] In 2005, worldwide there were 7 758 cross-border M&As, 26% more than 2004, driving the sharp rise in FDI flows in 2005 (up 29%, see above). Deal value was up by 44% during the year to more than USD 777 billion. M&A activity increased at the domestic and regional levels as well as the global level, with a large share of the transactions taking place among developed-country firms. Nevertheless, cross-border deals during 2005 increased more than domestic M&As both in number and in value. There was also a significant rise in cross-border M&A purchases in China and India, with a doubling of value in both countries (UNCTAD, 2005).

The ICT sector has played a major role in recent cross-border M&A trends (Figure 2.13).[12] During 2005, around 20% of all cross-border M&A deals targeted the ICT sector, and the value of cross-border deals in which the ICT sector was the target rose by 47%, compared with a 43% increase in value for all other cross-border M&A deals, and this focus on the ICT sector has continued in 2006, particularly in telecommunications. The rapid increase in M&A deal values during the boom years of 1999 and 2000 was the result of increased deal making, with some very large deals in telecommunications following the sector's liberalisation, and increased stock market valuations that made targets more expensive. Both the level of cross-border M&A deal making and the value of the deals were affected by the sharp downturn in the ICT sector from 2000. In the recovery, the ICT sector has again played a leading role and has continued to do so in the first half of 2006 as profits have grown strongly, global growth is more widespread and interest rates remain low despite some concerns about sustainability of this strong upward trend (Tables 2.A1.16 and 2.A1.17).

Figure 2.13. **Value of cross-border M&As in ICT and non-ICT industries, 1995-2005**

Current prices, index 1995 = 100



Source: OECD, based on data provided by Dealogic.

StatLink: http://dx.doi.org/10.1787/710167832210

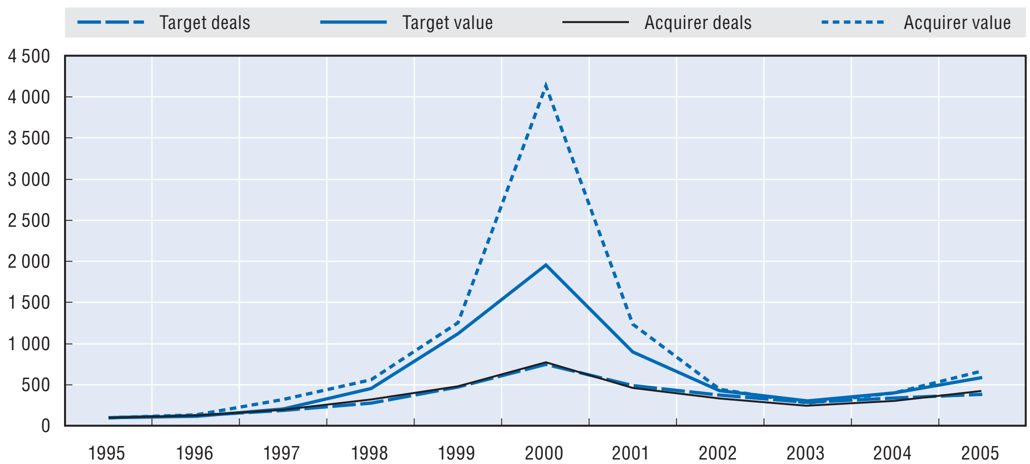
Cross-border M&As in the ICT sector

Over the last decade, 14 566 completed cross-border M&A deals targeted the ICT sector and the ICT sector was the acquirer in 11 634. With the shift to services, the largest number of deals has been in IT services, followed by telecommunications and electronics, and the fastest growth has been in IT services and telecommunications (Table 2.A1.16). In general, ICT sector deals have bought into services and out of manufacturing. The number of deals targeting services was higher than that for deals in which services were the acquirer, while the contrary holds for manufacturing. The value of cross-border M&A deals targeting the ICT sector reached USD 134 billion in 2005, an increase of more than 19% a year from 1995 (in current prices); the value of deals in which the ICT sector was acquirer was up by 21% a year (Table 2.A1.17). Some of the largest deals have occurred in telecommunication services, which has been the target of 63% of total cross-border ICT industry M&A deal value over the last decade. As targets, the electronics, telecommunication and IT services industries have experienced the most rapid increases in cross-border M&A deal values over the decade; as acquirers have increased fastest in the communication equipment, media and content, and IT services industries.

Whether one looks at number of deals or deal values, the extraordinary peak of cross-border M&A activity around 2000 is evident (Figure 2.14). Owing to the combination of deregulation and privatisation in telecommunications, the auctioning of 3G mobile licences and the Internet bubble stock valuations, the total value of cross-border M&As in the ICT sector rose dramatically. Deals targeting the ICT sector reached USD 444 billion in 2000, with telecommunications accounting for USD 307 billion, and the value of deals in which the ICT sector was acquirer reached USD 604 billion, with telecommunications accounting for USD 466 billion. The recent recovery in both the number of ICT sector deals and deal values is also evident, with a 29% increase during 2005 in the number of deals in which the ICT sector was acquirer, and a 66% increase in deal values.

Figure 2.14. **Cross-border M&As deals in the ICT sector, 1995-2005**

Number of deals and deal value in USD millions at current prices index 1995 = 100



Source: OECD, based on data provided by Dealogic.

StatLink: http://dx.doi.org/10.1787/516550867724

The recovery in cross-border M&A deals covers a wide range of activity in equipment manufacturing, semiconductors, telecommunications, IT and Internet services. Notable deals of the last three years include France Telecom's acquisition of Retevision Movil SA of Spain, Vodafone's acquisition of ClearWave of the Netherlands, 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 acquisition of

PanAmSat, Oracle's acquisition of Siebel Systems, the buyout of SunGard Data Systems, the equity firm purchase of Agilent's semiconductor operations, Lenovo's purchase of IBM's PC manufacturing operations, and Alcatel's merger with Lucent announced early in 2006.

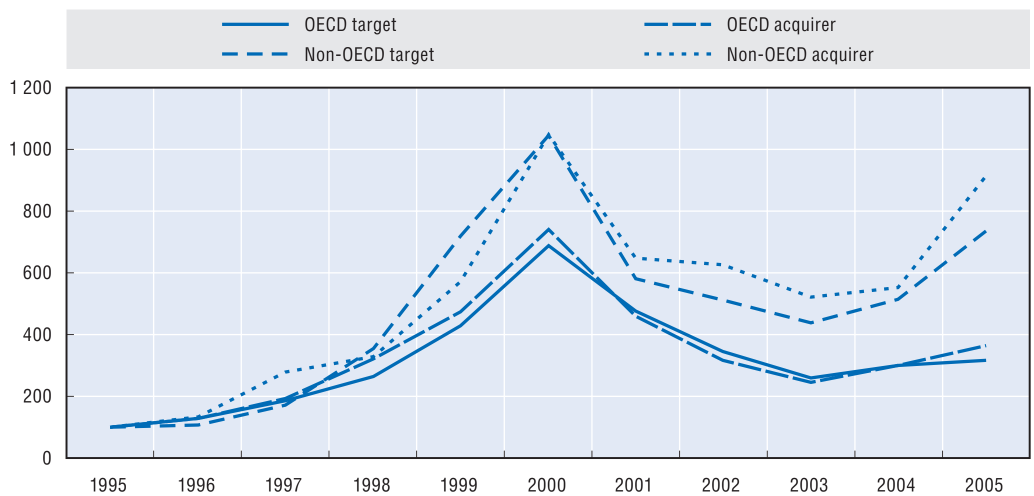
ICT sector M&As by country

Analysis of the origin and destination of cross-border M&As shows the expansion of domestic ICT firms into foreign ICT industries and of foreign firms into domestic ICT industries.[13] Over the decade to 2005, the value of cross-border M&A deals targeting the ICT sector amounted to USD 1 492 billion worldwide, of which 80% were deals in which OECD member countries were the target (Table 2.A1.18). The value of cross-border M&A deals in which the ICT sector was acquirer amounted to USD 1 392 billion worldwide, of which 86% were deals in which OECD member countries were the acquirer (Table 2.A1.19).

During the decade to 2005, the United States accounted for 30% of all cross-border M&A deals targeting the ICT sector in OECD countries by value, the United Kingdom accounted for 18%, Germany 11% and the Netherlands 6%. 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 Denmark, Finland, the Netherlands, Switzerland, Ireland and Japan. Inward ICT sector M&A deal values declined for Australia and Italy. These data match the ICT trade specialisation indicators discussed above and indicate a global rationalisation of production in the ICT sector, rather than simply market access. The United Kingdom accounted for 32% of outward ICT sector M&A deals from OECD countries by value over the last decade, and the United States for 17%. France was the only other member to account for more than 10%. In France, Sweden, Austria and Spain the value of outward ICT sector M&A deals increased most rapidly during the last decade.

Figure 2.15. **ICT sector cross-border M&As deals by region, 1995-2005**

Number of deals index 1995 = 100



Source: OECD, based on data provided by Dealogic.

StatLink: http://dx.doi.org/10.1787/436810486472

However, ICT sector cross-border M&As are increasingly targeting and originating in non-OECD countries (Tables 2.A1.18 and 2.A1.19).[14] The phenomenon is more evident in terms of number of deals than deal values, because non-OECD country deals tend to be smaller. The number of cross-border M&A deals targeting the ICT sector in non-OECD countries increased by 22% a year over the decade to 2005, while those targeting ICTs in OECD countries increased by 12% a year. The number of deals in which the ICT sector in non-OECD countries was acquirer increased by 25% a year, compared with 14% a year for OECD country acquirers (Figure 2.15). In this new wave of globalisation of ICT production, cross border M&A deals are increasingly targeting services and rapidly emerging non-OECD economies (*e.g.* China and India).

Activities of affiliates

International production by MNEs spans virtually all countries, sectors and economic activities. Reflecting increasing globalisation, global sales and gross product associated with international production have increased faster than world GDP (Table 2.A1.15 and UNCTAD, 2005). Between 1995 and 2001, the employment of manufacturing affiliates under foreign control in OECD countries increased by 24%, and their share of manufacturing sector turnover in 2001-02 ranged from 75% in Ireland and Hungary to less than 3% in Japan, with shares exceeding 40% in Canada, Belgium and Luxembourg, and 30% in the Czech Republic, Sweden, United Kingdom, France, Poland and the Netherlands. The share of turnover under foreign control in the services sector is also relatively high in a number of countries, and more than 35% in Ireland and Hungary (OECD, 2005c).

Foreign affiliates' shares in the ICT sector are often higher than their shares in the economy as a whole. Their share of computer equipment manufacturing turnover exceeded 80% in the Czech Republic, Ireland, Hungary, France, Spain and the United Kingdom in 2002. Their share in electronic equipment manufacturing exceeded 80% in Hungary, Ireland, the Czech Republic and Poland. Foreign affiliate turnover shares in computer and related services are somewhat lower, but still exceeded 30% in Belgium, the United Kingdom, the Czech Republic and Norway, and have been increasing in telecommunications services following high levels of M&A activity in telecommunications (OECD, 2005a, 2005c) (Figure 2.16).

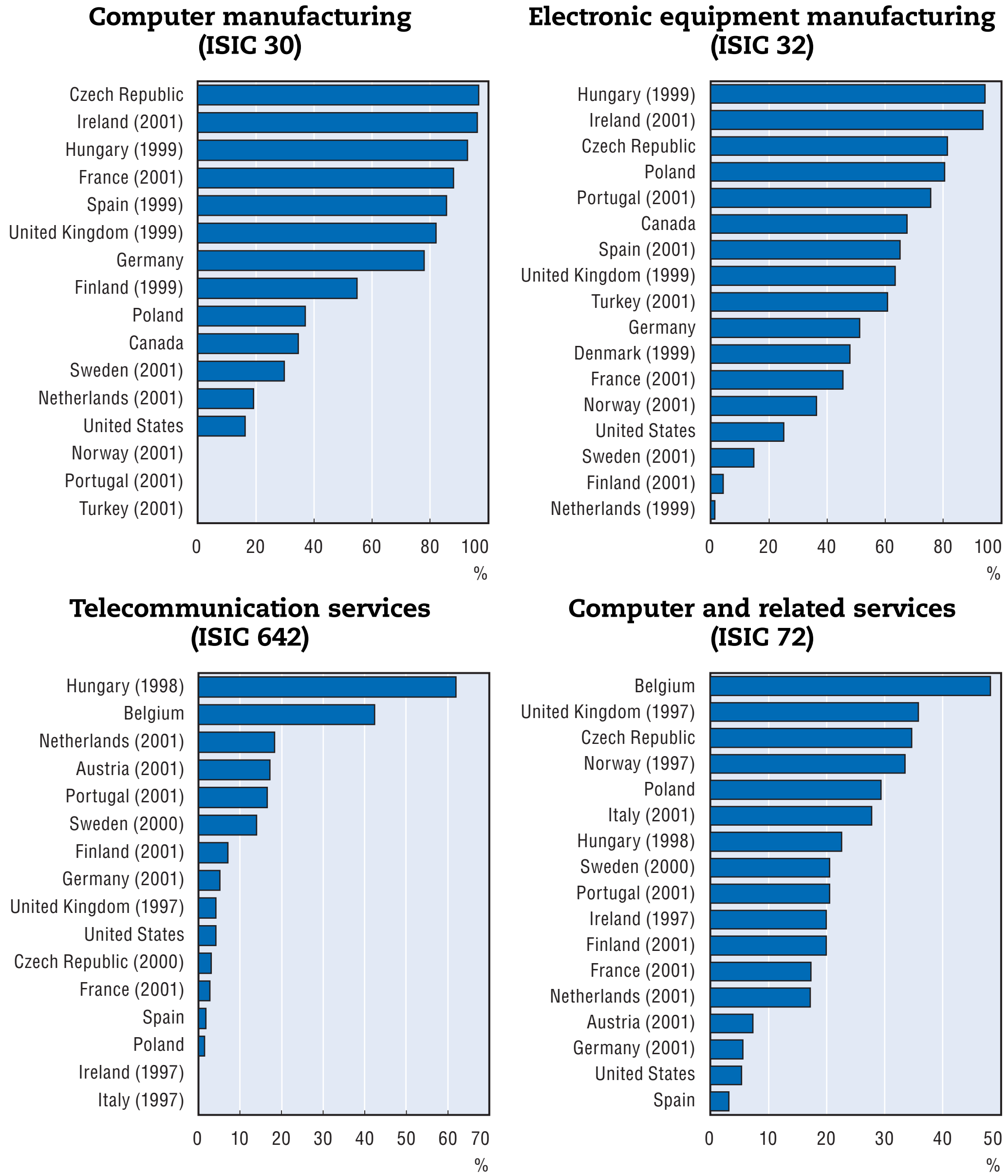
The United States and Sweden are among the few countries that provide more detailed information on the activities of ICT sector MNEs and their foreign affiliates. These data are explored in order to present a picture of the extent and nature of ICT sector affiliate activities in a large and a smaller OECD economy. Together, they are indicative of the level and nature of ICT sector affiliate activities across OECD countries.

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

In 2003, foreign affiliates operating in the United States (in all industries) accounted for 21% of merchandise exports and 28% of imports. ICT sector foreign affiliates operating in the United States accounted for 5.5% of all foreign affiliate employment in the United States, 5.5% of affiliate sales, more than 6% of affiliate value added, and more than 9% of affiliate exports (Table 2.A1.20) (Zeile, 2005). New investment in US businesses reached USD 80 billion during 2004, USD 7.3 billion for the establishment of new businesses and USD 72.5 billion for the acquisition of existing businesses. Of this, USD 2.8 billion was spent on new investment in computers and electronic products, USD 306 million on electrical equipment, appliances and components, and USD 3.1 billion in the information industries (Anderson, 2005; Lowe, 2005; Mataloni, 2005).

Figure 2.16. **Foreign affiliates' share of turnover, 2002**

Percentages



Source: OECD (2005) *OECD Economic Globalisation Indicators 2005*, OECD, Paris, p. 144-145.

StatLink: http://dx.doi.org/10.1787/503175533857

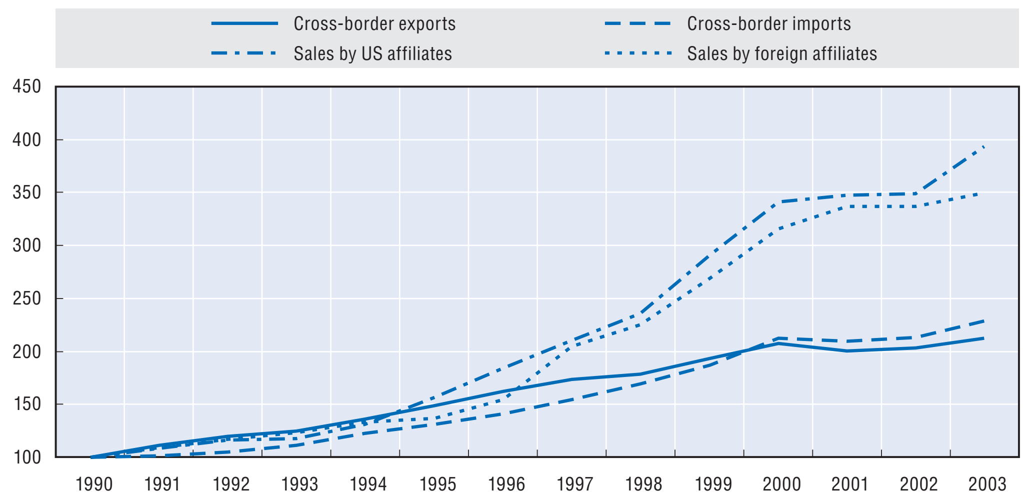
Majority-owned affiliates of US firms operating abroad employed more than 8 million people and realised gross product of almost USD 705 billion in 2003 (Table 2.A1.21). Affiliates in the ICT sector employed almost 1.2 million people, and realised USD 73 billion in gross product on sales of USD 300 billion. Within the ICT sector, affiliates in computer and electronic products manufacturing employed around 600 600 and realised USD 35 billion in gross product, affiliates in electrical equipment and appliances manufacturing employed 231 400 and realised almost USD 8.4 billion, and affiliates in information services employed 344 000 and realised more than USD 29 billion.

There are wide differences in the relative importance of affiliate activities across countries. Across all sectors, the gross product of majority-owned foreign affiliates of US parents was highest in Ireland, at almost 19% of GDP in 2003. Canada, the United Kingdom and Belgium were the only other OECD countries in which US foreign affiliates accounted for more than 5% of GDP. As a share of GDP, ICT sector US affiliates are most significant in Ireland, Sweden, the United Kingdom, Canada and Mexico; in employment terms, the ICT sector accounted for a relatively large share of US affiliate activities in Ireland, Finland, Korea, the Czech Republic and Mexico. ICT sector US affiliates have relatively larger shares of employment and gross product in non-OECD economies; 21% of all US affiliate employment in the ICT sector is outside the OECD, as is 16% of industry gross product. China alone accounts for 10% of such employment and 4% of industry gross product. This shows both the importance of non-OECD economies as production locations and the growing integration of China in global ICT production systems (see CEDA, 2005).

As global integration increases, the 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 122 billion in 2004, compared with sales of US affiliates operating abroad of some USD 207 billion in 2003. US cross-border and affiliated services sales have increased since 1990, but affiliated sales increased faster than cross-border sales, by 11% a year, compared with 6% a year (Figure 2.17). In 2002, US cross-border exports of computer and information services were worth USD 7 billion, while sales of US affiliates abroad were worth USD 18.4 billion; and cross-border exports of telecommunication services were worth USD 5 billion, while sales of US affiliates abroad were worth USD 17.6 billion (Borga and Mann, 2004).

Figure 2.17. **US cross-border and affiliated services sales, 1990-2003**

Current prices, index 1990 = 100



Source: US Department of Commerce, 2005.

StatLink: http://dx.doi.org/10.1787/203863441778

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

There were more than 10 000 foreign-owned enterprises in Sweden in 2003, employing 564 180 people. During 2003, the number of foreign-owned ICT enterprises decreased by 438 and the number of employees by 10 200, even though the total number of foreign-owned enterprises in Sweden increased by 1 576 and the level of foreign affiliate employment increased to 23% of total business sector employment (Table 2.3). Nevertheless, affiliate activity in Sweden's ICT sector is significant. Of all foreign-owned enterprises operating in Sweden in 2003, 1 170 (12%) were in the ICT sector and employed 57 269 (10%) of all people employed by foreign-owned affiliates. Most foreign enterprises in Sweden's ICT sector are in services; 94 ICT manufacturing enterprises employ 11 784, whereas 1 076 ICT services enterprises employ 45 485.[15]

In 2003, the top ten countries' affiliates accounted for 89% of affiliate employment in Sweden's ICT sector and 82% of the total number of enterprises (Table 2.A1.22). The United States (19 257 employees) was the leading country of origin. Singapore (6 537 employees) has overtaken France in second place. Affiliates of Singapore parents are relatively highly focused on the ICT sector, with 47% of all Singapore-owned affiliates operating in the ICT sector, and employment in ICT affiliates accounting for more than 90% of all Singapore-owned affiliate employment in Sweden. Japan and the United States are the other top ten countries with a relatively strong ICT sector focus.

Table 2.3. **Foreign-owned enterprises in Sweden's ICT sector, 2003**

Numbers of enterprises and employees and percentage shares

Industry	Enterprises	Employees
Electronic equipment manufacturing	94	11 784
Wholesale	401	11 529
Computer and related services	583	25 982
Renting office machinery	12	85
Telecommunication services	80	7 889
Total ICT sector	1 170	57 269
ICT sector share	*12%*	*10%*
All industries	10 077	564 180

Source: ITPS (2004a).

StatLink: http://dx.doi.org/10.1787/386070312356

Swedish-owned ICT sector enterprises operating abroad employed a total of 176 600 in 2002, of whom 38% were abroad. Those employed by Swedish ICT sector affiliates accounted for 7% of those employed abroad by Swedish affiliates in all industries (Table 2.A1.23). Not surprisingly, communication equipment manufacturing was a major activity of Swedish affiliates abroad, and employed 43 055 abroad in 2002, and Swedish ICT equipment manufacturing enterprises (including communications) employed fewer at home (36 319) than abroad (45 467), whereas Swedish-owned ICT services enterprises employed fewer abroad (21 358) than at home (73 456).

The US and Swedish data on the activities of affiliates in the ICT sector highlight the extent of globalisation and its continuing development both within and beyond OECD countries. Affiliate activities are extensive and play an increasingly important role in the ICT sector in many countries.

Conclusion

There is a global restructuring of ICT production activities, with the emergence of eastern European and non-OECD developing countries as both producers and growth markets and the global rationalisation of ICT and ICT-enabled services production. This new wave of globalisation has largely been driven by efficiency-seeking competition, with firms taking advantage of cost differences and the rapid development of goods and services production capabilities in developing economies to service global markets. With the growth of developing economies there is also an increasing need for the presence of ICT firms in these new growth markets. Once again, the ICT sector is at the forefront of globalisation and is enabling the continued international rationalisation of production within the sector and beyond.

ICT goods and services trade has recovered strongly and OECD exports of ICT goods reached a new peak in 2004 in current USD, driven by growth in electronic components, audio and video and other ICT-related equipment. Imports also reached a new peak, driven by growth in communication, audio and video equipment. However at 13.2%, the share of ICT goods in total goods trade is only a little above the share in 1996. After the strong recovery of 2003-04, ICT trade settled back to steady growth during 2005 and is expected to grow overall at around the same rate as manufacturing trade in 2006. Strong commodity prices in 2005 and 2006, coupled with ongoing price declines for ICT equipment, disguise the relative performance of ICT goods trade in total trade. Computer and information services trade has been more dynamic than goods trade in value terms. Ireland is by far the major OECD exporter of these services and a major exporter of software goods, making it by far the OECD leader in exports of software and IT services.

There has been a major change in the direction of trade, as ICT manufacturing and, to a lesser extent, services activities shift to non-OECD and eastern European countries, with China, India and a number of eastern European countries joining such countries as Korea and Ireland as major ICT producers and exporters. The focus in such countries had been on relatively low value process and assembly activities for export, but international investment trends suggest that this is changing as higher value manufacturing and services functions move offshore, and as these markets develop.

Worldwide FDI increased strongly in 2005 following the recovery in 2004 from the depressed levels of 2002 and 2003. A major feature of recent FDI flows is an overall shift to developing countries and towards services. M&A activity has also recovered strongly and has continued strongly in the first half of 2006. The value of cross-border deals in which the ICT sector was the target was up 47% in 2005, and overall around 20% of all cross-border M&As targeted the ICT sector. A new wave of globalisation of ICT production is under way, with FDI flows and cross-border M&A deals increasingly focusing on services and rapidly emerging eastern European and non-OECD economies (*e.g.* China and India).

Notes

1. World Trade Organisation (2006), "Trade picks up in mid-2005, but 2006 picture is uncertain", Press/437, 11 April.
2. All values are expressed in current USD at annual average exchange rates, unless otherwise indicated.
3. Computer and information services (262) include a range of processing, bureau, consulting, development, database and other subscription services. See Annex A for details.

4. Communication services (245) include a range of telecommunication and postal services. See Annex A for details.

5. Some of this is due to developments in communications services. Prior to the liberalisation of telecommunications many national carriers pursued local purchasing policies and communications equipment manufacturing operated multi-domestically (*i.e.* manufacturing was based in most countries to serve the local market). Purchasing practices changed with liberalisation and communications equipment manufacturing evolved towards a more characteristic transnational model with manufacturing activities rationalised on a global basis.

6. Revealed comparative advantage is calculated as the ratio of the share of ICT goods exports in total merchandise exports for each country to the share of OECD ICT exports in total OECD merchandise exports – *i.e.* (country ICT exports/country total exports)/(OECD ICT exports/OECD total exports). A value greater than 1 indicates a comparative advantage in ICTs, and a value of less than 1 a comparative disadvantage (Table 2.A1.14).

7. Traditional economic theory suggests that trade patterns reflect factor endowments and comparative advantage, with countries specialising in producing those goods and services in which they have a comparative advantage and trading them for products of different industries in which other countries have a comparative advantage.

8. 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 when 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.

9. US-related party trade includes trade by US companies with their subsidiaries abroad, as well as trade by US subsidiaries of foreign companies with their parent companies.

10. It is also notable that US intra-firm trade with China is growing rapidly, accounting for 10.5% of merchandise imports from China in 1992 rising to 27.1% in 2004, and 4.9% of exports rising to 14.2%.

11. Detailed analysis of cross-border mergers and acquisitions (M&As) is based on Dealogic data (*www.dealogic.com*). The data include completed deals 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, so detailed movements should not be over-interpreted.

12. 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, electromedical, and control instruments manufacturing; 33461: Manufacturing and reproducing magnetic and optical media.

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

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

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

Communication services. 51711: Wired telecommunications carriers; 51721: Wireless telecommunications carriers (except satellite); 51731: Telecommunications resellers; 51741: Satellite telecommunications; 51751: Cable and other program distribution; 51791: Other telecommunications; 51811: Internet service providers and Web search portals; 51821: Data processing, hosting, and related services.

13. Analysis focuses on target country when the ICT sector is the target of deals, and acquirer country when the ICT sector is the acquirer. Hence, the data relate to country inflows targeting the ICT sector, and country outflows in which the ICT sector is acquirer.
14. For example, the value of cross-border M&A deals targeting ICT entities in China increased by 100% a year over the decade to 2005, and the value of those targeting ICT entities in India by 94% a year.
15. Similarly in Ireland, around 10% of IT services enterprises were foreign-owned in 2003, but they accounted for 77% of turnover and 44% of employment; in ICT manufacturing around 70% of enterprises were foreign-owned and accounted for 97% of turnover and 84% of employment (WTO, 2005).

References

Anderson, T.W. (2005), *Foreign Direct Investment in the United States: New investment in 2004,* Department of Commerce, Washington DC.

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

Borga, M. and M. Mann (2004), *US International Services: Cross-Border Trade in 2003 and Sales Through Affiliates in 2002*, Department of Commerce, Washington, DC.

CEDA (2005), *China in Australia's Future,* Committee for Economic Development of Australia, Melbourne.

Department of Commerce (2005), *US Goods Trade: Imports and Exports by Related Parties, 2004,* Department of Commerce, Washington, DC.

Financial Times (2006), "Record deal cycle may be at peak", 30 June.

Hemerling, J., D. Young and T. Bradtke (2005), *Navigating the Five Currents of Globalization*, Boston Consulting Group.

IMF (2005), *World Economic Outlook: Building Institutions,* International Monetary Fund, Washington DC.

ITPS (2004a), *Foreign owned enterprises 2003*, Institute for Growth Policy Studies, Ostersund.

ITPS (2004b), *Foreign owned enterprises: Economic figures 2001-02,* Institute for Growth Policy Studies, Ostersund.

ITPS (2004c), *Swedish owned groups with business operations abroad 2002*, Institute for Growth Policy Studies, Ostersund.

Lowe, J.H. (2005), *US Direct Investment Abroad: Detail of Historical Cost Position and Related Capital and Income Flows, 2004,* Department of Commerce, Washington DC.

Lucey, M. (2005), "The measurement of payments, licences and royalties for S&T activities", mimeo.

Manufacturing Market Insider (MMI) (2006), "The MMI top 50", Press release, March.

Mataloni, R.J. (2005), *US Multinational Companies: Operations in 2003*, Department of Commerce, Washington DC.

Nephew, E., J. Koncz, M. Borga and M. Mann (2005), *US International Services: Cross-border Trade in 2004 and Sales through Affiliates 2003*, Department of Commerce, Washington, DC.

OECD (2003), *A Proposed Classification of ICT Goods*, OECD, Paris.

OECD (2004), *Classifying Information and Communication Technology (ICT) Services*, OECD, Paris.

OECD (2005a), *OECD Handbook on Economic Globalisation Indicators*, OECD, Paris.

OECD (2005b), *Trends and Recent Development in Foreign Direct Investment*, OECD, Paris.

OECD (2005c), *OECD Economic Globalisation Indicators,* OECD, Paris.

OECD (2006), "Trends and recent developments in foreign direct investment" available at: *www.oecd.org/dataoecd/54/58/37010986.pdf*.

UNCTAD (2004), *World Investment Report 2004: The Shift Towards Services*, United Nations, New York and Geneva.

UNCTAD (2005), *World Investment Report 2005: Transnational Corporations and the Internationalization of R&D*, United Nations, New York and Geneva.

UNCTAD (2006), "Data show foreign direct investment climbed sharply in 2005", UNCTAD/PRESS/PR/2006/002, 23 January.

WITSA (2004), *Digital Planet 2004: The Global Information Economy*, WITSA, Arlington VA.

WTO (2005), *World Trade Report 2005: Exploring the Links between Trade, Standards and the WTO*, World Trade Organisation, Geneva.

WTO (2006), "Trade picks up in mid-2005, but 2006 picture is uncertain", Press/437, 11 April.

Zeile, W.J. (2005), *US Affiliates of Foreign Companies: Operations in 2003*, Department of Commerce, Washington, DC.

ANNEX 2.A1

Tables

Table 2.A1.1. **OECD trade in ICT goods, 1996-2004**

USD millions, current prices

	1996	1997	1998	1999	2000	2001	2002	2003	2004
EXPORTS									
Communication equipment	71 279	81 849	92 527	108 416	140 915	126 008	114 130	113 111	137 901
IT and related equipment	158 363	177 287	178 045	191 990	220 251	199 959	183 252	195 101	218 381
Electronic components	157 216	173 173	169 373	192 080	243 319	186 133	185 156	208 224	246 575
Audio and video equipment	54 678	54 796	57 680	61 715	67 225	63 111	66 783	74 658	89 146
Other ICT related goods	52 966	56 331	57 327	59 808	69 156	67 848	69 589	79 122	97 037
Total ICT	494 502	543 435	554 950	614 010	740 867	643 059	618 910	670 216	789 041
ICT share of merchandise exports	13.0%	13.7%	13.9%	15.0%	16.7%	15.0%	13.9%	13.1%	13.0%
IMPORTS									
Communication equipment	56 220	61 151	72 884	93 895	128 523	112 836	97 298	105 827	138 608
IT and related equipment	197 912	217 056	233 144	259 542	286 599	252 680	245 880	269 561	313 070
Electronic components	144 434	154 441	152 915	174 149	230 436	179 517	164 806	181 900	218 055
Audio and video equipment	65 538	65 415	71 520	76 376	86 518	85 104	93 414	105 379	130 577
Other ICT related goods	46 406	48 123	50 152	52 688	59 419	59 936	60 456	68 204	79 787
Total ICT	510 510	546 187	580 615	656 650	791 496	690 073	661 853	730 871	880 098
ICT share of merchandise imports	13.2%	13.6%	14.2%	15.2%	16.4%	14.9%	13.9%	13.2%	13.4%

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/112867541761

Table 2.A1.2. **OECD trade in ICT goods, 1996-2004**

USD millions, current prices

	Exports				Imports			
	1996	2000	2004	CAGR	1996	2000	2004	CAGR
Australia	2 111	1 976	2 129	0.1	9 211	11 314	14 503	5.8
Austria	3 025	5 436	7 862	12.7	5 366	7 476	9 982	8.1
Belgium	8 463	11 456	13 581	6.1	9 534	13 121	16 237	6.9
Canada	12 080	22 636	14 225	2.1	23 533	35 957	29 868	3.0
Czech Republic	885	2 128	9 104	33.8	2 732	3 900	9 290	16.5
Denmark	3 548	4 306	5 823	6.4	5 166	5 886	7 872	5.4
Finland	5 935	11 630	11 506	8.6	4 214	6 334	6 857	6.3
France	25 892	35 715	32 579	2.9	28 951	39 601	43 306	5.2
Germany	41 631	60 373	91 308	10.3	46 477	69 066	89 894	8.6
Greece	160	480	585	17.6	1 241	2 464	3 506	13.9
Hungary	664	7 777	16 984	50.0	1 485	7 619	14 097	32.5
Iceland	2	12	18	36.6	164	274	270	6.4
Ireland	13 271	26 352	23 673	7.5	9 302	17 231	15 562	6.6
Italy	13 046	12 790	14 453	1.3	18 458	23 466	29 844	6.2
Japan	103 213	123 542	124 238	2.3	47 858	66 871	72 698	5.4
Korea	29 171	61 525	86 099	14.5	21 000	39 086	42 833	9.3
Luxembourg	..	1 118	1 229	..	..	1 287	1 478	..
Mexico	16 410	38 312	41 336	12.2	14 774	36 331	41 019	13.6
Netherlands	25 022	41 218	58 302	11.2	25 021	42 118	57 637	11.0
New Zealand	232	184	464	9.0	1 620	1 755	2 382	4.9
Norway	1 301	1 430	1 670	3.2	3 208	3 642	5 030	5.8
Poland	648	1 424	3 341	22.8	2 989	5 107	7 661	12.5
Portugal	1 369	1 893	2 899	9.8	2 701	3 588	4 997	8.0
Slovak Republic	..	461	1 811	..	..	994	2 429	..
Spain	4 969	6 137	8 218	6.5	10 565	14 238	20 393	8.6
Sweden	11 164	16 657	14 807	3.6	8 988	11 934	12 964	4.7
Switzerland	4 141	4 652	4 750	1.7	7 263	9 108	9 470	3.4
Turkey	504	1 115	3 096	25.5	2 592	6 061	7 239	13.7
United Kingdom	41 844	55 870	43 678	0.5	45 625	67 726	65 936	4.7
United States	123 802	182 262	149 273	2.4	150 475	237 943	234 845	5.7
Total	494 502	740 867	789 041	6.0	510 510	791 496	880 098	7.0

Note: .. no data available. Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/322282745727

Table 2.A1.3. **OECD trade in communication equipment, 1996-2004**

USD millions, current prices

	Exports				Imports			
	1996	2000	2004	CAGR	1996	2000	2004	CAGR
Australia	417	616	470	1.5	1 606	3 188	3 164	8.8
Austria	261	717	1 205	21.1	642	1 665	2 091	15.9
Belgium	1 209	2 459	1 605	3.6	1 151	2 273	1 980	7.0
Canada	3 526	10 825	4 761	3.8	2 877	6 205	4 771	6.5
Czech Republic	72	211	1 082	40.2	647	907	1 136	7.3
Denmark	681	1 478	1 691	12.0	914	1 602	2 252	11.9
Finland	3 477	8 504	7 929	10.9	562	1 383	1 253	10.6
France	4 245	10 764	7 867	8.0	2 768	5 880	6 419	11.1
Germany	7 888	13 446	19 157	11.7	4 293	9 292	14 469	16.4
Greece	64	310	325	22.6	322	884	1 147	17.2
Hungary	30	861	6 989	97.3	391	725	2 575	26.6
Iceland	0	1	1	92.7	37	71	51	4.1
Ireland	889	2 923	1 305	4.9	419	1 964	1 332	15.6
Italy	2 210	3 197	3 515	6.0	2 476	5 493	7 838	15.5
Japan	10 407	10 409	5 765	–7.1	4 343	5 663	3 668	–2.1
Korea	2 099	7 138	21 045	33.4	1 713	3 338	1 743	0.2
Luxembourg	..	454	234	..	..	526	418	..
Mexico	2 144	8 950	7 942	17.8	1 488	4 986	4 008	13.2
Netherlands	1 608	4 990	4 828	14.7	1 805	6 262	6 227	16.7
New Zealand	81	88	106	3.4	392	495	499	3.1
Norway	470	496	651	4.1	750	951	1 164	5.6
Poland	75	118	245	15.9	662	1 477	1 530	11.0
Portugal	81	119	195	11.7	409	759	967	11.4
Slovak Republic	..	42	67	..	..	153	403	..
Spain	930	1 337	1 526	6.4	2 448	4 367	5 149	9.7
Sweden	5 752	10 933	8 535	5.1	1 272	2 572	3 139	12.0
Switzerland	767	833	828	0.9	1 076	1 685	1 712	6.0
Turkey	110	118	112	0.3	536	2 456	1 553	14.2
United Kingdom	7 224	14 963	9 602	3.6	6 882	13 548	14 058	9.3
United States	14 561	23 617	18 319	2.9	13 339	37 753	41 890	15.4
Total	71 279	140 915	137 901	8.6	56 220	128 523	138 608	11.9

Note: .. no data available. Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.

Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/151146200846

Table 2.A1.4. **OECD trade in computer and related equipment, 1996-2004**

USD millions, current prices

	Exports				Imports			
	1996	2000	2004	CAGR	1996	2000	2004	CAGR
Australia	1 270	697	719	–6.9	4 181	4 438	5 391	3.2
Austria	520	926	1 720	16.1	1 761	2 113	2 956	6.7
Belgium	2 581	3 949	5 182	9.1	3 670	4 766	6 699	7.8
Canada	4 028	5 228	3 085	–3.3	8 359	11 197	10 007	2.3
Czech Republic	178	472	4 012	47.7	876	1 057	3 207	17.6
Denmark	990	945	1 343	3.9	2 323	2 133	3 093	3.6
Finland	974	408	408	–10.3	1 369	1 302	1 598	1.9
France	8 722	9 133	6 874	–2.9	11 957	14 303	16 016	3.7
Germany	10 162	15 698	24 496	11.6	18 001	27 527	32 123	7.5
Greece	20	87	87	20.5	336	696	989	14.4
Hungary	34	3 869	3 675	79.7	322	2 192	2 137	26.7
Iceland	1	1	1	3.7	66	102	114	7.2
Ireland	9 609	17 428	15 879	6.5	6 017	10 177	9 499	5.9
Italy	4 438	2 964	2 249	–8.1	6 705	7 618	8 687	3.3
Japan	27 913	27 558	23 154	–2.3	18 362	26 509	26 022	4.5
Korea	5 420	19 241	20 981	18.4	3 627	7 400	5 596	5.6
Luxembourg	..	135	267	..	..	355	467	..
Mexico	3 778	11 365	13 710	17.5	1 961	5 201	11 653	25.0
Netherlands	13 957	21 346	29 093	9.6	14 479	22 556	31 067	10.0
New Zealand	66	35	105	5.9	666	665	964	4.7
Norway	345	394	240	–4.5	1 395	1 557	2 102	5.3
Poland	59	89	200	16.4	978	1 473	2 000	9.4
Portugal	59	73	627	34.5	783	884	1 196	5.4
Slovak Republic	..	102	650	..	..	271	550	..
Spain	1 498	1 669	1 412	–0.7	3 393	4 140	6 035	7.5
Sweden	763	556	1 289	6.8	3 219	3 059	3 780	2.0
Switzerland	816	1 204	524	–5.4	3 490	4 305	3 980	1.7
Turkey	15	59	44	14.0	658	1 385	1 497	10.8
United Kingdom	17 000	19 857	14 435	–2.0	17 927	27 868	25 314	4.4
United States	43 146	54 761	41 921	–0.4	61 031	89 351	88 331	4.7
Total	158 363	220 251	218 381	4.1	197 912	286 599	313 070	5.9

Note: .. no data available. Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/771324527005

Table 2.A1.5. **OECD trade in electronic components, 1996-2004**

USD millions, current prices

	Exports				Imports			
	1996	2000	2004	CAGR	1996	2000	2004	CAGR
Australia	131	284	322	11.9	1 225	1 181	1 316	0.9
Austria	1 382	2 352	3 165	10.9	1 320	1 962	2 326	7.3
Belgium	1 523	1 763	1 981	3.3	1 815	2 719	2 414	3.6
Canada	3 124	4 634	3 502	1.4	7 521	10 954	5 833	–3.1
Czech Republic	491	1 031	2 002	19.2	496	1 243	3 205	26.3
Denmark	489	572	659	3.8	671	1 115	794	2.1
Finland	733	1 889	1 874	12.4	1 587	2 806	2 814	7.4
France	7 670	10 019	9 835	3.2	7 113	11 792	9 425	3.6
Germany	9 889	17 075	21 858	10.4	11 886	18 786	23 071	8.6
Greece	13	28	54	19.2	94	281	302	15.7
Hungary	314	1 068	2 264	28.0	380	3 060	7 403	44.9
Iceland	0	0	0	81.9	7	16	14	8.6
Ireland	2 103	4 868	4 895	11.1	1 994	4 055	3 567	7.5
Italy	3 719	4 457	5 350	4.6	4 849	5 295	5 214	0.9
Japan	42 108	54 653	57 723	4.0	15 707	23 280	27 944	7.5
Korea	14 348	28 287	34 927	11.8	10 528	23 359	27 754	12.9
Luxembourg	..	261	131	..	..	239	113	..
Mexico	4 080	6 593	5 900	4.7	8 240	20 466	19 168	11.1
Netherlands	5 215	8 469	13 105	12.2	3 950	7 720	10 867	13.5
New Zealand	38	35	124	15.7	135	252	238	7.4
Norway	158	170	224	4.4	365	439	480	3.5
Poland	287	443	1 181	19.3	575	1 028	2 373	19.4
Portugal	482	745	960	9.0	736	1 027	1 685	10.9
Slovak Republic	..	187	406	..	..	297	785	..
Spain	737	1 131	1 875	12.4	1 550	2 268	2 846	7.9
Sweden	3 551	3 620	3 084	–1.7	2 707	4 194	2 743	0.2
Switzerland	887	1 177	1 312	5.0	1 052	1 412	1 374	3.4
Turkey	45	56	91	9.1	688	1 180	2 384	16.8
United Kingdom	9 025	12 745	9 295	0.4	12 324	16 019	10 991	–1.4
United States	44 672	74 710	58 476	3.4	44 921	61 992	38 613	–1.9
Total	157 216	243 319	246 575	5.8	144 434	230 436	218 055	5.3

Note: .. no data available. Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.

Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/517387574226

Table 2.A1.6. **OECD trade in audio and video equipment, 1996-2004**

USD millions, current prices

	Exports				Imports			
	1996	2000	2004	CAGR	1996	2000	2004	CAGR
Australia	53	64	133	12.3	1 195	1 504	3 063	12.5
Austria	280	793	679	11.7	922	960	1 350	4.9
Belgium	2 512	2 644	3 732	5.1	2 003	2 145	3 409	6.9
Canada	211	327	472	10.6	2 086	3 413	4 566	10.3
Czech Republic	32	286	1 519	61.8	310	304	1 055	16.6
Denmark	723	689	1 053	4.8	897	669	1 200	3.7
Finland	198	123	289	4.8	355	504	719	9.2
France	2 417	2 697	2 768	1.7	3 916	4 300	6 571	6.7
Germany	4 324	3 779	6 850	5.9	7 528	7 576	11 688	5.7
Greece	9	13	37	19.9	315	366	766	11.7
Hungary	209	1 808	3 246	40.9	214	1 276	1 269	24.9
Iceland	0	0	0	28.3	28	44	57	9.1
Ireland	400	519	545	4.0	643	491	698	1.0
Italy	846	485	578	–4.6	2 172	2 460	4 686	10.1
Japan	13 753	19 423	22 787	6.5	5 551	7 040	9 195	6.5
Korea	6 831	6 114	8 083	2.1	1 213	1 637	2 922	11.6
Luxembourg	..	187	481	..	..	117	407	..
Mexico	5 682	9 490	11 111	8.7	1 773	3 221	3 535	9.0
Netherlands	2 094	2 531	4 911	11.2	3 078	3 672	6 768	10.4
New Zealand	7	3	16	10.2	259	213	467	7.7
Norway	39	74	94	11.6	378	430	790	9.6
Poland	169	707	1 337	29.5	347	671	963	13.6
Portugal	637	882	927	4.8	510	545	756	5.0
Slovak Republic	..	87	593	..	..	105	321	..
Spain	1 172	1 334	2 210	8.3	1 852	2 094	4 337	11.2
Sweden	291	717	862	14.5	840	1 140	2 037	11.7
Switzerland	135	106	170	2.9	811	806	1 277	5.8
Turkey	310	845	2 764	31.5	269	453	761	13.9
United Kingdom	4 263	2 921	3 414	–2.7	4 599	5 581	9 423	9.4
United States	7 082	7 575	7 485	0.7	21 473	32 783	45 517	9.8
Total	54 678	67 225	89 146	6.3	65 538	86 518	130 577	9.0

Note: .. no data available. Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/508113638650

Table 2.A1.7. **OECD trade in other ICT related goods, 1996-2004**

USD millions, current prices

	Exports				Imports			
	1996	2000	2004	CAGR	1996	2000	2004	CAGR
Australia	239	314	485	9.2	1 004	1 003	1 569	5.7
Austria	582	648	1 094	8.2	720	776	1 259	7.2
Belgium	639	642	1 081	6.8	896	1 218	1 734	8.6
Canada	1 190	1 621	2 404	9.2	2 690	4 188	4 689	7.2
Czech Republic	112	127	488	20.2	403	390	687	6.9
Denmark	665	623	1 076	6.2	361	366	533	5.0
Finland	552	706	1 006	7.8	341	339	473	4.2
France	2 838	3 102	5 235	8.0	3 198	3 325	4 875	5.4
Germany	9 368	10 375	18 948	9.2	4 768	5 885	8 543	7.6
Greece	55	42	83	5.4	174	236	302	7.2
Hungary	77	170	809	34.2	178	366	712	18.9
Iceland	1	10	16	43.1	25	41	33	3.4
Ireland	270	614	1 050	18.5	229	544	465	9.2
Italy	1 833	1 687	2 760	5.3	2 256	2 599	3 419	5.3
Japan	9 031	11 499	14 809	6.4	3 895	4 380	5 870	5.3
Korea	474	746	1 062	10.6	3 918	3 352	4 818	2.6
Luxembourg	..	81	116	..	..	50	72	..
Mexico	726	1 915	2 674	17.7	1 313	2 457	2 655	9.2
Netherlands	2 148	3 882	6 365	14.5	1 709	1 907	2 709	5.9
New Zealand	39	23	113	14.2	168	131	213	3.0
Norway	288	297	462	6.1	320	266	495	5.6
Poland	57	67	379	26.6	428	459	795	8.1
Portugal	111	74	190	6.9	262	373	392	5.2
Slovak Republic	..	43	95	..	..	167	369	..
Spain	633	666	1 195	8.3	1 321	1 368	2 026	5.5
Sweden	806	831	1 036	3.2	950	968	1 265	3.6
Switzerland	1 536	1 333	1 917	2.8	834	901	1 127	3.8
Turkey	24	37	86	17.1	441	586	1 043	11.4
United Kingdom	4 332	5 384	6 931	6.1	3 893	4 709	6 150	5.9
United States	14 340	21 598	23 072	6.1	9 711	16 065	20 495	9.8
Total	52 966	69 156	97 037	7.9	46 406	59 419	79 787	7.0

Note: .. no data available. Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/780472171140

Table 2.A1.8. **OECD trade in software goods, 1996-2004**

USD millions, current prices

	Exports				Imports			
	1996	2000	2004	CAGR	1996	2000	2004	CAGR
Australia	22	54	80	17.7	197	400	478	11.7
Austria	213	780	1 174	23.8	152	269	545	17.3
Belgium	173	308	362	9.7	323	354	626	8.6
Canada	295	241	341	1.8	829	1 054	1 232	5.1
Czech Republic	143	24	64	–9.6	72	107	143	8.9
Denmark	115	156	128	1.3	179	246	114	–5.5
Finland	30	76	44	4.7	115	140	233	9.2
France	428	483	783	7.8	980	959	1 345	4.0
Germany	734	793	3 210	20.3	946	1 208	1 813	8.5
Greece	24	39	41	6.6	43	78	140	15.9
Hungary	15	25	51	16.6	9	94	114	37.2
Iceland	0	0	0	9.7	9	21	16	7.8
Ireland	3 567	3 819	2 029	–6.8	636	315	246	–11.2
Italy	89	75	109	2.7	558	831	1 301	11.2
Japan	254	317	468	8.0	560	629	596	0.8
Korea	27	120	231	31.0	438	527	441	0.1
Luxembourg	..	28	135	..	..	48	96	..
Mexico	36	26	255	27.8	178	347	282	5.9
Netherlands	569	1 079	1 663	14.4	521	567	837	6.1
New Zealand	8	4	9	1.1	74	55	121	6.3
Norway	20	26	42	9.6	149	184	255	6.9
Poland	38	26	151	18.9	16	59	133	30.1
Portugal	4	7	20	22.2	62	108	181	14.4
Slovak Republic	..	5	6	..	..	21	44	..
Spain	53	63	179	16.3	267	281	778	14.3
Sweden	87	159	512	24.8	266	255	481	7.7
Switzerland	305	179	235	–3.2	487	823	713	4.9
Turkey	11	5	17	4.8	43	158	125	14.4
United Kingdom	1 102	895	1 523	4.1	1 137	1 592	1 754	5.6
United States	3 087	3 380	3 030	–0.2	714	994	1 244	7.2
Total	11 448	13 191	16 893	5.0	9 959	12 721	16 426	6.5

Note: .. no data available. Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/835175750125

Table 2.A1.9. **Direction of ICT goods exports, 1996-2004**

USD millions, current prices and percentages

From	To	1996	2000	2004	CAGR %
Values					
OECD	World	494 502	740 867	789 041	6.0
OECD	OECD (incl. unrecorded)	361 134	552 373	547 054	5.3
OECD	Non-OECD	133 368	188 494	241 987	7.7
Shares					
OECD	World	100%	100%	100%	
OECD	OECD (incl. unrecorded)	73%	75%	69%	
OECD	Non-OECD	27%	25%	31%	

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/215861776766

Table 2.A1.10. **Direction of ICT goods imports, 1996-2004**

USD millions, current prices and percentages

To	From	1996	2000	2004	CAGR %
Values					
OECD	World	510 510	791 496	880 098	7.0
OECD	OECD (incl. unrecorded)	364 873	548 709	512 301	4.3
OECD	Non-OECD	145 638	242 787	367 798	12.3
Shares					
OECD	World	100%	100%	100%	
OECD	OECD (incl. unrecorded)	71%	69%	58%	
OECD	Non-OECD	29%	31%	42%	

Note: Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.
Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/602412803060

Table 2.A1.11. **China's trade in ICT goods, 1996-2004**

USD millions, current prices

	1996	1998	2000	2002	2004	CAGR
EXPORTS						
Communication equipment	2 417	3 004	6 675	10 801	25 579	34.3
IT and related equipment	5 317	10 168	16 577	33 253	83 790	41.2
Electronic components	3 782	5 781	11 263	15 520	34 884	32.0
Audio and video equipment	6 283	7 501	11 165	17 855	33 309	23.2
Other ICT related goods	785	965	1 316	1 948	2 859	17.5
Total ICT	18 584	27 419	46 996	79 377	180 422	32.9
IMPORTS						
Communication equipment	2 861	4 427	6 297	6 792	6 904	11.6
IT and related equipment	2 877	5 300	9 883	15 929	28 209	33.0
Electronic components	7 375	12 149	28 432	44 849	97 302	38.1
Audio and video equipment	1 889	1 961	2 920	3 978	6 877	17.5
Other ICT related goods	1 848	1 677	3 065	4 900	9 371	22.5
Total ICT	16 850	25 514	50 597	76 447	148 663	31.3

Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/714084004733

Table 2.A1.12. **Trade in ICT services, 1996 and 2004**

USD millions, current prices

	Communications		Computer and information		Communications		Computer and information	
	Exports 1996	Imports 1996	Exports 1996	Imports 1996	Exports 2004	Imports 2004	Exports 2004	Imports 2004
Australia	752	843	167	173	563	556	864	748
Austria	338	362	84	171	667	500	254	480
Belgium	..	..	..	..	2 185	1 586	2 409	1 972
Canada	1 282	1 243	788	529	1 809	1 677	2 788	1 523
Czech Republic	77	63	28	22	149	386	109	202
Denmark	..	..	..	..	..	..	..	..
Finland	155	194	888	615	334	266	750	733
France	581	418	509	482	3 011	1 869	1 469	1 428
Germany	2 025	2 692	1 603	2 379	3 148	4 625	7 810	7 906
Greece	71	77	362	55	390	362	197	221
Hungary	42	24	93	58	286	313	328	393
Iceland	23	24	17	2	10	21	56	8
Ireland	85	254	105	306	940	1 216	18 484	362
Italy	536	945	207	590	1 977	2 752	574	1 215
Japan	1 378	1 869	1 223	2 443	454	621	1 043	2 189
Korea	643	706	6	76	446	636	25	157
Luxembourg	..	..	..	..	928	1 066	2 262	560
Mexico	846	..	..	..	423	176	..	..
Netherlands	649	668	638	651	3 289	2 844	3 670	3 088
New Zealand	..	..	29	58	277	..	172	201
Norway	216	172	122	149	315	230	563	625
Poland	315	203	28	135	296	312	195	419
Portugal	282	173	41	112	487	369	140	210
Slovak Republic	20	19	8	16	82	72	115	171
Spain	642	443	1 279	976	1 211	1 583	2 907	1 584
Sweden	211	161	154	151	1 202	1 394	2 520	1 398
Switzerland	516	727	..	..	1 227	1 132	..	..
Turkey	..	74	..	..	346	207	..	..
United Kingdom	1 649	2 091	1 700	519	3 678	3 507	10 469	3 536
United States	3 543	8 792	2 775	422	4 632	4 925	8 501	5 804

Note: .. no data available. Communications services include postal and telecommunications. Computer and information services include IT and subscription services.

Source: OECD/Eurostat statistics on international trade in services.

StatLink: http://dx.doi.org/10.1787/345411254548

Table 2.A1.13. **Share of ICT goods in total merchandise exports, 1996-2004**

Percentages

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Australia	3.5	3.4	3.1	3.1	3.1	3.0	2.6	2.8	2.5
Austria	5.3	6.3	6.7	7.3	8.7	8.9	8.7	7.4	7.1
Belgium	5.0	4.9	5.2	5.3	6.2	6.4	4.9	4.9	4.4
Canada	6.4	6.9	6.8	6.6	8.2	5.8	4.8	4.4	4.5
Czech Republic	4.1	4.2	5.3	5.0	7.3	9.6	12.4	12.2	13.5
Denmark	7.0	7.9	8.3	8.2	8.7	8.3	9.8	7.9	7.8
Finland	14.6	16.9	20.0	22.4	25.4	22.0	22.0	21.1	18.9
France	9.1	9.9	10.7	10.8	12.1	10.5	9.1	7.9	7.9
Germany	8.1	8.5	8.7	9.4	11.0	10.3	10.0	9.4	10.0
Greece	1.4	2.0	2.4	2.9	4.4	3.7	3.7	3.3	3.8
Hungary	5.1	17.3	20.7	23.8	27.7	24.6	26.0	27.8	30.6
Iceland	0.1	0.1	0.2	0.3	0.6	0.4	0.6	0.7	0.6
Ireland	27.6	30.3	29.0	33.3	34.5	39.8	30.8	24.3	22.7
Italy	5.2	4.9	4.9	5.0	5.3	5.3	4.4	4.2	4.1
Japan	25.1	24.8	24.1	24.3	25.8	23.5	22.8	22.6	22.0
Korea	23.4	26.6	25.6	31.4	35.7	31.1	33.9	34.3	33.9
Luxembourg	..	..	..	14.2	14.2	18.3	15.1	11.0	10.1
Mexico	17.2	18.5	21.1	22.3	23.2	24.2	22.6	21.8	22.0
Netherlands	14.0	16.1	18.8	20.8	22.9	20.4	18.0	20.0	20.1
New Zealand	1.6	1.7	2.5	1.5	1.4	1.3	1.4	2.2	2.3
Norway	2.6	3.0	3.7	3.3	2.4	2.6	2.3	2.2	2.0
Poland	2.7	3.6	4.6	4.6	4.5	4.9	5.3	5.0	4.5
Portugal	5.6	5.8	6.0	7.3	7.8	8.6	7.8	8.5	8.1
Slovak Republic	..	3.2	3.6	4.1	3.9	4.5	4.3	4.7	6.6
Spain	4.8	4.8	5.2	5.4	5.4	5.3	4.7	4.9	4.5
Sweden	13.5	15.4	15.6	17.8	19.1	12.3	12.4	11.1	12.0
Switzerland	5.2	5.1	5.2	5.4	5.8	5.2	4.1	4.1	4.1
Turkey	2.2	2.5	3.9	3.5	4.0	3.8	4.8	4.5	4.9
United Kingdom	16.2	15.4	17.4	18.2	19.8	19.6	18.5	14.0	12.5
United States	19.9	20.5	19.9	21.4	23.4	20.8	19.1	18.9	18.3
OECD	13.0	13.7	13.9	15.0	16.7	15.0	13.9	13.1	13.0

Note: .. no data available. Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999.

Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/522016320871

Table 2.A1.14. **Revealed comparative advantage in ICT goods exports, 1996-2004**

Balassa Method

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Australia	0.27	0.25	0.22	0.21	0.19	0.20	0.19	0.21	0.19
Austria	0.41	0.46	0.48	0.49	0.52	0.59	0.62	0.57	0.55
Belgium	0.38	0.36	0.38	0.36	0.37	0.43	0.35	0.37	0.34
Canada	0.49	0.50	0.49	0.44	0.49	0.38	0.34	0.34	0.35
Czech Republic	0.31	0.31	0.38	0.33	0.44	0.64	0.89	0.93	1.04
Denmark	0.54	0.57	0.59	0.55	0.52	0.55	0.70	0.61	0.60
Finland	1.13	1.23	1.44	1.50	1.52	1.47	1.58	1.61	1.46
France	0.70	0.72	0.77	0.72	0.72	0.70	0.65	0.60	0.61
Germany	0.63	0.62	0.63	0.63	0.66	0.69	0.71	0.72	0.77
Greece	0.11	0.14	0.17	0.19	0.26	0.25	0.26	0.25	0.30
Hungary	0.39	1.26	1.49	1.59	1.66	1.64	1.87	2.12	2.36
Iceland	0.01	0.01	0.01	0.02	0.04	0.03	0.04	0.05	0.05
Ireland	2.12	2.21	2.09	2.23	2.07	2.65	2.21	1.86	1.75
Italy	0.40	0.36	0.35	0.33	0.32	0.35	0.32	0.32	0.32
Japan	1.93	1.80	1.74	1.62	1.54	1.57	1.63	1.72	1.69
Korea	1.80	1.94	1.84	2.10	2.14	2.08	2.43	2.62	2.61
Luxembourg	..	..	..	0.95	0.85	1.22	1.09	0.84	0.78
Mexico	1.32	1.35	1.52	1.49	1.39	1.61	1.62	1.66	1.69
Netherlands	1.08	1.17	1.36	1.39	1.37	1.36	1.29	1.53	1.55
New Zealand	0.13	0.12	0.18	0.10	0.09	0.08	0.10	0.17	0.18
Norway	0.20	0.21	0.27	0.22	0.14	0.17	0.16	0.17	0.16
Poland	0.20	0.26	0.33	0.31	0.27	0.33	0.38	0.38	0.35
Portugal	0.43	0.42	0.44	0.49	0.46	0.57	0.56	0.65	0.63
Slovak Republic	..	0.23	0.26	0.27	0.23	0.30	0.31	0.36	0.51
Spain	0.37	0.35	0.37	0.36	0.32	0.35	0.34	0.37	0.35
Sweden	1.04	1.12	1.12	1.19	1.14	0.82	0.89	0.85	0.93
Switzerland	0.40	0.37	0.37	0.36	0.35	0.35	0.29	0.31	0.31
Turkey	0.17	0.18	0.28	0.23	0.24	0.25	0.34	0.34	0.38
United Kingdom	1.24	1.12	1.26	1.22	1.18	1.31	1.33	1.07	0.97
United States	1.53	1.49	1.43	1.43	1.40	1.39	1.37	1.44	1.41
OECD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Note: .. no data available. Incomplete data for totals: no data for Slovak Republic prior to 1997, and no data for Luxembourg prior to 1999. RCA calculated using Balassa method (Country ICT X / Country Total X) / (OECD ICT X / OECD Total X).

Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/143727441580

Table 2.A1.15. **Worldwide FDI and activities of affiliates, 1990-2004**

USD billions in current prices, number of employees and percentages

	1982	1990	2003	2004	CAGR 1990-2004
FDI Inflows	59	208	633	648	8.5
FDI outflows	27	239	617	730	8.3
FDI inward stock	628	1 769	7 987	8 902	12.2
FDI outward stock	601	1 785	8 731	9 732	12.9
Cross-border M&As	..	151	297	380	6.8
Sales of foreign affiliates	2 765	5 727	16 963	18 677	8.8
Gross product of foreign affiliates	647	1 476	3 573	3 911	7.2
Total assets of foreign affiliates	2 113	5 937	32 186	36 008	13.7
Exports of foreign affiliates	730	1 498	3 073	3 690	6.7
Employment by foreign affiliates ('000)	19 579	24 471	53 196	57 394	6.3
GDP (current prices)	11 758	22 610	36 327	40 671	4.3
Gross fixed capital formation (GFCF)	2 398	4 905	7 853	8 869	4.3
Royalties and fees receipts	9	30	93	98	8.8
Exports of goods and non-factor services	2 247	4 261	9 216	11 069	7.1
FDI inward flows as % GFCF	2.5	4.0	8.1	7.3	..
FDI outward flows as % GFCF	1.1	4.7	7.9	8.2	..
FDI inward stock as % GDP	5.3	8.9	22.0	21.9	..
FDI outward stock as % GDP	5.1	8.4	24.0	23.9	..

Source: UNCTAD (2005).

StatLink: http://dx.doi.org/10.1787/302634822024

Table 2.A1.16. **ICT sector cross-border M&A deals, 1995-2005**

Number of deals

	1995	2000	2001	2002	2003	2004	2005
Target							
Communications equipment	31	102	90	93	63	76	67
IT equipment	23	80	41	30	24	38	47
Electronics	61	246	225	199	164	193	190
IT services	95	1 275	816	619	445	527	610
IT wholesale	60	155	108	70	65	58	85
Telecommunications	64	669	402	293	236	301	323
Media and content	52	347	218	129	112	95	153
Total targeting ICTs	386	2 874	1 900	1 433	1 109	1 288	1 475
Acquirer							
Communications equipment	23	160	92	86	61	98	113
IT equipment	24	95	59	42	46	43	63
Electronics	57	234	199	163	118	150	179
IT services	69	876	522	351	313	363	503
IT wholesale	43	122	63	68	40	27	62
Telecommunications	68	589	344	242	164	240	247
Media and content	20	255	169	97	79	59	92
Total acquiring ICTs	304	2 331	1 448	1 049	821	980	1 259

Source: OECD, based on data provided by Dealogic.

StatLink: http://dx.doi.org/10.1787/075525321854

Table 2.A1.17. **ICT sector cross-border M&A deal values, 1995-2005**

USD millions, current prices

	1995	2000	2001	2002	2003	2004	2005
Target							
Communications equipment	1 452	22 288	14 513	1 670	3 415	3 182	4 738
IT equipment	1 098	13 938	3 737	2 892	703	1 566	3 227
Electronics	1 184	25 557	18 121	6 515	5 772	9 748	15 164
IT services	3 166	41 335	19 851	7 403	7 009	13 985	22 058
IT wholesale	1 569	5 355	1 411	2 013	343	1 908	2 093
Telecommunications	8 022	306 591	131 772	54 715	42 543	58 364	76 886
Media and content	6 248	29 121	14 321	21 727	9 054	2 699	10 010
Total targeting ICTs	22 740	444 184	203 726	96 935	68 840	91 452	134 176
Acquirer							
Communications equipment	466	36 662	5 143	3 467	1 774	4 833	7 877
IT equipment	668	7 072	1 345	1 429	644	1 289	2 957
Electronics	1 701	20 721	17 473	2 910	4 800	6 911	4 556
IT services	1 022	35 745	12 922	11 981	4 353	9 843	10 486
IT wholesale	2 186	2 655	633	433	1 215	857	1 099
Telecommunications	7 946	466 134	127 857	37 591	22 217	32 608	64 793
Media and content	619	34 896	14 570	7 452	4 915	2 438	5 742
Total acquiring ICTs	14 609	603 885	179 943	65 264	39 919	58 780	97 510

Source: OECD, based on data provided by Dealogic.

StatLink: http://dx.doi.org/10.1787/766652551033

Table 2.A1.18. **ICT sector cross-border M&A values by country of target, 1995-2005**

USD millions, current prices

	1995	2000	2001	2002	2003	2004	2005
Australia	2 483	1 699	8 725	692	1 019	1 203	706
Austria	..	627	184	231	17	453	704
Belgium	130	5 972	4 590	591	161	545	381
Canada	1 994	15 998	5 090	3 729	1 843	1 639	3 116
Czech Republic	1 469	969	503	140	348	273	6 575
Denmark	1	3 864	563	1 411	37	2 465	280
Finland	2	519	256	8 534	279	458	949
France	785	5 905	4 303	1 736	3 322	5 152	4 285
Germany	1 146	76 315	22 286	3 998	11 935	4 734	3 471
Greece	..	16	89	315	381	1 364	50
Hungary	852	3 997	64	920	382	366	609
Iceland	..	6	7	26	9	24	..
Ireland	30	3 949	5 811	711	116	486	991
Italy	1 243	6 598	347	144	1 252	654	792
Japan	226	3 972	12 537	388	5 368	6 336	7 260
Korea	..	2 891	4 920	2 682	637	1 242	1 526
Luxembourg	..	2 399	1	8 081	109	19	4 844
Mexico	86	4 304	1 192	1 810	37	223	213
Netherlands	226	22 095	2 454	6 737	4 512	817	10 238
New Zealand	..	44	142	1 013	156	62	2
Norway	..	4 438	501	213	301	61	540
Poland	..	6 275	1 404	288	112	63	3 589
Portugal	17	33	924	276	769	954	242
Slovak Republic	..	911	180	8	13	15	318
Spain	622	12 963	2 780	2 697	2 668	239	12 014
Sweden	..	4 228	922	1 753	1 277	1 677	1 578
Switzerland	173	6 819	8 583	96	2 719	2 285	6 067
Turkey	24	72	..	1	..	..	8 440
United Kingdom	5 108	95 980	11 818	2 927	7 983	7 012	11 141
United States	3 227	65 086	75 730	13 844	11 516	22 443	15 212
OECD total	19 843	358 944	176 904	65 990	59 279	63 264	106 133
Other countries	2 897	85 240	26 822	30 946	9 561	28 189	28 043
China	2	34 236	1 636	10 607	1 303	7 199	2 329
Hong Kong, China	634	4 344	4 570	1 443	762	528	2 855
India	4	2 169	161	516	244	1 323	2 932
Chinese Taipei	60	2 015	853	26	120	183	411
Total	22 740	444 184	203 726	96 935	68 840	91 452	134 176

Note: .. no data. Includes cross-border deals targeting the ICT sector.
Source: OECD, based on data provided by Dealogic.

StatLink: http://dx.doi.org/10.1787/686613583027

Table 2.A1.19. **ICT sector cross-border M&A values by country of acquirer, 1995-2005**

USD millions, current prices

	1995	2000	2001	2002	2003	2004	2005
Australia	348	1 041	12 718	576	1 320	248	689
Austria	45	227	185	42	72	1	1 970
Belgium	..	1 663	398	89	2	297	523
Canada	178	26 877	3 397	545	1 847	2 933	1 834
Czech Republic	..	..	..	..	..	..	..
Denmark	..	2 699	1 454	78	1 196	749	250
Finland	8	2 686	794	304	112	368	244
France	10	85 806	12 006	9 196	9 239	3 336	18 527
Germany	600	21 053	42 585	2 843	1 373	5 005	5 722
Greece	..	144	30	13	278	3	1 247
Hungary	..	..	1	..	..	..	..
Iceland	..	..	16	20	51	..	24
Ireland		609	443	70	..	15	67
Italy	148	11 697	3 553	239	690	352	666
Japan	2 099	12 821	10 066	3 028	321	597	2 886
Korea	786	..	24	50	101	122	..
Luxembourg	..	6 990	5 281	127	80	309	1 279
Mexico	..	153	771	569	2 739	1 429	1 505
Netherlands	827	23 744	6 162	2 445	180	496	2 198
New Zealand	10	269	215	1	..	..	27
Norway	38	3 579	492	1 201	52	976	1 309
Poland	..	0	..	..	9	15	5
Portugal	..	2 452	1 234	854	82	..	4
Slovak Republic	..	..	..	..	..	..	..
Spain	200	39 370	3 447	1 848	15	6 397	8 207
Sweden	12	6 659	691	8 327	456	1 756	3 508
Switzerland	..	453	1 150	38	92	387	317
Turkey	..	..	..	61	..	..	..
United Kingdom	780	222 737	39 139	4 040	8 119	7 566	9 397
United States	6 571	50 297	20 724	14 166	7 272	12 414	14 999
OECD Total	12 660	524 027	166 976	50 767	35 698	45 770	77 404
Other countries	1 948	79 858	12 967	14 496	4 220	13 010	20 106
China	..	39	127	22	540	155	2 864
Hong Kong, China	50	42 522	1 037	12 427	532	4 723	793
India	22	430	96	27	73	100	503
Chinese Taipei	..	1 344	469	99	290	345	552
Total	14 609	603 885	179 943	65 264	39 919	58 780	97 510

Note: .. no data. Includes cross-border deals in which the ICT sector was acquirer.

Source: OECD, based on data provided by Dealogic.

StatLink: http://dx.doi.org/10.1787/542680286187

Table 2.A1.20. **ICT sector foreign affiliates operating in the United States, 2003**

USD millions and percentage shares

	Employees ('000)	Total assets	Sales	Value added	Exports of affiliates	Imports by affiliates
All industries	5 253	5 093 531	2 136 617	486 344	150 829	356 659
Manufacturing	2 138	1 035 133	854 519	227 682	93 260	138 965
Computers and electronic products	*220*	*92 661*	*91 809*	*22 849*	*13 987*	*24 218*
Computers and peripheral equipment	25	..	11 193	2 272	2 857	5 160
Communications equipment	43	27 372	17 361	4 527	..	..
Audio and video equipment	..	..	..	..	..	..
Semiconductors and other electronics	34	17 141	16 852	3 568	4 913	4 885
Magnetic and optical media	..	..	..	..	..	..
ICT share of manufacturing	4.2%	1.8%	4.3%	4.7%	9.3%	6.8%
ICT services	*68*	*66 233*	*25 673*	*7 299*	..	..
Telecommunications	40	59 317	19 371	4 316	..	..
Information services and data processing	..	..	..	..	..	..
Computer systems design services	28	6 916	6 302	2 983	..	..
Total ICT sector	288	158 894	117 482	30 148	13 987	24 218
ICT share of total	5.5%	3.1%	5.5%	6.2%	9.3%	6.8%

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 (2005).

StatLink: http://dx.doi.org/10.1787/734125484122

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Table 2.A1.21. **US foreign affiliates operating overseas, 2003**

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	279.7	23 865	3.6	106	0.8	88	14.4	1 013
Austria	31.2	3 715	2.5	405	0.7	45	1.9	389
Belgium	117.0	16 136	0.6	69	3.7	220	2.9	146
Canada	1 067.2	83 514	39.0	2 518	11.7	678	32.5	1 573
Czech Republic	51.6	1 875	6.7	79	1.7	31	0.5	46
Denmark	37.1	3 415	1.4	85	..	..	1.3	87
Finland	20.0	2 169	4.6	175	0.1	8	0.5	40
France	556.8	41 764	24.7	1 489	10.5	857	13.0	985
Germany	584.3	66 861	35.0	2 791	19.0	1 685	14.6	1 605
Greece	13.8	1 075	0.1	9	0.0	0	..	1
Hungary	47.8	2 074	3.4	7	..	..	1.9	58
Iceland	..	..	..	..	..	..	..	..
Ireland	85.0	28 287	19.9	3 995	2.5	160	5.1	2 023
Italy	223.1	25 252	17.1	1463	11	592	9.6	806
Japan	238.7	38 930	20.9	2 262	2.8	468	11.4	1 647
Korea	78.1	5 476	12.6	711	0.8	107	2.4	182
Luxembourg	9.2	890	0.0	0	0.1	2	..	2
Mexico	827.1	22 897	88.9	1 388	34.5	536	18.3	597
Netherlands	173.4	25 027	5.9	492	1.7	89	9.0	1 533
New Zealand	38.6	2 432	0.1	–4	..	2	2.6	80
Norway	29.8	9 639	0.5	81	0.4	–100	0.8	120
Poland	72.9	3 528	0.6	64	2.1	50	2.5	51
Portugal	33.7	3 619	2.2	119	0.3	13	0.7	40
Slovak Republic	..	..	..	..	..	..	..	..
Spain	191.9	13 323	6.9	402	7.2	323	6.0	307
Sweden	98.8	9 210	3.3	157	1.1	56	4.2	1 823
Switzerland	63.0	13 035	2.9	386	2.3	215	4.8	562
Turkey	33.7	2 714	0.0	..	0.2	6	..	1
United Kingdom	1 171.3	117 516	36.8	2 403	10.9	566	99.8	9 160
United States	..	..	..	..	..	..	..	..
Other countries	2 189.1	136 415	265.6	13 695	105.5	1 682	83.2	4 540
Total	8 363.9	704 653	605.8	35 347	231.4	8 379	343.9	29 417

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 (2005).

StatLink: http://dx.doi.org/10.1787/168213145540

Table 2.A1.22. **Country origin of foreign-owned enterprises in Sweden's ICT sector, 2003**

Numbers and percentage shares

	ICT		All industries		ICT share	
	Enterprises	Employment	Enterprises	Employment	Enterprises	Employment
United States	260	19 275	1 240	106 063	21	18
Singapore	8	6 537	17	7 046	47	93
France	57	5 199	374	39 958	15	13
Finland	79	4 606	815	59 495	10	8
Netherlands	91	3 911	1 126	47 718	8	1
Norway	129	3 086	1 243	43 201	10	7
United Kingdom	156	3 042	965	55 461	16	5
Germany	76	2 459	896	42 001	8	6
Denmark	72	1 344	1 070	52 833	7	3
Japan	31	1 338	124	5 943	25	23
Top 10	959	50 797	7 870	459 719	12	11
Other countries	211	6 490	2 207	104 461	10	6
Total	1 170	57 269	10 077	564 180	12	10

Source: ITPS 2004a.

StatLink: http://dx.doi.org/10.1787/050520138872

Table 2.A1.23. **Swedish-owned ICT sector enterprises operating overseas, 2002**

Numbers and percentage shares

	Enterprises	Employees	Industry shares	Location shares
Total				
ICT equipment manufacturing	13	81 786	5.5	..
Office machinery	4	3 970	0.3	..
Communication equipment	9	77 816	5.3	..
ICT services	74	94 814	6.4	..
Communications and post	7	61 970	4.2	..
Computer and related services	67	32 844	2.2	..
Total ICT	87	176 600	11.9	..
All industries	858	1 481 410	100.0	..
Abroad				
ICT equipment manufacturing	..	45 467	4.7	55.6
Office machinery	..	2 412	0.3	60.8
Communication equipment	..	43 055	4.5	55.3
ICT services	..	21 358	2.2	22.5
Communications and post	..	9 017	0.9	14.6
Computer and related services	..	12 341	1.3	37.6
Total ICT	..	66 825	7.0	37.8
All industries	..	960 852	100.0	64.9
Sweden				
ICT equipment manufacturing	..	36 319	7.0	44.4
Office machinery	..	1 558	0.3	39.2
Communication equipment	..	34 761	6.7	44.7
ICT services	..	73 456	14.1	77.5
Communications and post	..	52 953	10.2	85.4
Computer and related services	..	20 503	3.9	62.4
Total ICT	..	109 775	21.1	62.2
All industries	..	520 558	100.0	35.1

Source: ITPS 2004a.

StatLink: http://dx.doi.org/10.1787/231141275228

ISBN 92-64-02643-6
OECD Information Technology Outlook 2006

Chapter 3

ICT-enabled Globalisation of Services and Offshoring

This chapter examines the globalisation of ICT-enabled services and business functions. OECD countries account for the bulk of ICT-enabled trade in services, but other countries, including the BRICS and other developing countries, are gaining in importance. Infrastructure and framework conditions in non-OECD services-exporting countries show that there is still a huge potential for these countries to expand exports. Quality of service is important for ensuring further growth and globalisation of these services. Operational strategies of Indian IT services firms, which have been particularly successful in becoming part of ICT-enabled globalisation, are examined in detail.

Introduction

Services now account for around two-thirds of output and foreign direct investment (FDI) in most developed countries and for up to 20-25% of total international trade. This share is comparatively modest because many have only recently become tradable and many others remain non-tradable. However, rapid advances in information and communication technologies (ICTs) have made the production of a variety of services, including ICT services, increasingly independent of location. Together with the ongoing liberalisation of trade and investment in services, this has increased the tradability of many services activities and created new kinds of tradable services. This has resulted in the globalisation of services activities and facilitated ICT-enabled offshoring of services,[1] with associated changes in trade and cross-border investment in service activities and employment patterns.

This chapter looks at the types of services and business functions that can be traded with the help of ICTs and can be produced anywhere. It analyses data on trade and FDI in services as well as on the activities of multinationals to describe the globalisation of ICT-enabled services. It examines the scope and limitations of ICT-enabled globalisation of services, including infrastructure and framework conditions in services-exporting countries, and quality of service issues, in particular privacy- and security-related aspects of ICT-enabled offshoring of services. The final section presents an overview of the operational strategies of Indian IT services firms.

The globalisation of ICT-enabled services

The globalisation of ICT-enabled services is linked to ongoing efforts to liberalise trade and investment in services. Box 3.1 outlines what has been achieved so far in the GATS negotiations on business services and computer and information services, particularly in the context of ICT-enabled globalisation and offshoring of services.

Trade in ICT-enabled services

The globalisation of services activities and their increasing tradability can be measured in part by services trade statistics. The extent of international trade in ICT-enabled services can be approximated by summing the IMF balance of payments categories "Computer and information services" and "Other business services" (Table 3.A1.1 lists the services included in these categories). Data on computer and information services are not available for all countries. For some, such as India, they are included under "Other business services".[2] The shares of IT and ICT-enabled services in the "Other business services" category are variable in different countries. As the data are reported in current USD, they may also be affected by currency movements.

Trade in services with India has received particular attention in recent years in the context of ICT-enabled offshoring of services. The offshoring of services activities from one country (the country of origin) to another (the country supplying services) should result in a return flow of services to the country of origin and should figure in the balance of payments

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Box 3.1. **Trade liberalisation of potentially offshorable ICT-enabled services**

Rapid developments in ICTs have enabled greater electronic cross-border delivery of services, and both developed and developing countries are among the most dynamic exporters. This is however still a relatively new phenomenon from the perspective of the multilateral trade rules of the World Trade Organisation (WTO). Theoretically, the WTO's instrument to secure free international trade in services, the General Agreement on Trade in Services (GATS), fully applies to the cross-border electronic delivery of services. Free trade commitments under the GATS involve promises to grant market access (*i.e.* no quotas or prohibitions) and national treatment (*i.e.* no discrimination against foreign providers). When the last multilateral trade negotiations were completed in 1993, the number of services that could be traded electronically was limited by the state and cost of technology, telecommunications and computer equipment. Moreover, the offshoring of computer and information and other business services was essentially unheard of. As a result, WTO negotiations have not yet focused on expanding free trade commitments for potentially offshorable services, and these commitments have not evolved as quickly as the potential for cross-border services trade.

The ongoing multilateral trade negotiations under the WTO's Doha Development Agenda (DDA), which started in 2001, provide a new opportunity to promote free cross-border trade in services.[1] The Hong Kong Ministerial Declaration in December 2005 gave new impetus to the services negotiations as WTO members pledged to expand the relevant GATS commitments while also committing to a new deadline for their final offers (31 October 2006) and to move towards this negotiation's conclusion.[2] The challenge is to increase free trade commitments for the cross-border delivery of computer and other business services and ensure that, in light of the further potential for services trade that will arise from future technological developments, the broadening spectrum of business process outsourcing (BPO) services will be covered by the GATS free trade commitments.

In the ongoing services negotiations, the liberalisation of cross-border trade in computer and related services is one of the least contested areas. Many developed and developing WTO members agree that cross-border trade in these services should not face trade barriers. Moreover, there is a good chance that most WTO members are ready to liberalise all existing and future computer and related services (*i.e.* all those captured by the broad computer service category of the United Nations Central Product Classification, CPC 84).

The liberalisation of BPO services is a more difficult undertaking. First, it concerns an ever-expanding range of services. Capturing all potentially offshorable services today and in the future would involve across-the-board trade commitments for almost all services sectors. Such an objective is hard to achieve even for the most liberal WTO members. Second, there is often no obvious correspondence between the services that are offshored and the service classifications under which service trade commitments are made; this makes binding liberalisation in the WTO more difficult (*e.g.* payroll, call centre and similar services are not uniquely identified in these classifications). Still, the issue of liberalising offshorable services has attracted increasing attention in the WTO negotiations owing to the shared interests of developed and developing countries. Several proposals for liberalising the offshoring of services in the WTO[3] have been made, with vigorous support from members such as India.

However, the problem is complicated by the fact that in multilateral trade negotiations "[v]irtually every item of the negotiation is part of a whole and indivisible package and cannot be agreed separately".[4] Put differently, the trade liberalisation of offshorable services will only take place if WTO members agree on a vast array of other negotiation items under the DDA in order to conclude the ongoing global trade talks.

Box 3.1. **Trade liberalisation of potentially offshorable ICT-enabled services** *(cont.)*

At present, however, a broad agreement that would allow for concluding the WTO's global trade round has not been achieved. Within the services negotiations alone, WTO members cannot, for example, agree on how to treat the liberalisation of services supplied by the movement of persons, i.e. service providers travelling to other WTO members to supply a service (e.g. an Indian software programmer completing a project in Germany). While some developing countries insist that this type of service delivery also merits full liberalisation, other WTO members see difficulties relating to immigration and other regulations. Also, the modalities of the special treatment for least-developed country members in services trade are the object of much attention. More problematically, WTO members have not reached a number of key DDA negotiation objectives in areas unrelated to services; essentially basic agreements permitting the negotiations to advance in the area of agriculture and non-agricultural market access (basically all industrial goods, including information technologies) without which the WTO's DDA cannot be concluded.

If not resolved, these obstacles could hinder achievements in the area of liberalising cross-border trade in services and thus potentially the growth of international trade in BPO services itself. If possible, renewed negotiation efforts should aim at preventing such an outcome.

1. UN ICT Task Force (2005) *WTO, E-Commerce and Information Technologies: From the Uruguay Round through the Doha Development Agenda*, New York: United Nations Information and Communication Technology Task Force.
2. WTO Hong Kong Ministerial Declaration, Sixth Session, WT/MIN(05)/DEC (22 December 2005), paras. 25-27, Annex C.
3. See the WTO Symposium on Cross-border Supply of Services (April 2005) under *www.wto.org/english/tratop_e/serv_e/sym_april05_e/sym_april05_e.htm* and A. Mattoo and S. Wunsch-Vincent (2004), "Pre-empting Protectionism in Services: The WTO and Outsourcing", *Journal of International Economic Law*, Vol. 7, No. 4.
4. "Doha Declaration", Background Note by the WTO, *www.wto.org/english/tratop_e/dda_e/dohaexplaine- d_e.htm*.

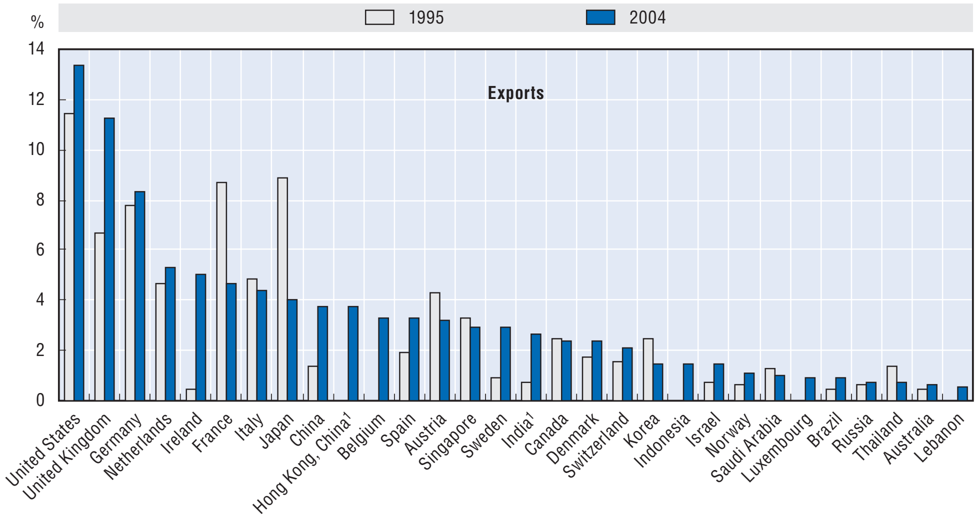
statistics on trade in services. Concerns have been voiced about the export figures reported by India, particularly the large statistical discrepancies in the data (OECD, 2004, Chapter 2). Box 3.2 briefly outlines these discrepancies as well as possible explanations that have been put forward, in particular for the bilateral discrepancy with the US data.

Most exports (nearly 83%) of other business services and computer and information services still originate in OECD countries. Figure 3.1 shows the 30 countries that accounted for the largest value shares in 2004. OECD countries had the top eight shares and 19 OECD countries were among the top 30. China and Hong Kong, China, are the two non-OECD countries in the top 10. India ranked 16th (based on 2003 data as the 2004 data were not yet available at the time of writing). At 85th place, Mexico is the lowest-ranked OECD country. Most countries experienced an increase in share between 1995 and 2004, with the largest increases for the United Kingdom and Ireland. Shares of some countries, particularly Japan and France, declined.

Even though OECD countries tend to account for the largest shares, the Baltic countries and most of the so-called BRICS (Brazil, Russia, China, India and South Africa) are seeing particularly rapid growth, albeit from relatively low levels (Figures 3.5 and 3.6). Four of the BRICS (China, India, Brazil, Russia) are among the 30 countries with high export shares (see Figure 3.1). India in particular is also often mentioned in the context of offshoring of services. Rapid growth in exports is one indicator of their emergence as a location for receiving offshored services activities.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Figure 3.1. **Top 30 country shares of reported exports (in current USD) of business services and computer and information services, 1995 and 2004**[1]

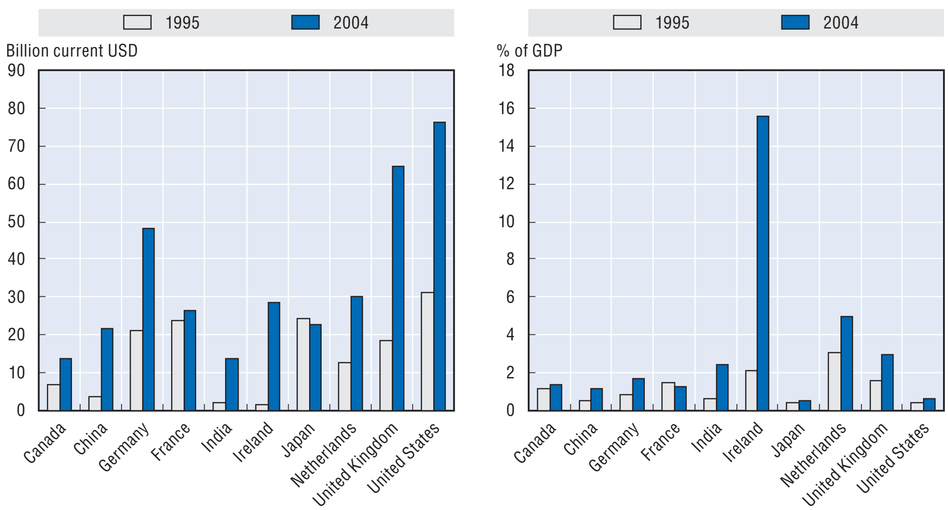


1. 2004 data not yet available for all countries. For Hong Kong (China), India and the Slovak Republic data for 2003.
Source: Based on IMF Balance of Payments database, March 2006.

StatLink: http://dx.doi.org/10.1787/221286561717

Although exports of business and computer and information services may be large in absolute terms, they generally account for a relatively modest but increasing share of GDP (Figure 3.2). In Ireland, however, they accounted for nearly 16% of GDP in 2004, reflecting in part Ireland's rapid shift into services activities (Barry and van Welsum, 2005).The share of these services exports in GDP tends to be somewhat larger in small open economies than in larger ones, as in the Netherlands.

Figure 3.2. **Exports (in current USD) of business services and computer and information services, absolute numbers and per cent of GDP, selected countries, 1995-2004**[1]

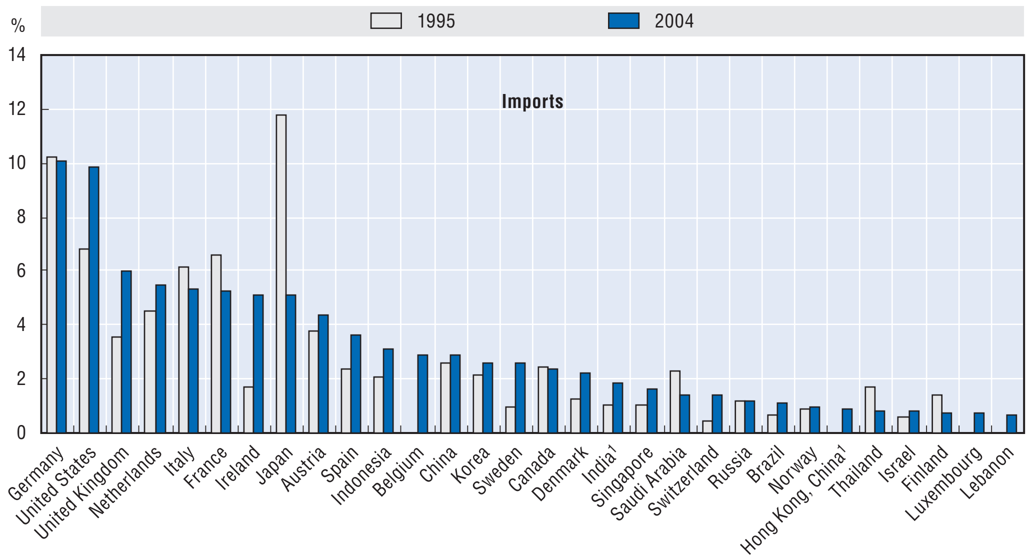


1. India 2003 instead of 2004.
Source: Based on IMF Balance of Payments database, March 2006.

StatLink: http://dx.doi.org/10.1787/514031246454

OECD countries account for over 80% of imports of business and computer and information services, and take the top ten positions (Figure 3.3). China ranks 13th and India 18th (based on 2003 data). In 66th place, Iceland is the lowest-ranked OECD country. Many of the countries with high export shares also have large import shares. China, India, Russia and Brazil are again among the 30 countries with high shares.

Figure 3.3. **Top 30 country shares of reported imports (in current USD) of business services and computer and information services, 1995 and 2004**[1]



1. 2004 data not yet available for all countries. For Hong Kong (China), India and the Slovak Republic data for 2003.

Source: Based on IMF Balance of Payments database, March 2006.

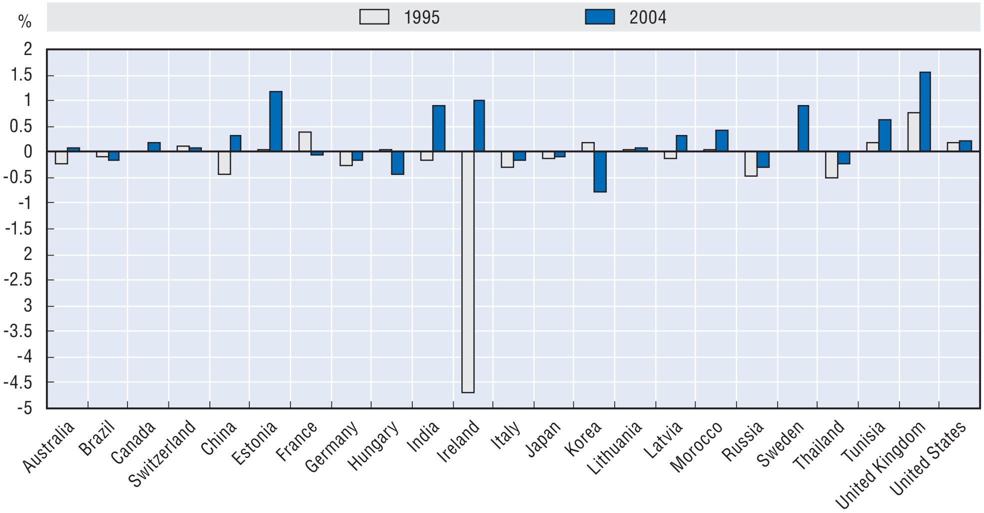
StatLink: http://dx.doi.org/10.1787/348008605656

Figure 3.4 presents the trade balance as a percentage of GDP (in current USD) for the IMF categories "Other business services" and "Computer and information services" for selected countries in 1995 and 2004. The United States has a relatively large and increasing surplus, although it is relatively small as a percentage of GDP. The United Kingdom also has a large and growing surplus, and the share in GDP is increasing, in spite of the impression given by (media) reports on the extent of offshoring and related imports. Ireland registered a surplus in these categories for the first time in 2004; it had previously registered a very large surplus in computer and information services, but a deficit for the two categories together.

While OECD countries still account for the largest shares of trade in ICT-enabled services, some others are experiencing rapid growth in exports of ICT-enabled services (Figures 3.5 and 3.6). Overall, the fastest-growing are the Baltic countries, some eastern European countries, and some of the BRICS (India, China, and Brazil), which indicates that they are receiving some offshored services activities. Among OECD countries, Ireland has registered the fastest growth in ICT-enabled exports, and it is also known to be an important receiver of offshored services activities. The total reported value of these exports for all countries grew on average by around 9.5% a year in current USD between 1995 and 2004.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Figure 3.4. **Trade balance for business services and computer and information services (in current USD) as a percentage of GDP, selected countries, 1995 and 2004**[1]

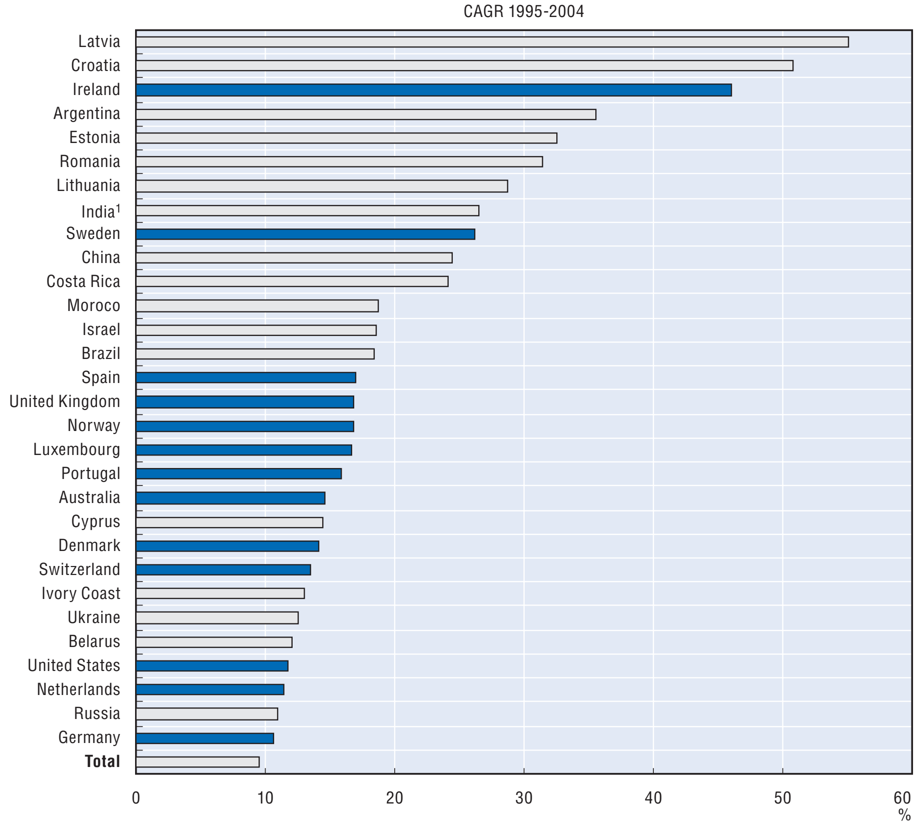


1. India 2003 instead of 2004.

Source: Based on IMF Balance of Payments database, March 2006.

StatLink: *http://dx.doi.org/10.1787/040527572740*

Figure 3.5. **Countries with rapid growth in reported exports (in current USD) of business services and computer and information services**

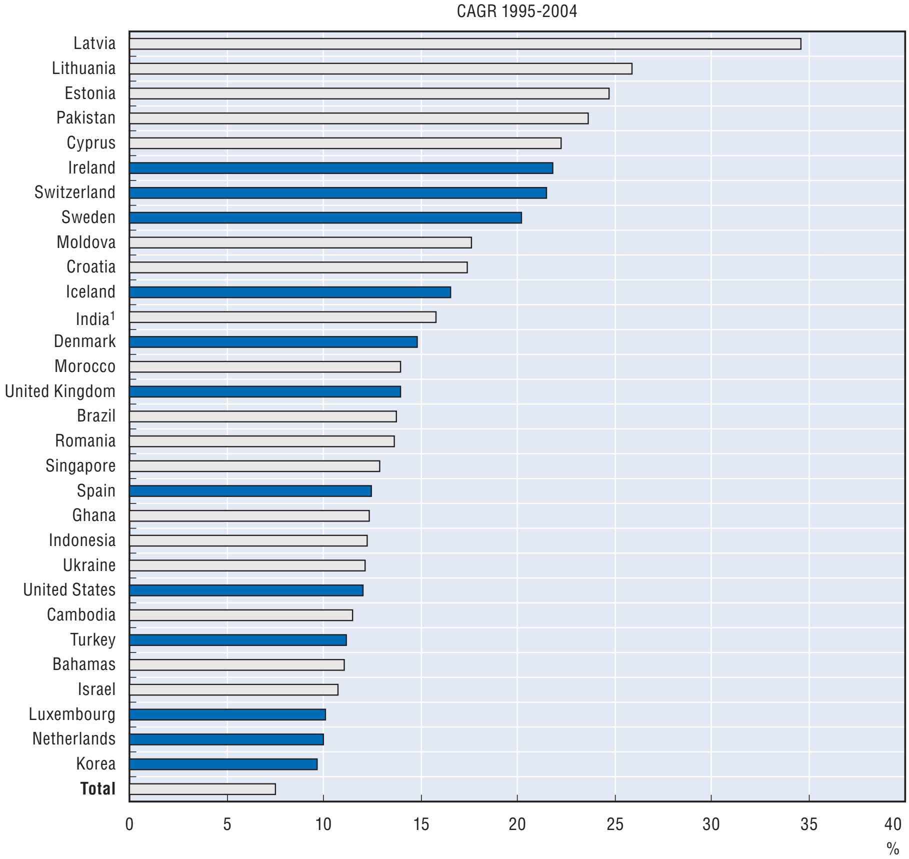


1. 2003 instead of 2004. OECD member countries in dark shading.

Source: Based on IMF Balance of Payments database, March 2006.

StatLink: *http://dx.doi.org/10.1787/277438182132*

Figure 3.6. **Countries with rapid growth in reported imports (in current USD) of business services and computer and information services**



1. 2003 instead of 2004. OECD member countries in dark shading.
Source: Based on IMF Balance of Payments database, March 2006.

StatLink: http://dx.doi.org/10.1787/505463636258

The picture for imports is very similar, as many countries with strong export growth also show rapid growth in imports. This may indicate that the globalisation of services is very much a "two-way street" from which many countries stand to benefit. Total reported values for imports grew on average by around 7.5% a year over the period 1995-2004. The Baltic countries (Latvia, Lithuania and Estonia) are again growing very rapidly. The BRICS are represented by India and Brazil. China and Russia fall below with imports growing at an average annual rate of 9.1% and 7.2%, respectively.

There is increasing interest in services developments in China and the impact that China's integration into the world economy will have on OECD economies. It is therefore increasingly important to gather statistical information on China's ICT and ICT-related (services) sectors as these very dynamic growth sectors are at the heart of the globalisation process. Box 3.3 describes what is known about trade in services data for China.

FDI in services

Foreign direct investment in the services sector is an increasingly important aspect of services globalisation and provides insight into how services activities are globalising.[3] The sectors distinguished in the OECD FDI database are listed in Table 3.A1.2. It is difficult to know which category best matches the categories used as proxies for ICT-enabled trade in services,[4] but the best approximation would probably be "business activities", which can be obtained by subtracting "real estate" from "real estate and business activities". While this breakdown is not widely available, real estate tends to account for a relatively small proportion of this category. Where the breakdown is available, the shares vary widely across countries, but business services (or real estate and business services) tended to account for 10-50% of total FDI and between 20-60% of services FDI by 2002.

Box 3.2. **Data discrepancies in trade in services with India**

There are significant data discrepancies between exports of services reported by India and imports reported by its main importers (OECD, 2004):

Difference in exports reported by india and imports reported by importers (USD millions)

	1997	1998	1999	2000	2001	2002
Total services						
Exports to all countries reported by India	9 111	11 691	14 509	19 175	20 886	24 859
Imports from India reported by US, EU15, Japan, Canada	3 582	4 084	4 595	4 694	4 740	4 268
Discrepancy (%)	**61**	**65**	**68**	**76**	**77**	**83**
All commercial services, excl. travel and transport						
Exports to all countries reported by India	3 852	6 096	8 892	13 018	15 126	18 630
Imports from India reported by US, EU15, Japan, Canada	1 170	1 441	1 721	1 782	1 994	1 650
Discrepancy (%)	**70**	**76**	**81**	**86**	**87**	**91**
Computer and information services						
Exports to all countries reported by India				6 341	7 556	9 600
Imports from India reported by US, EU15, Japan, Canada				262	485	294
Discrepancy (%)				**96**	**94**	**97**

Note: Imports of US private-sector services only.
Source: OECD (2004, Chapter 2), based on Reserve Bank of India, US Bureau of Economic Analysis, Eurostat, UK Office of National Statistics, Bank of Japan, and Statistics Canada.

The US GAO (2005) has investigated this issue in the context of the US data; their main findings are summarised below. The focus is on trade in business, professional and technical services (BPTs). The US data suggest that the United States imports only a fraction of what India reports exporting to the United States, and the discrepancy is increasing over time.

	2002	2003
US imports of unaffiliated BPT services from India	USD 240 million	USD 420 million
Indian exports of affiliated and unaffiliated similar services categories to the United States	USD 6,5 billion	USD 8,7 billion

1. The US BEA does not report bilateral affiliated BPT services trade data.

The GAO report finds at least five definitional and methodological factors that contribute to the discrepancy in the data. The first three reflect the non-conformity of the Indian data with IMF rules.

Box 3.2. **Data discrepancies in trade in services with India** *(cont.)*

- The first concerns the treatment of the earnings of temporary Indian workers residing in the United States. India counts these earnings as exports to the United States, but the United States only includes temporary foreign workers who have been in the United States less than one year and who are not on the payroll of firms located in the United States. Indian officials estimate that this factor may account for as much of 40-50% of the discrepancy.
- Second, services are defined more broadly in the Indian data than in the US data.
- Third, India counts sales to US firms located outside the United States as exports to the United States, but the United States does not count these as US imports.
- Fourth, the Indian exports data include both affiliated and unaffiliated transactions whereas the US import data include only unaffiliated transactions in the BPT category. The US Bureau of Economic Analysis does not report bilateral affiliated BPT services trade data.
- Fifth, there may be further methodological or collection differences between the two countries for data on trade in services.

The methodology for collecting data on trade in services, namely through surveys of importing firms, is a possible source of discrepancies in the data (OECD, 2004). The GAO report makes recommendations to improve the survey data and coverage. It should be noted that India's service exports as reported to the IMF have since been revised downward and total imports from India reported by OECD countries have been revised slightly upward, although taken together these modifications are not sufficient to remove concerns about comparability.

Box 3.3. **Chinese data on trade in services: Another statistical challenge?**

This box highlights some of the discrepancies found in the balance of payments data for China, and compares them to those for India (Box 3.2). Overall the evidence is not very clear and the issues set out here warrant further study.

From the IMF and OECD trade in services data the following observations can be made. In 2003:

- China's services exports were twice India's.
- Transport, travel, and a variety of manufacturing-related services are more important in China's services exports than in India's.
- India's "computer and information services" exports were ten times China's.
- China's "other business services" exports were nearly seven times India's.
- China's combined "other business services" and "computer and information services" were 30% higher than India's.
- China overtook India in combined "other business services" and "computer and information services" exports, with China recording a large step increase.

Also:

- OECD countries report more "computer and information services" imports from India but more "other business services" imports from China.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Box 3.3. **Chinese data on trade in services – Another statistical challenge?** *(cont.)*

- It is likely that there are methodological problems of comparability between China's and India's balance of payments data in services.
- A relatively higher proportion of China's exports are probably reflected in OECD + Hong Kong + Russia imports (see table below) than in India's as Korea, Japan, Russia and Hong Kong are geographically close to China but not to India, bearing in mind that relatively few data for Russia and Hong Kong are available for checking.
- China's reported services exports grow at a faster pace than the mirror imports reported by OECD + Russia + Hong Kong.

Differences in exports reported by China and India and imports reported by OECD countries + Russia + Hong Kong, China, 2000 and 2003

	% exports reported by China accounted for by imports reported by OECD countries, Hong Kong and Russia		% exports reported by India accounted for by imports reported by OECD countries, Hong Kong and Russia	
	2000	2003	2000	2003
Total services	70.1	56.6	29.6	26.2
Other business services (OBS)	31.8	18.4	12.9	24.2
Computer and information services (CIS)	32.6	11.3	2.7	2.7
OBS taking unaffiliated business, professional and technical services less CIS for the US into account	33.1	19.1	14.6	27.6
CIS taking unaffiliated CIS for the US into account	35.0	11.9	5.5	5.7

2. The category "Other business services" includes both some trade-related and technical (engineering and design types of services).
3. US import data for "Other business services" and "Computer and information services" are based on that for unaffiliated trade only.

In most countries, the share of services in the total stock of FDI increased between 1995 and 2003 and now tends to account for more than half of the total FDI stock in most developed economies (Table 3.1). However, much of this FDI is for services that are not necessarily tradable (services where a local presence and/or face-to-face contact is necessary to provide the service), at least not in the ICT-enabled sense, and FDI in business services activities tends to account for a relatively small share of total investment. Moreover, most services FDI is not directed to the types of ICT-enabled services that are the focus of this chapter.

A further indicator of the globalisation of services is the share of services FDI in GDP. In all countries, both the total share of FDI (inward and outward) and the share of services FDI in GDP have increased between 1995 and 2003 (Table 3.2).

Activities of multinationals

The activities of multinationals can be measured to get a better idea of the impact of the globalisation of services activities. The most recent data on the activities of affiliates (*e.g.* turnover and employment) are somewhat dated. Most countries for which data are available generate more turnover abroad from services than from manufacturing. Finland

Table 3.1. **The share of FDI in services in total FDI, 1995 and 2003**

Percentages

	Inward		Outward	
	1995	2003	1995	2003
Australia	47.0	52.7	35.1	34.2
Austria	65.2	76.8	69.9	79.1
Canada	30.7	29.2	40.0	55,1
Denmark	73.4	77.1	64.5	69.6
Finland	39.5	64.9	9.7	13.2
France	67.4	80.5	80.0	81.8
Germany	76.1	88.1	67.6	81.1
Italy	55.8	54.5	63.6	59.1
Netherlands	55.2	63.1	49.5	58.1
Sweden	33.0	38.8	31.7	42.5
United Kingdom	46.6	66.1	40.1	61.7
United States	51.0	62.6	55.2	74.1

Source: Based on the OECD Direct Investment Statistics Database.

StatLink: http://dx.doi.org/10.1787/670182655422

Table 3.2. **Share of services FDI in GDP, 1995 and 2003**

Percentages

	Total inward		Services inward		Total inward		Services inward	
	1995	2003	1995	2003	1995	2003	1995	2003
Australia	25.8	37.9	12.1	20.0	14.2	28.6	5.0	9.8
Austria	7.3	21.0	4.8	16.1	4.9	21.8	3.4	17.3
Canada	21.2	32.1	6.5	9.4	20.3	36.5	8.1	20.1
Denmark	12.1	41.3	8.9	31.8	12.5	42.6	8.0	29.7
Finland	6.5	31.0	2.6	20.1	11.5	46.9	1.1	6.2
France	12.2	29.1	8.2	23.4	13.0	40.3	10.4	32.9
Germany	7.6	27.5	5.8	24.2	10.2	30.4	6.9	24.7
Italy	5.8	12.3	3.2	6.7	8.8	16.3	5.6	9.6
Netherlands	29.4	89.3	16.2	56.4	43.0	103.6	21.3	60.1
Sweden	12.3	39.9	4.1	15.5	29.0	53.3	9.2	22.7
United Kingdom	17.6	33.7	8.2	22.3	26.9	68.4	10.8	42.3
United States	7.3	12.9	3.7	8.1	9.5	16.4	5.3	12.2

Source: OECD calculations, based on OECD Direct Investment Statistics Database.

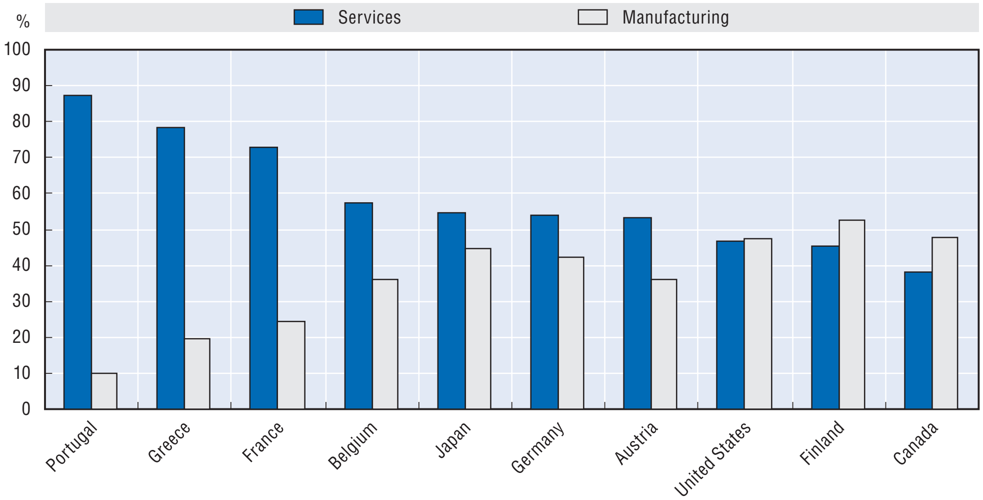
StatLink: http://dx.doi.org/10.1787/488147675772

and Canada are exceptions; the split is approximately equal for the United States (Figure 3.7). See Chapter 2 for a discussion of the data.

For inward investment activity in the ICT sector, there are important differences between ICT manufacturing and ICT services. Foreign ICT manufacturing affiliates account for relatively larger shares of a country's turnover than computer and related services and telecommunications services (Figure 3.8). For the latter two, foreign affiliates account for relatively more of the turnover in computer and related services than in telecommunications services in most countries, although recent high levels of international merger and acquisition activity in telecommunications and to a lesser extent in other ICT industries is likely to change this picture (see Chapter 2).

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Figure 3.7. **The share of services and manufacturing in the turnover of affiliates located abroad and controlled by the compiling country, 2002**[1]

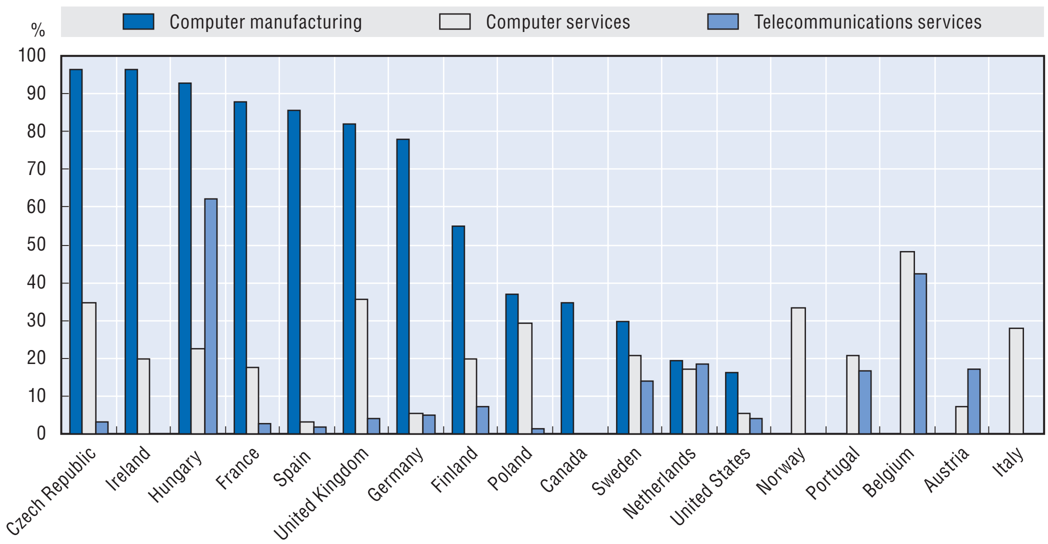


1. France and Japan, 2001; Finland, 2000.

Source: Based on *OECD Economic Globalisation Indicators* (2005), Indicator E.3.

StatLink: http://dx.doi.org/10.1787/430245248385

Figure 3.8. **The share of foreign controlled affiliates in turnover of the ICT sector,**[1] **2002**[2]



1. Computer manufacturing, ISIC 30; Computer and related services, ISIC 72; and Telecommunications services, ISIC 642.
2. *For computer manufacturing*: France, Ireland, Netherlands, Norway, Portugal, and Sweden, 2001; Hungary, Finland, Spain, and United Kingdom, 1999. *For computer and related services*: Austria, Finland, France, Italy, Germany, Netherlands, and Portugal, 2001; Sweden, 2000; Hungary, 1998; Ireland, Norway and United Kingdom, 1997. *For telecommunications services*: Austria, Finland, France, Germany, and the Netherlands, 2001; Czech Republic and Sweden, 2000; Hungary, 1998; Ireland and Italy, 1997.

Source: Based on *OECD Economic Globalisation Indicators* (2005), Indicator H.6.

StatLink: http://dx.doi.org/10.1787/127361812383

Scope and limitations of ICT-enabled globalisation of services

In addition to liberalisation of trade and investment in services, the scope for further ICT-enabled globalisation of services will depend to some extent on ICTs, in particular physical infrastructure (availability and quality) and prices, the skills required to use ICTs for trading services (Chapter 6), and framework conditions such as the procedures for setting up new businesses. Quality of service, including information security and privacy issues, is also important for ICT-enabled globalisation and offshoring of services activities. At the firm level, in particular, infrastructure and costs, the conditions for business start-ups and contract enforcement as well as quality of service are all important when deciding whether to offshore and whether to rely on affiliates or unrelated firms. More general considerations, such as political and macroeconomic stability, IPR protection, the investment climate and the legal system, are obviously also important and will determine the extent to which firms go abroad for services and where they go.

ICT infrastructure

The availability and quality of basic ICT-related infrastructure are very important for determining the location of globalised services activities. The quantity and quality of infrastructure and their prices vary greatly across countries (Tables 3.3 and 3.A1.3). Some countries have large absolute amounts of infrastructure, one indication of national capacity for receiving ICT-enabled offshored services. For example, China has more PCs than Germany and more Internet subscribers than the United States. Brazil, India and Russia each have about as many PCs as Canada or Italy, and Brazil and India have slightly fewer Internet subscribers than Canada. However, apart from China, these countries' broadband subscriber numbers are much lower, and broadband costs are much higher, than in most OECD countries in all of them. Furthermore, while some of the numbers appear very favourable for some countries, *e.g.* China, when they are scaled to the population (see Table 6.6 in Chapter 6) the huge potential for growth in the diffusion of ICTs and ICT infrastructure is obvious. Overall the stock of ICT-related infrastructure in countries often seen as potential recipients of offshored services activities suggests enormous potential, but there is still a long way to go before these countries, including the largest, can match OECD countries in terms of the intensity and quality of their infrastructure. Furthermore, India, the major supplier of ICT-enabled services, has neither the largest stock of ICT-related infrastructure nor the cheapest broadband costs among the BRICs. The source of India's comparative advantage lies instead in the availability of ICT-trained engineers, entrepreneurial domestic firms, linguistic advantages, global ties, recent economic liberalisation, etc.

Framework conditions

Economy-wide framework conditions are important factors in firms' decisions about where to locate globalised services activities. These include the cost and ease of setting up a business, the procedures for enforcing contracts, patent applications and urban population (Table 3.4). They paint a picture broadly similar to indicators of the intensity and quality of infrastructure, with the countries often mentioned as possible destinations for offshored services activities lagging somewhat behind the higher-income OECD countries. Nevertheless, most have a huge catch-up potential, so their competitiveness, which may also reside in other factors, such as relatively lower costs for the factors of production (land, capital and labour), different time zones, pool of skilled labour, language skills, etc. (see also Chapter 6), can reasonably be expected to increase in future.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Table 3.3. **Indicators of the stock of ICT-related infrastructure, selected countries, 2004**

	PCs (000s)	Internet subscribers (000s)	Internet hosts total (000s)	Dial-up (%)	BB subscribers (000s)	Lowest sampled BB cost – USD per 100 kbit/s	Cellular mobile subscribers (000s)
Australia	13 720	5 741.0	3 939.3	77.4	1 548.3	3.57	16.4
Brazil	19 350	7 900.0	3 485.8	71.4	2 256.0	9.21	65.6
Canada	22 390	8 131.7	3 562.5	30.7	5 631.7	1.05	15.0
China	52 990	71 713.0	162.8	64	25 785.0	1.93	334.8
Czech Rep.	2 450	2 276.1	384.6	96.7	75.7	3.99	10.8
Estonia	1 242	171.5	63.6	34.9	111.7	3.96	1.3
France	29 410	11 936.5	2 335.6	43.4	6 754.0	3.67	44.6
Germany	46 300	23 000.0	3 021.1	70	6 905.2	0.52	71.3
Hungary	1 476	741.8	483.8	49.9	371.8	11.3	8.7
India	13 030	5 450.0	143.7	95.7	235.0	3.67	47.3
Italy	18 150	19 900.0	1 635.8	76.4	4 701.3	1.16	62.8
Japan	69 200	33 883.9	16 445.2	56	19 087.2	0.07	91.5
Latvia	501	90.0	59.1	45.4	49.1	15.21	1.5
Lithuania	533	512.2	94.5	83.8	82.9	5.53	3.4
Morocco	620	102.6	4.1	37	64.7	5.49	9.3
Philippines	3 684	1 200.0	65.4	95.4	55.0	6.95	32.9
Poland	7 362	2 511.2	271.8	67.7	811.8	4.28	23.1
Romania	2 450	980.4	49.1	90.7	91.5	42.97	10.2
Russia	19 010	1 890.5	854.3	na	675.0	28.13	74.4
South Africa	3 740	1 000.0	350.5	94	60.0	12.45	19.5
Sri Lanka	530	93.4	2.1	96.3	3.4	3.25	2.2
Thailand	3 716	2 403.7	360.3	98.1	45.0	2.38	28.0
Tunisia	472	121.0	0.4	97.7	2.8	16.5	3.7
United Kingdom	35 890	15 800.0	2 130.8	60.4	6 255.5	1.35	61.1
United States	220 000	63 703.0	195 138.7	40.5	37 890.6	0.49	181.1
Vietnam	1 044	1 895.5	0.4	100	8.3	3.69	5.0

Note: Numbers in italics are estimates or refer to years other than 2004.
Source: ITU (2005).

StatLink: http://dx.doi.org/10.1787/018585283328

Quality of service issues related to offshoring

In addition to availability and quality of infrastructure and business framework conditions, quality of service is important in decisions to begin or to continue offshoring of ICT-enabled services. Within overall quality of services, information security and privacy concerns help shape the scope and limitations of ICT-enabled offshoring. While offshoring includes both insourcing to foreign affiliates and outsourcing to independent third parties abroad, this section mainly focuses on the latter. It is assumed that there may be fewer concerns for transactions and interactions between affiliated parties as many problems related to Web-based service provision, for example, can be overcome in the shared ownership environments in which intra-firm trade takes place (van Welsum, 2004). However, some of the issues related to international outsourcing may also apply to some extent to international insourcing.

Security, and privacy issues in international sourcing

The offshoring of information technology (IT) and business-related services has grown rapidly, and although much of the focus has been on countries that provide offshored services, such as India and the Philippines, other countries in the Asia-Pacific region and

Table 3.4. **Business framework indicators in selected countries, 2004**[1]

	Cost of business start-up procedures (% of GNI per capita)	Procedures to enforce a contract (number)	Start-up procedures to register a business (number)	Time required to enforce a contract (days)	Patent applications, nonresidents	Patent applications, residents	Urban population (millions)	Urban population (% of total)
Australia	2.0	11	2	157	96 434	10 823	18.6	92.3
Brazil	11.7	25	17	566	95 225	6 521	153.8	83.6
Canada	0.9	17	2	346	102 418	5 934	25.8	80.8
China	15.8	25	13	241	140 910	40 346	513.0	39.6
Czech Rep.	10.8	22	10	300	158 592	608	7.6	74.4
Estonia	7.4	25	6	150	157 901	33	0.9	69.6
France	1.1	21	7	75	160 056	21 959	46.2	76.5
Germany	5.8	26	9	184	230 066	80 661	72.9	88.3
Hungary	22.9	21	6	365	91 497	962	6.6	65.5
India	49.5	40	11	425	91 704	220	308.0	28.5
Italy	16.2	18	9	1 390	159 865	4 086	38.8	67.5
Japan	10.6	16	11	60	115 411	371 495	83.8	65.6
Latvia	17.5	23	7	189	140 637	8	1.5	66.1
Lithuania	3.6	17	8	154	140 674	91	2.3	66.7
Morocco	12.2	17	5	240	89 300		17.3	58.1
Philippines	19.4	25	11	380	81 697		50.4	61.8
Poland	20.6	41	10	1 000	92 176	2 342	23.7	62.0
Romania	7.4	43	5	335	141 294	1 486	11.9	54.7
Russia	6.7	29	9	330	96 315	24 049	105.4	73.3
South Africa	9.4	26	9	277	90 471	184	26.1	57.4
Sri Lanka	10.7	17	8	440	89 759		4.1	21.1
Thailand	6.7	26	8	390	4 548	1117	20.5	32.2
Tunisia	10.9	14	9	27	72 604		6.4	64.1
United Kingdom	0.9	14	6	288	251 239	33 671	53.4	89.2
United States	0.5	17	5	250	183 398	198 339	236.2	80.4
Vietnam	57.4	37	11	404	90 135	2	21.6	26.2

1. Patent applications (non-residents and residents): 2002; Thailand, 2000. Cost of start-up procedures: South Africa, 2003.

Source: World Development Indicators, World Bank, Online database (last accessed 25 April 2006).

StatLink: http://dx.doi.org/10.1787/471812108368

elsewhere are attempting to attract offshored ICT-enabled services activities. There is also evidence that countries that already provide offshored services are moving up the value chain as increasingly sophisticated functions and higher information security and privacy content are being moved offshore. This can increase both the level of risk and the complexity of managing it, particularly as service suppliers may serve multiple, sometimes competing, customers and may collaborate with other suppliers to meet customers' requirements. The most obvious risks involve storage, access and transfer of data. Activities which raise greater concerns include any function for which secure service provision is essential (*e.g.* core banking operations) or which handles personal data; there are fewer concerns about general development-related activities, such as source-coding or development of general user documentation. However, a large portion of more sophisticated offshoring so far has been internal to firms and thus raises fewer issues than transactions with independent third parties.

Nonetheless, as offshored tasks become more sophisticated and involve more sensitive data, consumers in countries from which offshoring originates have become more anxious about privacy and the misuse of personal data in health, insurance, tax returns and credit reports. Recent stories of data security breaches involving offshore outsourcing service suppliers have drawn further attention to this issue. There are also concerns that some offshore outsourcing facilities may be at risk from terrorist attacks,[5] that computer and network-related crime may not be detected, reported or dealt with effectively, or that the rapid growth of service suppliers may distract them from security issues.

Moreover, countries that receive offshored services activities often do not have specific data privacy or effective computer or network-related criminal laws or do not provide protection against interception of data by governments. In addition, there may be a lack of awareness on the service provider side of regulatory frameworks in foreign countries for resolving disputes and taking corrective action. In OECD countries various initiatives are in place. For example, broad and flexible framework guidelines have been established by the OECD in the areas of privacy and information security (OECD, 1980, 2002a). Some laws strengthening individual data privacy have been passed in the OECD area, such as the European Union's (EU) Directive on Privacy and Electronic Communications (2002) which builds on the preceding Directive on Data Protection (1995),[6] which restricts what data can be transferred or stored in countries without adequate rules and enforcement procedures. Other examples are the laws passed by 28 US states, such as the SB-1386 California law, which requires immediate notification to individuals of any security breach that may affect their personal data. The trend towards greater regulation is expected to continue (Table 3.5 presents selected examples of data regulations).

Actions by countries providing offshore outsourced services

To reduce the concerns of the local outsourcing industry's US or European customers about possible misuse of personal data, some countries are reviewing their privacy laws. India's Ministry of Information Technology and the National Association of Software and Service Companies (NASSCOM) have considered a data protection law that sets minimum industry requirements for data privacy and establishes a penal code for companies or individuals violating the rules, prompted by safeguards required by the EU Directive on Data Protection which restricts what data can be transferred or stored in countries without adequate rules and enforcement procedures.

Countries are also setting up organisations to deal with computer-related security, such as the 2004 CERT-In (Computer Emergency Response Team – India) set up by the Indian Department of Information Technology, to provide effective response to, or prevention of, computer security incidents, as well as to provide security quality management services. Its activities involve information collection, event monitoring, incident handling, data analysis, resource building, security research, security training and certification, security audits and information exchange, including internationally. Other examples include CERT Chile, CNCERT/CC China, CERT Malaysia, CERT Polska, CERT Slovenia, CERT Singapore.[7]

In addition, countries that provide outsourcing services are increasingly involved in international co-operation to fight crime more effectively, such as the Indo-US Cyber Security Forum. It has recently been announced that a Data Security Watchdog is to be set up in India, initially by NASSCOM, but it is to become an independently functioning self-regulatory organisation (SRO). It will focus on "the introduction and monitoring of best data security and privacy practices in the country's IT services, call centre and business process outsourcing industries" (CIO India, May 2006).[8] A company's membership in the SRO will act as a form of certification, as members will be expected to implement best practices. NASSCOM also launched the National Skills Registry in January 2006 which should make it easier for employers to check their employees' background. According to NASSCOM, it covered around 70% of IT employees in May 2006.

Table 3.5. **Selected examples of data regulations**

Regulation	Mandating organisation	Security requirements	Affected companies
IT Act 2000	Government of India	Authentication, access controls, encryption, data integrity controls, and audit controls	All organisations in India
Sarbanes-Oxley	US Securities and Exchange Commission (SEC)	CobiT framework – Authentication, access controls, user account management, credential lifecycle management, non-repudiation and audit controls	Companies publicly traded on US exchanges
Gramm-Leach-Bliley	US Office of the Comptroller of the Currency (OCC)	Authentication, access controls, encryption, data integrity controls and audit controls	All financial institutions regulated by the OCC
HIPAA Security	US Department of Health and Human Services (DHHS)	Authentication, access controls, transmission security, audit controls and data integrity	US healthcare organisations
21 CFR Part 11	US Food and Drug Administration (FDA)	Authentication, access controls, data integrity controls, audit controls, encryption and digital signatures	Companies regulated by FDA (*i.e.* pharmaceuticals)
Basel II	Basel Committee on Banking Supervision (Belgium, Canada, France, Germany, Italy, Japan, Luxemburg, The Netherlands, Spain, Sweden, Switzerland, United Kingdom, United States)	FFIEC framework – Access rights administration, authentication, network access, operating system access, application access, remote access, logging and data collection	Global financial service organisations
95/46/EC Data Protection Directive	European Union (EU)	Measures to protect personal data against accidental or unlawful destruction or accidental loss, alteration, unauthorised disclosure or access	Companies conducting business in EU member nations

Source: MphasiS, 2006.[9]

Actions by companies purchasing offshore outsourced services

Although companies may increasingly rely on independent outsourcing partners, the largest share of services offshoring is still performed by foreign affiliates or captive offshore facilities which are easier to control than independent suppliers. However, the search for lower-cost services provides further opportunities for independent services firms, while shifting to them some of the burden of quality assurance. In addition to careful supplier selection, contracts and service level agreements (SLAs) are important since they are the buyer's guarantee that standards and escape clauses are in place if problems should arise. The offshore outsourcing contract stipulates exactly what service is to be performed, determines the buyer's recourse and safeguards his interests. Penalty clauses can add protection. Beyond precisely defining the scope of the services, the contract must stipulate what happens if the process returns onshore, or migrates from one offshore supplier to another. Hence, thorough SLAs are among the most important means of risk reduction in offshore outsourcing.

While privacy legislation in the country supplying the offshored services is important, it is also important that companies purchasing these services ensure that their legal obligations (to their own customers) are fully reflected in their contract with

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

the offshore service supplier, that their sourcing agreements contain detailed and precise contractual specifications regarding data privacy and security, in particular, how data are categorised, transmitted, accessed, used, stored and shared by service suppliers. Furthermore contracts need to be legally and practically enforceable in the country of the supplying firms. In addition to ensuring their compliance with the home country's laws and regulations, companies purchasing services offshore need to compare best practice offshore service suppliers or have the service supplier's operations reviewed by a reputable third party.

International security standard certification to ISO 17799 or its BS7799 British equivalent ensures good practice for security. Uptake of the standard has grown rapidly during its ten-year history. In 2002, fewer than 200 organisations worldwide had achieved BS7799 certification, according to the Information Security Management Systems (ISMS) International User Group; by 2005, they numbered 1 870.[10] The objective of the standard and its successor, ISO 27001, is to help establish and maintain an effective information management system (OECD, 2005).

Actions by companies supplying offshore outsourced services

Companies supplying offshored services activities are increasingly aware that their continued growth depends on improving and maintaining all aspects of service quality. These include: categorising data and establishing standards and transparent procedures for security and privacy purposes for each class of data; staff recruitment and training in cryptography, TCP/IP and firewalls; internationally recognised certification; and, at operating level, biometric access controls, two-factor user authentication, data encryption and database monitoring. In addition, service suppliers should be aware of the risk of government interception of sensitive confidential information, and have planned responses to deal with potential natural disasters or terrorist attacks and security or privacy breaches. Finally, security is not just about developing complex security technologies, but also about changing the culture in some of the countries supplying offshored services where views on guarding information security and privacy may be more relaxed.

Service suppliers can reduce their risks of operational failure by having facilities in multiple countries and building additional capacity and disaster recovery capabilities, while gaining access to a broader set of skills. To be closer to their customers and have a global presence, some large offshore service suppliers are setting up affiliates in their customers' countries to help ensure service quality (*e.g.* Indian companies investing in OECD countries such as the United States, the United Kingdom and several eastern European countries, see below).

The Indian IT and ICT-enabled services sector

This section focuses on the Indian IT[11] and ICT-enabled services industry. Companies from OECD member countries are increasingly using both foreign affiliates based in India and Indian companies as part of their supply chains (international insourcing and outsourcing, respectively), but Indian companies are also increasingly globalising. The global delivery model of IT services and recent developments in the rapidly internationalising Indian IT and ICT-enabled services sector are analysed. The section should be compared with Chapter 6 of the *OECD Information Technology Outlook 2000*, "Software development in non-member economies: The Indian case", which concluded that, despite rapid growth, the work performed by the Indian software services industry was fairly mundane, with only limited potential for sustained growth. However, there was already some evidence that established Indian firms were maturing and growing in their ability to execute larger and more complex projects, including the higher value-added parts of such projects. Overall, the Indian experience was seen as a pertinent development model for developing countries. The recent achievements of Indian firms in maintaining their momentum and developing global business models in more advanced services are described below.

The global services delivery model

OECD countries were offshoring computer-related work to countries such as India and the Philippines, both of which had an abundant supply of English-speaking graduates, as early as the 1980s. Paper documents and audiotapes were flown in for digitisation and transcription and simpler computer programming tasks were performed for foreign clients. Indian professionals with IT backgrounds were also brought to clients in OECD countries for software coding. This practice was particularly common when companies hurried to modify computer systems before 2000 and demand for IT professionals exceeded supply in many OECD countries.

However, benefiting from rapid developments in ICTs and trade and investment liberalisation, the Indian IT industry pioneered the development of a "global delivery model". In the original model, a group of Indian professionals was sent to the overseas client and worked together with a team based in India. The professionals at the client's premises acted mainly as facilitators – they conducted negotiations, transferred information, supervised and implemented software solutions – while professionals in India provided most of the software coding and related tasks. Team members circulated between the client site and the Indian home office during the course of the project. With time, the model has become more complex, with services sometimes provided from a number of locations, thus turning it into a global delivery model.

The potential cost savings from using such a model are significant because local salaries for IT professionals working from the Indian offices are lower than those for client country professionals. In the early days, the relative number of Indian professionals working at the client site was large compared to the number working from India. However, the onsite ratio decreased over time as the global delivery model matured and Indian companies became more experienced at managing increasingly sophisticated projects from overseas.

The global delivery model of IT services tends to be recognised today as a sustainable and cost-effective way of sourcing IT services. It appears that for Indian IT firms, the challenge has shifted from convincing prospective clients that their business model works to convincing them that they offer a better value proposition than their competitors, especially as other relatively lower-cost countries in the region emerge, although these tend to be less experienced than India in the market for offshored IT and ICT-enabled services.

Indian exports of IT and ICT-enabled services have grown strongly, and India also accounts for a relatively large share of total reported exports by value (see above). The figures reflect a healthy export market in which the operations of both Indian and foreign-owned companies are rapidly expanding. However, they have different strengths, face different challenges and adopt different operational strategies.

Integrating India into operations of OECD multinationals

India has been very successful in attracting foreign multinationals wanting to benefit from local skills and cost structures. Approximately one-third of Indian exports of IT services and two-thirds of ICT-enabled services are estimated to be generated by foreign-owned companies (Business Standard, 2005). The most common type of establishment is the export-oriented affiliate. Companies that locate in India's software technology parks to serve foreign markets benefit from temporally limited but generous tax exemptions and various measures for facilitating investment and businesses' daily operations.[12] These establishments provide services to their parent companies and subsidiaries around the world.

Joint ventures are another, but less common, form of internationalisation for OECD companies. Mahindra British Telecom Ltd is India's eighth largest ITS company; other examples include NEC-HCL Infosystems, Deloitte Consulting-Mastek, and Microsoft-TCS-Uniware. Some OECD companies have expanded in the Indian market by buying local companies. For example, in 2004 IBM acquired Daksh eServices, India's third largest ITES company; in 2005 Oracle acquired i-flex, India's leading software product company.

OECD companies also expand in India by adopting a build-operate-transfer (BOT) model. In this case a foreign company agrees to let an Indian IT company establish, manage and expand a unit which is taken over by the foreign company after a few years. The model is dependent on a number of contract-based criteria and tends to work best for companies producing software products. For example, Oracle recently exercised an option to acquire such a unit with nearly 1 000 professionals from an Indian services company.

OECD multinationals enjoy a number of advantages over their Indian competitors. For example, their knowledge of many local markets is an advantage in areas from sales and marketing to dealing with local authorities and acquiring government contracts in those markets. They also often have well-established client relations and the infrastructure to take on the largest and most complex projects. This includes the ability to take over clients' entire IT departments, including personnel, which is crucial in many larger outsourcing deals. OECD multinationals can also afford to pay their Indian employees higher-than-market wages and offer career paths which attract some of the best Indian professionals to move from their Indian-owned software companies.

Business models of Indian software and IT companies

Indian IT companies may lag their OECD competitors in the areas mentioned above, but may still compete successfully by offering an attractive combination of quality, cost-effectiveness and short turnaround time. Their capacity to quickly scale up operations is an added benefit. The Indian market comprises thousands of IT services companies and companies providing ICT-enabled services. These companies operate under many different business models. Some large companies like Satyam Computer Services, TCS and Infosys Technologies are establishing software development centres in both client markets and countries in close proximity to clients. Other companies such as Patni Computer Systems and Wipro Technologies try to minimise the number of front offices in client countries and depend more on rotation of professionals in and out of client countries (OECD, 2006). Smaller Indian companies mostly compete for contracts from foreign small and medium-sized enterprises (SMEs) or create umbrella groups of partner companies that can be leveraged for scale and domain expertise when taking on larger clients.

Most Indian companies build expertise for offering software and support solutions targeted for specific industries. Another type of market differentiation is to develop unique technical competence. However, this model is seldom sustainable because it is easy to duplicate. The IT industry has few Indian-owned companies that produce software products or applications with intellectual property value. I-flex and Sasken are rare exceptions although industry leaders like Infosys Technologies and TCS are trying to increase their revenue derived from packaged software. The industry's focus on services provision is especially appreciated by clients worried about issues such as information security, intellectual property rights and privacy protection. NASSCOM's recent initiatives to set up a data security watchdog and a National Skills Registry (see above) should also help to ease worries about the risk of information security and privacy breaches in India.

Over the past few years, the leading Indian IT services companies have widened their services portfolios to include ICT-enabled services. Many companies are also establishing software development centres in other emerging market economies in close proximity to clients. This move is often referred to as "near-shoring" and includes development centres in eastern Europe to service the western European market and Latin American countries to service the United States, Spain and Portugal. Table 3.6 presents an example of the global delivery model implemented by Infosys Technologies. It shows how tasks can be fragmented and provided from different geographical locations: client site (*e.g.* Germany), near-site (*e.g.* Czech Republic) and offshore (*e.g.* India). This type of fragmentation is becoming increasingly common among large Indian companies.

The "near-shoring" centres help to overcome language and cultural barriers as well as certain restrictions to movement of service suppliers. Movement restrictions are of particular concern to the Indian IT industry since the global delivery model is dependent on frequent circulation of service professionals between home and client offices (OECD, 2006).

More than 30 Indian IT and ICT-enabled services companies are estimated to have subsidiaries in China (Times News Network, 2005). Large and medium-sized Indian companies have long had well-established sales and marketing organisations in their client countries. However, the larger Indian companies are now publicly listed companies with significant financial strength. Some have started to invest outside India to acquire new competence and intellectual property rights. A number of medium-sized companies have recently been bought in OECD member and other countries. For example in 2005, TCS acquired Australian Financial Network Services and Chilean Comicrom;[13] Wipro Technologies acquired Austrian NewLogic and US-based mPower Inc;[14] Satyam Computer Services acquired British Citisoft;[15] and in 2004, Infosys Technologies acquired Australian Expert Information System.[16]

Operational strategies for the future

As Indian companies become more internationalised, they increasingly compete with OECD multinationals in a growing number of locations. For example, Infosys Technologies is leading the way in the Indian IT services sector by establishing small front offices in client countries. The company plans to deploy around 30% of its workforce in client countries, of which around half will be local employees. The other half will be rotated in and out of India. This strategy points to potential global convergence of company strategies whereby successful companies from developing countries adopt business models similar to those of OECD multinationals in global, higher value-added activities,

Table 3.6. **The global delivery model and geographical choice**

	Client site locations	Near-site locations	Offshore locations
Strategy and roadmap definition	● Client interaction	● Analysis and synthesis	● Background research
	● Interviews		● Best practices in outsourcing
	● Reviews		● Information support
	● Programme leadership		
	● Goal-setting		
Development and integration	● Architecture	● Requirements analysis	● Detailed design
	● Requirements	● High-level design	● Code development
	● Change management	● Prototype building	● Testing and integration
	● Implementation	● Implementation support	
Systems integration and package implementation	● Client interaction	● Prototype building	● Custom components
	● Process mapping	● High-level design	● Integration interfaces
	● Solution definition	● Implementation support	● Report building
	● Architecture		
	● Change and programme management		
IT and business process outsourcing	● First-level support	● Near-site support centres	● Large offshore centres
	● Facilities support	● Service redundancy	● Core service delivery
	● Programme management		

Source: Infosys Technologies, 2006.

just as IT services companies in OECD countries are transforming their operations to include a larger offshore component (Engman, 2005).

Box 3.4 presents two examples of how Indian companies have recently received parts of some of the world's largest IT outsourcing contracts. They show that American and European IT services multinationals still perform most of the higher-value work. They also illustrate the advantages that locally based companies may have for taking over clients' entire IT departments, including personnel. The top Indian companies will need to continue to strive not only to deepen their expertise and widen their services offerings, but also to establish more of a local presence in their client countries.

Finally, a joint NASSCOM-McKinsey report published in 2005 identified four business models that are likely to succeed in the next five years. The first is the "full service provider" of IT and ICT-enabled services. Multinationals from a number of emerging market countries will offer multiple service lines and integrated solutions to companies. The second model entails specialised IT service providers focusing mainly on a limited number of industries (*e.g.* finance and telecommunications) and/or cross-industry services (*e.g.* infrastructure management). This model includes delivery centres in India and a few other low-cost locations. The third model is the "application development factory" which centres around application development and maintenance services based on principles similar to value chains in large-scale manufacturing. Scalability, cost consciousness and co-operation with smaller consulting companies are important. The final model covers specialist BPO companies with global coverage. Several sub-niches are possible, including process reengineering providers, vertical contractors providing highly skilled services (such as chip design and financial analyses), and standardised processing services.

Box 3.4. **Internationalisation of the Indian services delivery model**

The global delivery model pioneered by the Indian IT industry began to be truly international in 2005. The Indian IT services industry is now competing for the largest outsourcing contracts in the IT industry, at least in the area of applications development. Indian companies may not yet be in a position to single-handedly maintain multinationals' IT infrastructure but they are increasingly chosen as strategic partners in very large outsourcing contracts.

In September 2005, ABN AMRO announced that it would implement an IT strategy encompassing "in-house consolidation, partial outsourcing, multi-vendor strategies and offshoring" (ABN AMRO, 2005). The objective is to streamline the bank's IT organisation and to improve the performance of its IT services. The company hopes to realise annual cost savings of at least EUR 258 million from 2007 onwards. Five preferred IT vendors will work closely with the company over the next five years to help achieve this objective. The partners with which the bank signed global services agreements will together provide services worth approximately EUR 1.8 billion. Around 2 000 IT professionals will be transferred to the selected IT vendors and a majority will move to IBM.

Three of the five preferred partners are Indian companies. IT infrastructure management, including servers, storage systems and desktops, will be handled by IBM. Application support and enhancements will be provided by the Indian companies Infosys Technologies and TCS; application development by Accenture, IBM, Infosys Technologies, Patni Computer Systems and TCS. TCS estimates that this partnership – the largest it has had – will generate revenues of over EUR 200 million over the five years. Over USD 100 million will come from servicing ABN AMRO's Latin American operations. TCS's services will be provided from delivery centres in Brazil, Hungary and India. TCS plans to hire over 1 000 employees in Brazil and Uruguay in 2006, to add to its 700 local consultants providing services to nearly 100 regional and global clients in Mexico, Central America, South America, Spain and Portugal (TCS, 2005).

Another global IT deal was announced in February 2006 by General Motors. The company will spend approximately USD 15 billion on IT over the next five years and contracts were awarded to CapGemini, Compuware Covisint, EDS, HP, IBM and Wipro Technologies. Wipro's part of the contract covers integration of GM's middleware systems and information systems and services (IS&S) software tools worldwide (Wipro, 2006). Wipro co-operated and teamed with EDS while bidding for outsourcing contracts at GM. This type of co-operation may well be one of the ways forward for some of the more mature Western and Indian IT services companies.

Overall, the strategies and development of Indian software and IT services firms provide an example of the rapid rise of firms in non-OECD countries. Their experience provides a model of how a strong skills base and entrepreneurial business attitudes can overcome domestic handicaps (poor infrastructure, low domestic incomes) to build globally competitive firms delivering advanced services. If managed successfully, internationally sourced services lower costs and increase productivity in outsourcing firms and the success of supplying firms in turn contributes to growth and raising living standards in the economy supplying the services.

Conclusion

Rapid technological advances in ICTs have increased the tradability of services and created new tradable services and have made it possible to provide some services from remote locations, thus potentially enabling their globalisation. Indicators of trade, FDI and the activities of multinationals show that such services are in fact globalising rapidly. OECD countries still account for most services activities and services trade, but many non-OECD countries are showing very rapid growth. China and India already account for relatively large shares of trade in ICT-enabled services (7% of exports and around 5% of imports between them), and some Baltic and eastern European countries are increasing their share, reflecting new global patterns of ICT-enabled services supply.

There is still considerable scope for improvement and expansion in many of the countries supplying offshored services, as shown by indicators on ICT infrastructure and business framework conditions. At the same time, other countries with favourable ICT infrastructure and business infrastructure are also entering international services sourcing. While OECD countries still account for the bulk of ICT-enabled services trade, emerging countries, particularly China and India, are likely to take a larger share. However these countries' domestic services activities are also growing and adjusting to international competition and their markets offer increasing opportunities for services firms from OECD countries.

Firms from developing countries, and India in particular, are increasingly competing with those from OECD countries, not only from their home country but also increasingly abroad. They have begun to set up extensive global operations to deliver their services locally or regionally to clients. Overall, the location and growth of services activities depend on the quality of the services supplied as well as the ICT infrastructure and business framework. Firms and countries that are developing international services sourcing activities are increasingly paying attention to the quality of services and improving information security and privacy.

Finally, most countries have seen adjustment to international sourcing as part of more general adjustment policies. However, the countries that are building up their own international service supply capabilities are also actively pursuing strategies to improve domestic capabilities and the competitiveness of IT and software suppliers.

Notes

1. Under the definition of offshoring adopted here, offshoring includes both international outsourcing (activities are contracted to independent third parties abroad) and international insourcing (to foreign affiliates). The cross-border aspect is the distinguishing feature of offshoring, *i.e.* whether services are sourced within the domestic economy or abroad, not whether they are sourced from within the same company or from external suppliers (outsourcing).
2. For India, the category "Other business services" includes all services except travel, transport and government services. However, Indian firms now extensively export ICT-enabled services and business process services and the other services in the category are likely to be small in comparison. Furthermore, data on overseas revenues from annual reports of top Indian export firms show patterns similar to the IMF data. See van Welsum and Vickery (2005) and van Welsum and Reif (2006) for more details.
3. FDI may not be an ideal proxy for the activities of multinationals abroad because of a variety of ownership and measurement problems (*e.g.* differences across countries and data sets as to the definition of minority-held overseas investments included in FDI statistics), but it is the only widely available measure of the scale of cross-border investment for many countries.

Furthermore, as multinationals can be very large enterprises with multiple establishments that span a large number of industries, assigning their investments to their "primary" industry can be problematic. Thus, it may difficult to attribute FDI to manufacturing or services sectors. In many small open countries the size of the inward and outward FDI stocks relative to GDP may also be affected by large investments in holding companies. This section uses data from the OECD Direct Investment Statistics Database. Not all OECD countries record FDI in the same way, however. See the *OECD Direct Investment Statistics Yearbook* for methodological details.

4. "Real estate and business activities" represents section K of ISIC 3 (minus if available "of which real estate"), but the connection between service products and service activities for large enterprises is loose. Business services can be provided internally within multinationals with main activities, *e.g.* in manufacturing, carried out elsewhere.
5. See *www.itweek.co.uk/itweek/news/2148252/firms-offshoring-india-urged*.
6. The Directive on Data Protection (Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995) on the protection of individuals with regard to the processing of personal data and on the free movement of such data requires member states to ensure the rights and freedoms of natural persons with regard to the processing of personal data, and in particular their right to privacy, in order to ensure the free flow of personal data in the Community. The Privacy and Electronic Communications Directive seeks to respect the fundamental rights of individuals. See *http://europa.eu/eur-lex/pri/en/oj/dat/2002/l_201/l_20120020731en00370047.pdf*.
7. For an indicative list of CERTs see: *www.cert-in.org.in/worldcert.htm*.
8. www.cio.in/news/viewArticle/ARTICLEID=1381 (accessed 16 May 2006).
9. Abnash Singh, CIO, MphasiS, Presentation at ITAA/NASSCOM Global Conference, 18-19 January 2006, Delhi, India, "Addressing Customer Concerns: A Converged Model of Information Security".
10. Offshoring pushes BS7799 security – Offshoring specialists are using security certification to assure firms that data is safe, Madeline Bennett, IT Week 03 Nov 2005, *www.itweek.co.uk/articles/print/2145504*.
11. IT services include applications development and maintenance, system integration, hardware support and installation, and network consulting.
12. See *www.stpi.soft.net* (accessed 5 February 2006).
13. *www.tcs.com/investors/InvestorRelations/show.aspx?sname=Press%20Releases&index=1931* (accessed 9 March 2006) and *www.tcs.com/investors/InvestorRelations/show.aspx?sname=Press%20Releases&index=2038* (accessed 9 March 2006).
14. *www.wipro.com/news/newsitem1/newstory426.htm* and *www.wipro.com/news/newsitem1/newstory428.htm* (accessed 9 March 2006).
15. *www.satyam.com/mediaroom/pr7apr05.html* (accessed 9 March 2006).
16. *www.infosys.com/media/press_releases/agreement_expert_info_service_australia.asp* (accessed 9 March 2006).

References

ABN AMRO (2005), "ABN AMRO Signs Contracts with IT Vendors", 1 September, Press room: *www.abnamro.com/pressroom/releases/2005/2005-09-01-en.jsp*.

Barry, F., and D. van Welsum (2005), "Services FDI and offshoring into Ireland", paper prepared for the Panel session on ICT-enabled offshoring: Country experience and business perspectives, held as part of the June 2005 meeting of the OECD Working Party on the Information Economy, OECD, Paris; available at *www.oecd.org/sti/offshoring*.

Business Standard (2005), "BPO Boost IT Exports to $5.2 bn", Bangalore 3 June, *www.business-standard.com/common/storypage.php?storyflag=y&leftnm=lmnu1&-leftindx=1&lselect=6&chklogin=N&autono=190532* (accessed 9 March 2006).

Engman, M. (2005), "International Sourcing of IT and Business Process Services: Experiences from the United States, the European Union and India", paper presented at the WTO Symposium on Cross-Border Supply of Services in Geneva, 28-29 April.

US Government Accountability Office (GAO) (2005), "International Trade – US and India data on Offshoring Show Significant Differences", GAO-06-116, Report to Congressional Committees, October, Washington, DC.

Infosys Technologies (2006), "Different Parts of a Project (or Kinds of Work) May Be Suited to Onsite, Near-Shore or Offshore Locations", *www.infosys.com/gdm/table.asp*.

International Telecommunication Union (ITU) (2005), *The Internet of Things*, ITU, Geneva.

NASSCOM-McKinsey (2005), "NASSCOM-McKinsey Study 2005", *www.nasscom.org/download/Mckinsey_study_2005_Executive_summary.pdf* (accessed 9 March 2006).

OECD (1980), *Guidelines on the Protection of Privacy and Transborder Flows of Data*, OECD, Paris.

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

OECD (2002a), *Guidelines for the Security of Information Systems and Networks*, OECD, Paris.

OECD (2002b), *The Manual on Statistics of International Trade in Services*, joint publication of the United Nations, the International Monetary Fund, the OECD, the European Commission, the United Nations Conference on Trade and Development and the World Trade Organization. An electronic version of the manual is available free of charge at *www.oecd.org/std/trade-services.*

OECD (2004), *Information Technology Outlook 2004*, OECD, Paris.

OECD (2005), *The Promotion of a Culture of Security for Information Systems and Networks in OECD Countries*, OECD, Paris.

OECD (2006), "Facilitating Adjustment: International Sourcing of ITS and BPS", OECD Internal Working Document.

TCS (2005), "TCS Announces Robust Growth Plans in Latin America", 13 September 2005, News Release: *www.tcs.com/0_media_room/releases/200509sep/tcs_announce.htm* (accessed 9 March 2006).

Times News Network (2005), "IT's on a Roll: Revenue Grows 32% to $22b", 3 June.

van Welsum, D. (2004), "In search of 'offshoring': Evidence from US imports of services", Birkbeck Economics Working Paper 2004 No. 2, Birkbeck College, London.

van Welsum, D. and G. Vickery (2005), "Potential offshoring of ICT-intensive using occupations", DSTI Information Economy report, DSTI/ICCP/IE(2004)19/FINAL, OECD, Paris; available at: *www.oecd.org/sti/offshoring* .

van Welsum, D., and X. Reif (2006), "The share of employment potentially affected by offshoring: An empirical investigation", DSTI Information Economy report, DSTI/ICCP/IE(2005)8/FINAL, OECD, Paris; available at: *www.oecd.org/sti/offshoring*.

Wipro (2006), "Wipro signs new global information technology deals with General Motors 5-year agreements provide support for GM information systems and services globally", *www.wipro.com/news/newsitem1/newstory429.htm* (accessed 9 March 2006).

ANNEX 3.A1

Table 3.A1.1. IMF balance of payments categories

7.	**Computer and information services**
7.1	Computer services
7.2	Information services
7.2.1	News agency services
7.2.2	Other information provision services
9.	**Other business services**
9.1	Merchanting and other trade-related services
9.1.1	Merchanting
9.1.2	Other trade-related services
9.2	Operational leasing services
9.3	Miscellaneous business, professional, and technical services
9.3.1	Legal, accounting, management consulting, and public relations
9.3.1.1	Legal services
9.3.1.2	Accounting, auditing, bookkeeping, and tax consulting services
9.3.1.3	Business and management consulting, and public relations
9.3.2	Advertising, market research, and public opinion polling
9.3.3	Research and development
9.3.4	Architectural, engineering, and other technical services
9.3.5	Agricultural, mining, mining, and on-site processing services
9.3.5.1	Waste treatment and depollution
9.3.5.2	Agricultural, mining and other on-site processing services
9.3.6	Other business services
9.3.7	Services between related enterprises, n.i.e.

Source: OECD (2002b).

Table 3.A1.2. **Sectors distinguished in the OECD Direct Investment Statistics database**

PRIMARY SECTOR		
	Agriculture and fishing	
	Mining and quarrying	
	of which:	Extraction of petroleum and gas
MANUFACTURING		
	of which:	Food products
		Total textile and wood activities
		Total petroleum, chemical, rubber, plastic products
		Total metal and mechanical products
		Total machinery, computers, RTV, communication
SERVICE SECTOR		
	Electricity, gas and water	
	Construction	
	Trade and repairs	
	Hotels and restaurants	
	Transports, communication	
	of which:	Total land, sea and air transport
		Telecommunications
	Financial intermediation *of which:*	
		Monetary intermediation
		Other financial intermediation
		of which: Financial holding companies
		Insurance and activities auxiliary to insurance
		Total other financial intermediation and insurance activities
	Real estate and business activities	
	of which: Real estate	
	Other services	
UNALLOCATED		
TOTAL		

Table 3.A1.3. **Infrastructure indicators in selected countries, 2004**[1]

	International Internet bandwidth (bits per person)	International Internet bandwidth (Mbps)	International voice traffic (minutes per person)	International voice traffic (out and in, millions of minutes)	Secure Internet servers	Secure Internet servers (per 1 million people)	Telephone average cost of call to US (US$ per 3 minutes)	Telephone faults (per 100 mainlines)	Telephone mainlines (millions)	Telephone mainlines (per 1,000 people)
Australia	1096.7	22056	213.8	4150.0	8224	408.9	0.68	8.0	10.9	540.6
Brazil	149.3	27449	11.7	207202	2001	10.9	0.71	1.6	42.4	230.4
Canada	6803.0	217521	438.7	13499.6	15441	482.9	1.20		20.1	634.5
China	57.4	74429	6.3	8179.8	293	0.2	2.90		312.4	241.1
Czech Rep.	2450.5	25000	163.3	1666.4	316	30.9	1.06	6.8	3.5	337.7
Estonia	3409.9	4600	128.0	174.7	113	83.8	0.90	16.3	0.4	329.2
France	3312.3	200000	210.3	12697.0	3855	63.8	0.84		33.9	560.9
Germany	6859.9	566056	190.8	15683.0	13847	167.8	0.43		54.6	661.1
Hungary	989.4	10000	48.7	492.9	210	20.8	1.01	8.7	3.6	353.9
India	11.4	12300	3.0	3100.0	462	0.4	1.19	126.0	44.0	40.7
Italy	2078.1	119794	235.8	13593.0	1994	34.6	0.79	16.2	26.0	450.9
Japan	1037.9	132608	36.3	4634.0	20465	160.2	1.66		58.8	460.1
Latvia	972.0	2248	66.5	154.6	80	34.6	1.63	20.3	0.6	272.8
Lithuania	193.9	666	34.4	119.0	47	13.7	2.31	16.3	0.8	238.7
Morocco	26.0	775	54.9	1638.0	17	0.6	1.41	25.0	1.3	43.9
Philippines	39.4	3214.5	28.8	2348.0	161	2.0	1.20		3.4	42.1
Poland	559.9	21380	60.6	2315.3	565	14.8	0.99	17.2	12.3	321.8
Romania	186.0	4033	49.1	1071.0	65	3.0	0.82	9.0	4.4	202.4
Russia	99.9	14365	15.3	2224.6	297	2.1	2.03	35.2	37.0	255.8
South Africa	19.4	881.5	40.0	1822.0	909	20.0	0.79	48.2	4.8	105.2
Sri Lanka	16.7	324	19.7	374.4	30	1.5	2.11	6.8	1.0	51.0
Thailand	47.2	3006	12.5	795.8	258	4.1	0.67	2.6	6.8	106.7
Tunisia	44.0	437	61.3	599.7	19	1.9	2.28	30.0	1.2	121.2
United Kingdom	13054.9	781554	262.2	15600.0	21034	351.3	0.77	11.0	33.7	562.9
United States	3305.2	970594	200.6	58338.4	198098	674.6		12.5	177.9	606.0
Vietnam	23.0	1892	8.3	670.6	10	0.1	1.95		5.8	70.3

1. *Bandwidth data*: Czech Republic and Italy, 2003. *International voice traffic*: China, Czech Republic, Hungary, Japan, Latvia, Lithuania, Poland, United States, 2003; India, Romania, Russia, Sri Lanka, Tunisia and Vietnam, 2002; Australia, Brazil, Estonia, United Kingdom, 2001; Canada and Germany, 2000. *Average cost of telephone call to the US*: Brazil, 2003; Australia, Lithuania, Tunisia, 2002; Canada 1998. *Telephone faults*: Australia, Czech Republic, Hungary, Latvia, Lithuania, Romania, Sri Lanka, United States, 2003; India, South Africa, United Kingdom, 2002; Estonia and Poland, 2001; Russia, 1999; Italy, 1998. *Telephone mainlines*: Canada, Poland, Russia, South Africa 2003.

Source: World Development Indicators, World Bank, Online database (accessed 25 April 2006).

StatLink: http://dx.doi.org/10.1787/605123286156

ISBN 92-64-02643-6
OECD Information Technology Outlook 2006

Chapter 4

China, Information Technologies and the Internet

China has established itself as a leader in the production and use of information and communication technologies (ICTs). On the supply side, it has become one of the most important locations for the assembly and production of ICTs, mainly driven by foreign firms. Since 2004, it has been the biggest exporter of ICT goods and its strong ICT exports continued up until early 2006. China continues to import electronic components – now increasingly from other Asian countries – while exporting computer and related equipment. In spite of their relatively limited size and technological know-how, Chinese ICT firms are rapidly developing their production and export capacities (especially in the area of telecommunications equipment). On the demand and use side, China is the now the sixth most important global ICT market but still lags in the area of ICT services. PC penetration, Internet access and use (including e-commerce) are developing rapidly, albeit from low per capita levels.

Introduction

The Chinese economy continues to be one of the main engines of world growth, with a large and increasing share of global trade and foreign investment (OECD, 2005a) and steadily improving infrastructure. With GDP growth rates averaging close to 10% over the past two decades, the size of the Chinese economy, when measured at market prices, now exceeds that of a number of major European economies and in five years time may be exceeded by only three OECD member countries. Many industries based in China are now integrated into world supply and value chains, and China could become the world's largest exporter by the beginning of the next decade. Supported by strong income growth, business investment and consumption by its population of more than 1.3 billion, China is also becoming a major world market.

As part of its rapid development, China has established itself as a leading participant in the production and use of ICTs. On the supply side, it is now one of the world's most important locations for the assembly and production of ICTs. The question now concerns the extent to which, and how rapidly, it can move up the value chain into higher value added products and shift from being a goods assembler based on wage-cost advantages to being a major innovator and creator of new ICT goods and services. On the demand and use side, the question is how quickly China's ICT demand, personal and broadband penetration, and e-commerce activities will develop.

This chapter sheds light on the current position of China in global production, demand and use of ICTs. Following a description of its role in the global ICT goods trade, the discussion turns first to the Chinese ICT supply side and related policies and then to the ICT demand side and use. China's role in the international trade of ICT-related services is explored in Chapter 3. Whenever possible, and apart from the section on global trade, which relies on OECD data, and data for ICT spending, official Chinese data sources are used.[1] The stocktaking exercise in OECD (2005b) identifies and discusses certain problems with the Chinese ICT statistics which need to be kept in mind when evaluating them or making comparisons with ICT statistics supplied by OECD countries. Since 2005, the OECD maintains co-operation in the area of improvement of ICT statistics with the Chinese National Bureau of Statistics (NBS, 2006). China is currently surveying the government, household and business access and use of ICTs and some initial results are presented in this chapter.

China's global trade in ICT goods

Chapter 2 brings out the shift in ICT equipment manufacturing to China and its increasing importance as world centre of ICT production. High-technology exports, as defined by Chinese data sources,[2] are mostly made up of ICT-related products, and these have become China's most important export category, accounting for roughly 30% of its total exports in 2005 (China's Monthly Customs Statistics). In 2005, China's high-technology exports represented USD 218.3 billion, an increase of USD 52.7 billion from the preceding year. In the last months of 2005, rising exports of ICT goods made up

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

about two-thirds of all Chinese high-technology exports (sectors such as biotechnology and aerospace were comparatively small), a trend that appears likely to continue in 2006.

China, the number one exporter of ICT goods in 2004

In 2004, China became the biggest exporter of ICT goods (USD 180 billion). It surpassed Japan and the European Union in 2003 and in 2004 took the lead from the United States (USD 149 billion) (Figure 4.1). China's share of total world trade (exports plus imports) in ICT goods has grown rapidly. Worth less than USD 35 billion in 1996, China's ICT goods trade reached almost USD 329 billion in 2004, growing at almost 32% a year since 1996 (compound annual growth rate, CAGR).[3] While Chinese ICT imports initially grew faster than exports (imports totalled USD 149 billion in 2004), exports have caught up and reached USD 180 billion in 2004. This strong export growth is reflected in a trade surplus in ICT goods of USD 31 billion in 2004. Year-on-year export growth saw a relative but temporary slump from 2000 to 2001 (to 18% year-on-year growth, down from 44% in the previous year) when the sales of the ICT industry fell sharply. In 2002, however, the ICT export growth rate exceeded the high growth rates of 1999/2000, and then grew by 55% from 2002 to 2003 and by 46% from 2003 to 2004. Similar rates have been maintained in 2005 and early 2006.

While China's imports of ICT goods (USD 149 billion) have risen rapidly between 2001 and 2004, they have remained below imports of ICT goods into the United States (USD 235 billion) and the EU15 (USD 226 billion) but above those of Japan (USD 73 billion) (Figure 4.1).

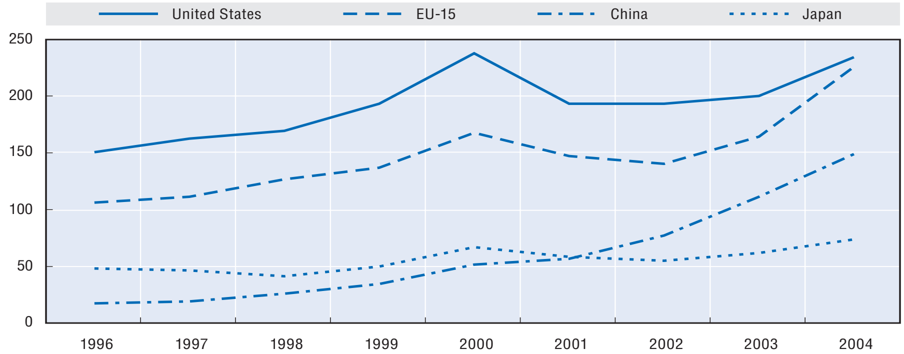
The increase in ICT exports can mostly be traced to the transfer to China of foreign companies' labour-intensive and often low value-added assembly and production activities of televisions, computers, handsets and DVD players; a phenomenon which became increasingly evident after the bursting of the IT bubble in 2000-01, as shown by the rapid recovery in ICT exports. The China-based affiliates of global ICT firms or third-party electronic manufacturing services (EMS) companies, which manufacture for leading global ICT firms, import intermediate products and produce mainly finished ICT goods that are exported (pure processing and assembly-related trade).[4] For this process, high-value added components such as central processors and memory chips are generally imported.

Data on the share of Chinese ICT-related processing trade or the share of foreign firms in total Chinese ICT exports corresponding to the OECD definition of ICT goods are not available. However, aggregate Chinese export figures for January to December 2005 show that 55% of total exports relate to processing and assembly-related trade (China's Monthly Customs Statistics) and that of total Chinese exports and imports from January to December 2005, around 58% are driven by foreign-invested enterprises[5] (with 38% wholly foreign-owned enterprises) (Table 4.A1.1 and MOFCOM, 2005a, all figures as by Chinese definitions). For ICT-related trade (high-technology exports or exports of electronics products according to the Chinese definition) these shares are even more important, as processing trade of foreign firms represents about 90% of Chinese ICT-related exports.[6] Also, among the top 100 exporting foreign-invested enterprises there are many ICT-related companies from Chinese Taipei and the United States (see Table 4.2). None of the top ten high-technology firms in China (classified by 2005 revenues) is domestic, with Motorola, Dell, Hewlett Packard and Nokia leading (Ministry of Information Industry [MII], 2006a).

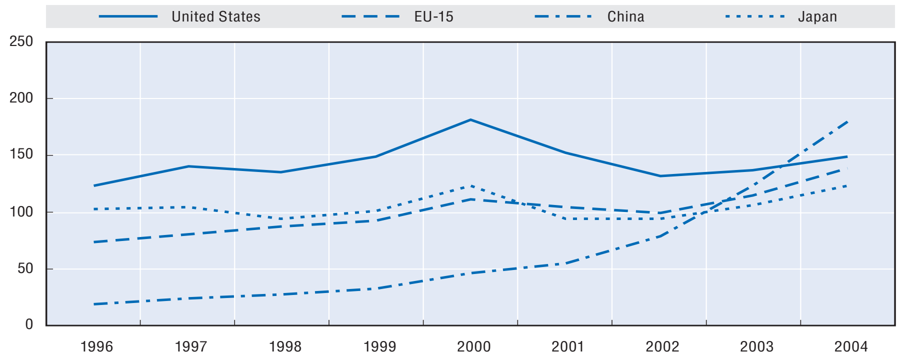
Figure 4.1. **Imports and exports of ICT goods**

Current USD billions

Imports of ICT goods



Exports of ICT goods



Note: Data for the EU exclude intra-EU trade.
Source: OECD, ITS database.

StatLink: http://dx.doi.org/10.1787/122466452114

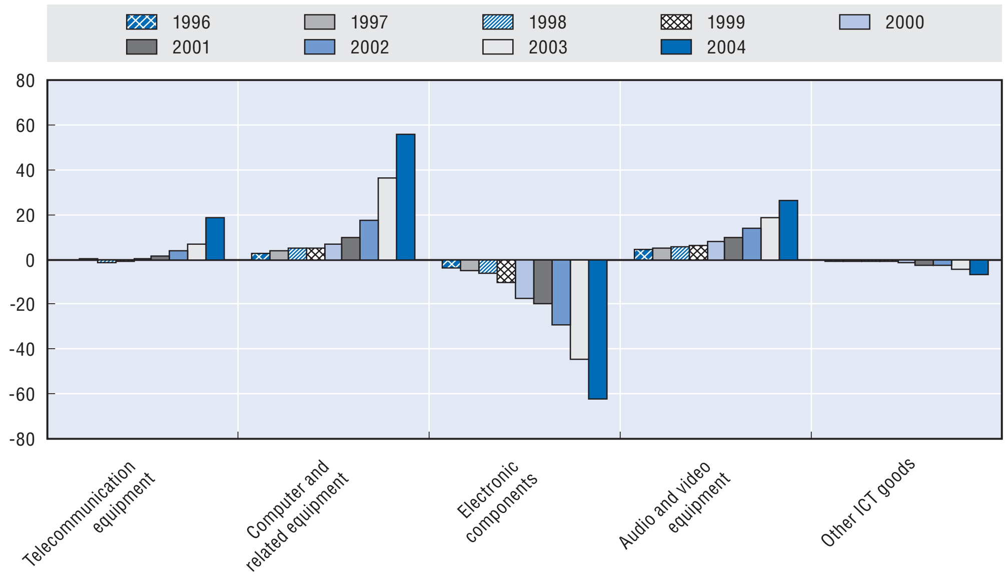
Despite the importance of foreign firms' ICT-related processing trade in China, there is mounting evidence that ICT-related foreign affiliates are evolving from simple assembly and manufacturing to more complex original design and production (US-China Economic and Security Review Commission, 2005) and to fulfilling more important roles in global innovation networks (Ernst and Naughton, 2005). They also increasingly cater to the rapidly growing Chinese market. Furthermore, as a sign of developing domestic capacity, production and exports of Chinese ICT-producing firms are rapidly increasing in importance. In 2005 high-technology exports of national firms increased to about 12% of the total high-technology exports (MOFCOM, 2006a); a figure which is still low but rising.

China largely imports electronic components and exports computer and related equipment

China continues to import electronic components (65% of imports in 2004) while exporting computer and related equipment (46% of total exports in 2004) (Figure 4.2 and Figures 4.A1.1 and 4.A1.2). In 2004, China imported USD 42 billion worth of electronic components from OECD countries and exported USD 57 billion in computer and related equipment and USD 22 billion in audio and video equipment to OECD countries. In addition to satisfying local market demand, electronic components are used to assemble computer and related, audio and video, and telecommunications equipment (80% of total exports in 2004) as well as consumer electronics (*e.g.* MP3 players).

Figure 4.2. **China's trade balance by ICT goods categories, 1996-2004**

Current USD billions



Source: OECD, ITS database.

StatLink: http://dx.doi.org/10.1787/053604063426

China is thus still dependent on imports of the high-value components needed for the manufacture of ICTs. It has significant trade deficits in electronic components: a USD 50 billion deficit in integrated circuits (HS 8542) and a USD 7 billion deficit in semiconductors and components (HS 8541)[7] and smaller deficits in products such as audio and video parts (Table 4.1 shows the top five Chinese ICT import and export items). Foreign semiconductor suppliers have been the main beneficiaries of rising Chinese demand for integrated circuits from abroad (Chapter 2, PwC, 2004, 2005). China also has a trade deficit in large and medium-sized computers.

In return, China is increasingly the main export platform for final ICT products. Items for which China has the biggest trade surplus in ICT goods are computer and related equipment, with a USD 45 billion trade surplus in data processing machines (HS 8471, including laptops but excluding PC accessories), along with a very considerable increase in laptop exports since 2002, and substantial surpluses in video cameras and recorders, TV receivers and telephones.

While computer and related equipment continues to be the major export item, exports of audio and video and telecommunications equipment have also soared. The most striking aspect is the strong growth in exports of telecommunications equipment, which were negligible in 1996 but grew to USD 26 billion in 2004 (14% of total ICT exports), with the second biggest yearly growth rates from 1996 to 2004 (34%), a trade surplus in 2000 and exports growing by 76% from 2003 to 2004 (see also OECD, 2005c). Chinese imports of telecommunications equipment from Indonesia, Korea, Malaysia and other Asian regions have been growing at very substantial rates and falling from countries such as the United States, suggesting new Asian intra-regional trade in telecommunications equipment.

Electronic components form the second biggest Chinese export item despite rapid growth in imports of electronic components. However component imports are growing at a somewhat slower rate than growth of exports of computer and related equipment. This suggests the slow decoupling of component imports and equipment exports and may be a sign that production in China is moving up the value ladder (*e.g.* developing its own semiconductor production). But the cause might also be different price movements in *e.g.* semiconductors vs. laptops.

Table 4.1. **Top five Chinese ICT import and export items by 4-digit HS code, 2004**
Billions of USD

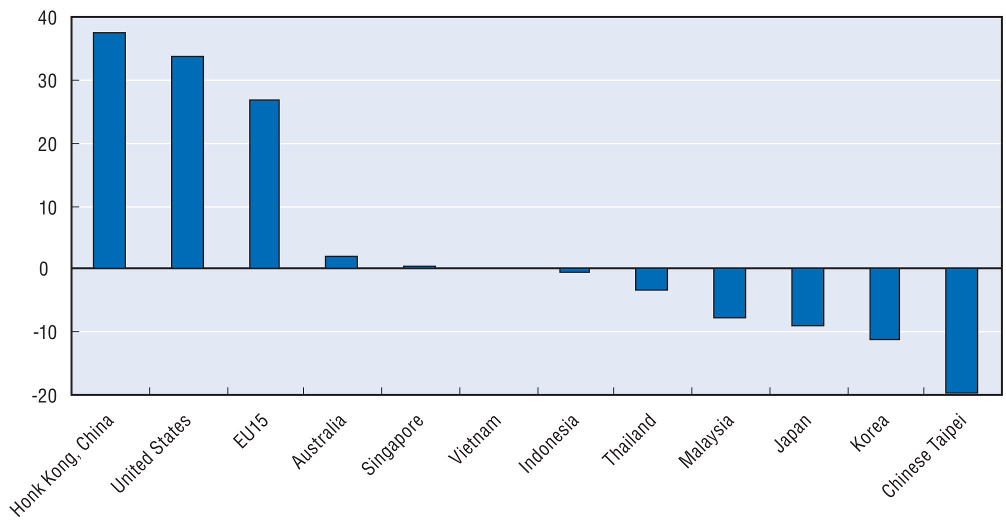
Main imports		Main exports	
8542 Integrated circuits	61.7	8471 Automatic data process machines, magnetic reader, etc., computer hardware	59.9
8471 Automatic data process machines, magnetic reader, etc. computer hardware)	14.5	8473 Parts, etc., for typewriters and other office machines, computer accessories	24.0
8473 Parts, etc., for typewriters and other office machines computer accessories	14.4	8525 Transmission apparatus for radio telephony/ telegraphy/broadcasting, television	21.8
8529 Parts for television, radio and radar apparatus	12.4	8529 Parts for television, radio and radar apparatus	12.0
8541 Semiconductor devices	9.8	8542 Integrated circuits	11.2

Source: OECD, ITS database.

Trade surpluses with the United States and the EU but deficits with Asian economies and increased Asian intra-industry trade

China had a trade deficit in ICT goods of USD 2 billion in 2001, but a significant trade surplus of USD 31 billion in 2004. In 2004 it had large surpluses with Hong Kong, China (henceforth, " Hong Kong") (USD 37 billion), the United States (USD 34 billion) and the EU15 (USD 27 billion) (Figure 4.3). The large surplus with Hong Kong underlines the significant

Figure 4.3. **China's trade balance in ICT goods, 2004**
Current USD billions



Note: In this graph the reporting country is China.
Source: OECD, ITS database. See endnote 3 and Box 4.1.

StatLink: http://dx.doi.org/10.1787/618331065530

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

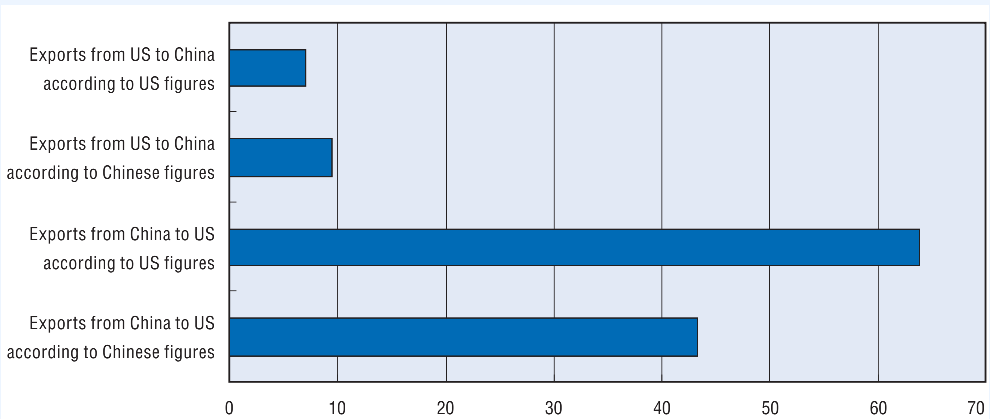
share of Chinese ICT exports that are transhipped before being delivered to their final destination (see Box 4.1), making Hong Kong one of the largest ICT exporters. Chinese exports to Hong Kong were up from USD 11 billion in 2000 to USD 41 billion in 2004, *i.e.* a little less than a quarter of all Chinese ICT goods exports.

Box 4.1. **Bilateral ICT trade data discrepancies**

There can be significant discrepancies in bilateral trade data; *i.e.* the importing trade partner reports different figures for imports from figures for exports reported by exporting trade partners (OECD, 2005d; Schindler and Becket, 2005, for China). This measurement problem is particularly acute in the case of Chinese bilateral ICT trade data. The fact that much of China's international ICT-related and other trade is transshipped through Hong Kong is a further contributor to this discrepancy relative to other countries.[1] Other reasons for the difference in reported trade figures are the distributed nature of assembly and final testing of ICT goods in third countries and transfer pricing of multinational enterprises for tax purposes, In general, this leads China to underestimate its ICT exports to other countries and to overestimate its ICT imports (and the reverse for its trade partners). Figure 4.4 shows bilateral trade data reported by the United States and China. Chinese figures for ICT exports to the United States for 2004 are 48% smaller than the value reported by the United States. Chinese figures for ICT imports from the United States are 35% larger than the value reported by the United States. This leads to the US trade balance deficit for ICT goods to be underestimated by China and overestimated by the United States, while the Chinese surplus would be lower according to China and higher according to the United States. In some cases, two countries report trade deficits with one another. This is the case for ICT goods trade between Japan and China. In reality, actual trade often lies between the two reported values.

Figure 4.4. **Bilateral ICT trade figures as reported by China and the United States for 2004**

USD billions



StatLink: *http://dx.doi.org/10.1787/173247330685*

1. For Hong Kong, for example, re-exports accounted for almost 98% of exports in 2003. In some cases, re-exports may also incorporate local value added (*e.g.* marketing).

Source: OECD, ITS database.

The United States-China trade relationship is characterised by a significant US trade deficit in computer and related equipment and a very small US surplus in electronic components. China is the single largest exporter of ICT goods to the United States, and its share of total US imports rose from 10% in 2000 to 27% in 2004, overtaking Japan as the biggest ICT exporter to the United States. The United States is very active in supplying China with high-value components, and integrated circuits and semiconductors account for the second largest items among US exports of manufactured products to China.[8] For a number of ICT-related products, exports of the United States to China are limited by export controls.[9]

In contrast, China's Asian trade deficits have increased with Chinese Taipei (USD 20 billion), Korea (USD 11 billion) and Japan (USD 6 billion), and its surplus with Indonesia has become a deficit. China also has a significant trade deficit in electronic components with Japan, Korea and Malaysia (Figures 4.3 and 4.5). Chinese ICT-related intermediate goods imports, especially electronic components, increasingly come from Asia, particularly from Chinese Taipei, but also Malaysia (see also Ando and Kimura, 2003[10]).

The main destinations for Chinese ICT exports are the United States (24% of total ICT exports), Hong Kong (23%), EU15 (20%) and Japan (10%), with Hong Kong losing its place as the main export destination (Figure 4.5). Again the regional shift in ICT trade is apparent in the increase in exports to Asia (Chinese Taipei, Korea, Singapore, Malaysia, Thailand, etc.). The major sources of China's ICT imports are Japan (18%), Chinese Taipei (16%), Korea (13%) and Malaysia (8%). The most notable shift is the falling share of imports from the EU15 and the United States.

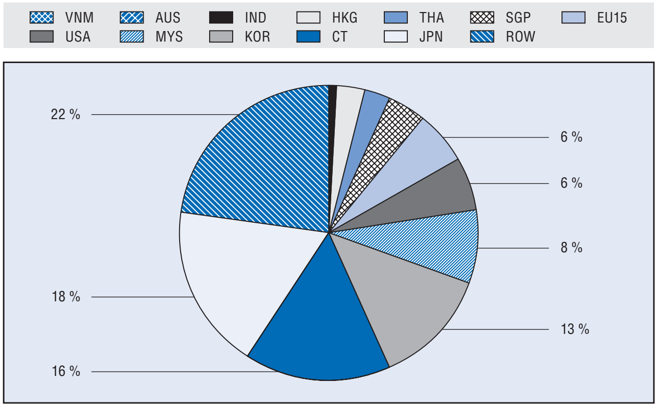
ICT-related manufacturing in Asia has grown over the past two decades, led first by Japan in the 1980s, by Korea and Chinese Taipei in 1990s, and now by China as other Asian countries find it increasingly difficult to compete with China, in particular for low-cost assembly. Chinese Taipei, for instance, was until recently the uncontested global centre for electronic products and PC/laptop design and assembly. Hon Hai Precision (Foxconn), Flextronics and Cellon from Chinese Taipei, for instance, are among the world's largest contract or original design manufacturers, and produce products for the leading global ICT firms. Recently, however, Chinese Taipei's and Hong Kong's ICT firms have migrated manufacturing to mainland China to reduce costs, thereby increasing China's ICT exports and making it the world's main production centre for IT equipment (Reed, 2005 and 2006).[11] In 2004, 80% of Chinese Taipei's notebook production was estimated to have been carried out in China (Yang, 2006). This significantly boosted China's IT production, with some sources suggesting a doubling between 2000 and 2003 (Reed, 2006).[12] While Chinese Taipei remains an important production centre for higher value-added ICT goods (*e.g.* semiconductors, flat panel displays), more technically complex activities such as design and testing tasks have also been partly shifted to China in recent years (Center for Strategic Supply Research CAPS, 2006; Yang, 2006). Accessing the pool of Chinese researchers and university graduates is increasingly the reason for Chinese Taipei IT firms to extend R&D activities to the Chinese mainland (Lu and Liu, 2004). Chinese Taipei and Japan also increasingly rely on the temporary immigration of Chinese ICT workers to cover domestic skills shortages.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

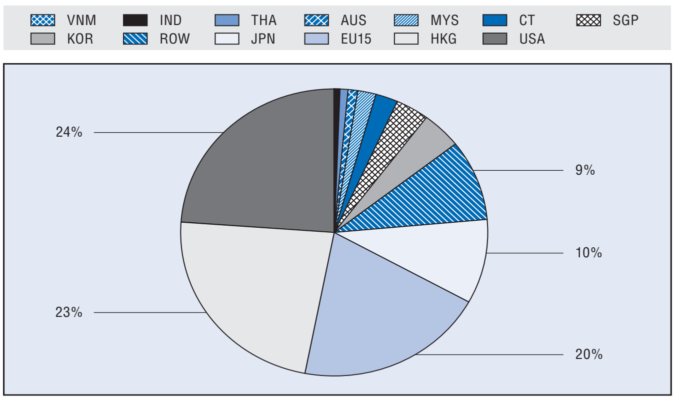
Figure 4.5. **China's ICT goods export and import destinations, 2004**

Percentage of total imports and exports

China imports in 2004



China exports in 2004



Note: VNM Vietnam, IND India, THA Thailand, AUS Australia, CT Chinese Taipei, KOR Korea, SGP Singapore, JPN Japan, ROW Rest of World, EU European Union, HKG Hong Kong, USA United States of America.
Source: OECD, ITS database.

StatLink: http://dx.doi.org/10.1787/474715138555

China's role as Japan's low-cost base for export production has also substantially grown with more complex stages of production moving to China (JETRO, 2005a) and Asia itself becoming an integrated ICT production platform. Japan is exporting more and more intermediate ICT products to China and, through assembly for Japanese-affiliated electrical machinery and IT firms, contributing to high Chinese export figures to Europe and the United States (JETRO, 2005b). China became the third biggest importer of ICT products from Japan in 2004, overtaking Chinese Taipei, Hong Kong, Singapore and Korea. For its part, Japan is increasingly importing final ICT products from China, which overtook Chinese Taipei and the United States as the largest ICT exporter to Japan between 2000 and 2004. The share of Japanese ICT imports from China rose from 11% of total ICT imports in 2000 to 30% in 2004[13] as the share of Japanese ICT imports from the United States fell from 25% in 2000 to 15% in 2004, underscoring the new importance of intra-regional Asian ICT trade. However, available information indicates that Korean ICT firms continue to focus on manufacturing domestically (Reed, 2006).

Strong upward trend in Chinese ICT goods exports and imports continues in 2005 and early 2006

Although OECD trade data for 2005 for ICT goods is not yet available, the Chinese Monthly Customs Statistics for January to December 2005 and the first two months of 2006 show a continued strong upward trend for ICT-related imports and exports. China's growing ICT trade in 2005 was bolstered by its elimination of tariffs on ICT products in January 2005 following its obligations under the WTO's Information Technology Agreement. While only complete data for 2005 will allow for thorough analysis, the adjustments in July 2005, with revaluation of the Chinese CNY by about 2% against the USD, do not seem to have significantly affected Chinese ICT exports. According to MOFCOM, China's exports of computer products in 2005 amounted to USD 104.8 billion. Exports of telecommunication in 2005 amounted to USD 72.3 billion (up by 37.8% from 2004) and exports of electronic products to USD 24.5 billion (up by 32.7% from 2004) (MOFCOM, 2006b, 2006c, 2006d).[14] This trend has continued in the first two months of 2006, led by mobile phones and ICT goods mostly manufactured with imported integrated circuits.[15] While growth in Chinese imports of all goods was nearly halved to 11.5% from 2004 to 2005, its imports of computers, telecommunication equipment and electrical machinery continued to rise significantly (WTO, 2006).

Inward and outward ICT-related FDI is growing

China's inward investment flow for 2005 is officially recorded as USD 72 billion in foreign direct investment (FDI) (OECD, 2006b and MOFCOM, 2006e) – compared to an estimated USD 165 billion in the United Kingdom, USD 3 billion in Japan and USD 6.6 billion in India - raising China's total FDI stock to about USD 260 billion. Much of the FDI is driven by ICT-related investments, which have been crucial to the growth in Chinese exports of ICT, and has been greatly facilitated by China's accession to the WTO in 2004 (in particular also in the area of telecommunication and Internet services). ICT companies have strengthened their investment portfolios in China through acquisitions and formation of joint ventures. In 2005, there were almost 3 000 instances of new FDI inflows with a contractual value of about USD 21 billion in the telecommunications equipment, computers and other electronic equipment sector (OECD, 2006a, based on MOFCOM FDI statistics). This openness to foreign ICT-related investment is in contrast to the situation in Japan or Korea when these OECD countries were at a comparable level of ICT industry development in the 1980s and 1990s, respectively. Furthermore, China is considered not only a production site but also an opportunity for market and revenue growth to compensate for revenue declines in more traditional markets such as Japan and Germany.

ICT-related firms from Chinese Taipei and the United States are among the top 100 firms investing in China in 2003, and Hon Hai Precision (Foxconn) is also one of the OECD's top 50 ICT companies (Table 4.2, and Chapter 1). According to data from the Ministry of Information Industry, ICT-related FDI remained strong in 2005 with Dell, Hewlett Packard, Motorola and Nokia leading.[16] China encourages these inflows by providing tax rebates and other financial incentives to foreign investors.[17]

Available data point to an increase in the production of communication equipment, computers and other electronic equipment by firms with direct investment in China. As Table 4.3 shows, in 2004 there were 3 384 ICT goods firms from abroad, and these accounted for 21% of total assets in this sector, 30% of total revenue, 20% of profits and 16% of employees. All figures, including the number of employees of ICT firms with direct investment (2.3 million

Table 4.2. **Eight ICT firms among top ten enterprises from abroad in China, by 2003 revenue**

Rank of ICT firms among top ten foreign firms	Name of firm	Country of origin	Revenue in China, USD billions
1	Hon Hai Precision (Foxconn)	Chinese Taipei	6.4
2	Tech-Front Computer	Chinese Taipei	5.2
4	Motorola Electronics	United States	3.0
5	Great Wall International Information Products Fubao	China/United States (Joint Venture between Chinese firm and IBM)	2.6
6	Dell Computer	United States	1.7
7	Benq Corp	Chinese Taipei	1.7
8	Intel Technology	United States	1.5
9	Seagate Technology	United States	1.5

Source: MOFCOM (2004) and MOFCOM (2003). Eight of the top ten investors were ICT firms. Great Wall is now part of Lenovo.

in 2004) increased from 2003 to 2004, including when shown as a share of total foreign investment in all sectors. Still, mainly due to issues relating to intellectual property rights, some global ICT firms hesitate to move high-end ICT goods production to China.

Table 4.3. **Main indicators for foreign funded communication equipment, computers and other electronic equipment enterprises in China, 2003 and 2004**

USD millions

	Number of firms	Total assets USD millions	Revenue USD millions	Profits USD millions	Number of employees (in million persons)
	2003				
Communication equipment, Computers and other electronic equipment	2 937	95 563			
		5 545	1.8		
Share of national total of enterprises from abroad		19%		16%	14%
	2004				
Communication equipment, Computers and other electronic equipment	3 384	126 918	21 975	8 604	2.3
Share of national total enterprises from abroad		21%	30%	20%	16%

Source: *China Statistical Yearbook*, 2004 and 2005.

StatLink: http://dx.doi.org/10.1787/316857556617

While detailled figures are hard to obtain, most Chinese sources show that FDI in services is increasing, with FDI in the telecommunication and information technology services sector (including computer services and software) growing fast from a low base (*China Statistical Yearbook*, 2005; MOFCOM, 2006e; OECD, 2006b). However, both in general and in the ICT industry, manufacturing plays a relatively large role, while that of the services sector is relatively small.

US majority-owned foreign affiliates in the ICT sector

Foreign affiliates of ICT firms are very active in China, increasingly also in the service sector. While comprehensive sector-specific data on global FDI in the ICT sector are not available, data on the activities of United States majority-owned foreign affiliates (MOFAs)[18] can be used to shed some light on US ICT investments in China (see also Mann and Kirkegaard, 2006). The North American Industry Classification System (NAICS) categories surveyed by the Bureau of Economic Analysis for IT goods are Computers and electronic products and, for ICT services and telecommunications, Information (a broad category relating to the production, transmission or processing of information including software publishing, Internet service providers, IT services and telecommunications but also broadcasting, publishing and the motion picture industries).

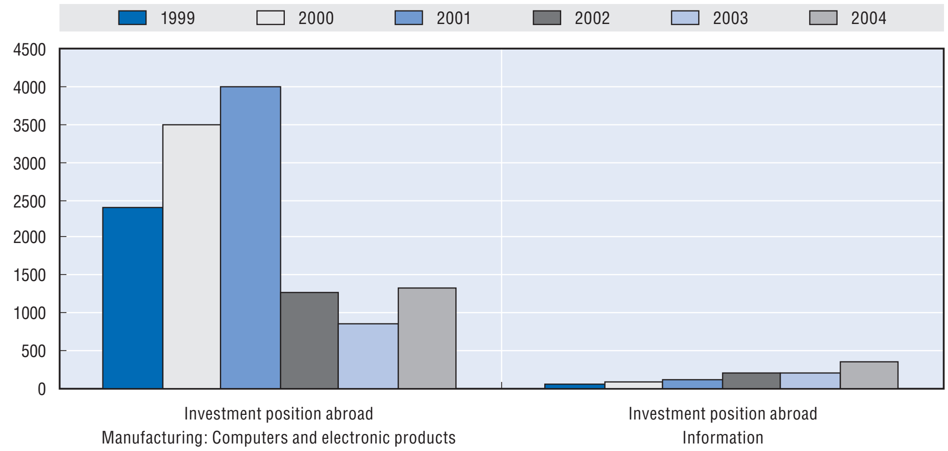
Although investment in the ICT services sector is growing fast, the vast majority of investment and employment of US MOFAs is in ICT goods manufacturing (Figure 4.6). In computer and electronic products, the investment position[19] abroad (stock based on current costs and on market valuations) increased rapidly to USD 3.9 billion in 2001, fell between 2001 and 2003 and started growing again between 2003 and 2004 to reach USD 1.3 billion. The contraction from 1999 and 2003 can partly be explained by changes in valuation rather than actual disinvestment. Moreover, most of the actual production and assembly in China is often outsourced by United States ICT firms to contract manufacturers elsewhere (*e.g.* Chinese Taipei, Singapore), a phenomenon that is not captured in this FDI data. US affiliate employment in the computer and electronic products sector was quite stable between 1999 and 2003, at around 71 000 employees (12% of MOFAs' global employment in computer and electronic products, a share far larger than those of Malaysia, Singapore or Japan). Employment in this sector represents 21% of total MOFA employment in China across all sectors.

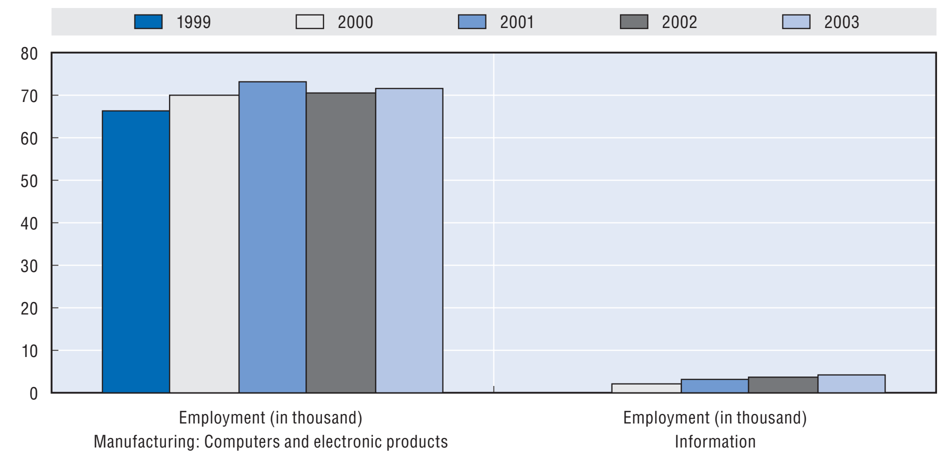
In terms of value added of US MOFAs in the ICT sector, China accounted for USD 2.1 billion in 2003, about the same level as Japan or Malaysia, and the ICT sector accounted for roughly 25% of MOFAs' total value added in China. Value added per employee of US MOFAs in the computer and electronic product sector in 2003, however, is lower than for US MOFAs in the same sector in Canada, Europe, Singapore or Japan. This may reflect the absence of high value-added activities such as the production or design of advanced components. However, value added per employee in this sector steadily increased in China between 1999 and 2003. In 2003, the ratio of value added to sales for US MOFAs in the computer and electronic product sector in China was 11%, compared to 20% for US MOFAs in the same sector in Japan and above 20% for US MOFAs in most western European countries (OECD based on BEA data).

Among affiliates in the NAICS Information category (used here as a proxy for ICT services), growth from a very low base has been very fast since 1999, reaching USD 368 million in 2004 (roughly 10% of value for computer manufacturing FDI).[20] In terms of value added, compared to MOFAs' value added in other sectors in China or China's share in MOFAs' global value added, the Information category is marginal. MOFA employment in this sector has also increased steadily from low starting values in 1999 and reached 4 300 employees in 2003 (roughly 6% of MOFAs' China-based employment in computer manufacturing), again very marginal compared to other MOFA sectors in China or to global MOFA employment in this sector.

Figure 4.6. **US majority-owned foreign affiliates in the computer and electronic product and information sector in China, 1999-2003/04**

Investment position on a historical cost basis (USD millions) and employment (thousands)





Source: OECD based on data from the United States Bureau of Economic Analysis.

StatLink: http://dx.doi.org/10.1787/868603363028

R&D-related FDI in China

The activity of foreign affiliates of global ICT firms in China does not stop at product assembly. Hard numbers on R&D-related FDI in China by ICT firms are not readily available.[21] However, several sources confirm the presence in China of an increasing number of R&D units, mainly from Europe, the United States and Chinese Taipei and generally in the computer, communications, electronics, chemical and automobile industry (see Chapter 2; Walsh, 2003, 2005; MOFCOM, 2006f). Total US R&D expenditures by MOFAs in China rose exponentially from USD 7 million in 1994 to over USD 565 million in 2003 and to fourth place in US overseas R&D investments (based on data from the Bureau of Economic Analysis). According to Chinese statistics, there were over 750 direct-invested R&D centres in China at the start of 2006 (MOFCOM, 2006f), mainly in Shanghai, Shenzhen and Beijing, and the numbers are increasing. Out of 466 foreign R&D centres in China listed by the Global R&D Management Centre at Tsinghua University, 52% were established by companies in the ICT industry (Zedtwitz, 2006). Because of the large presence of multinationals China has a high level of foreign ownership of domestic inventions (share of foreign-owned patents) compared with large OECD countries. Between 1999 and 2001, around half of Chinese ICT-related patents filed with the European Patent Office included inventors from other countries (OECD, 2005e).

In 2005, many ICT firms announced or completed the creation of R&D laboratories in China, among them Google, Cisco, Motorola, as well as Indian software and ICT services firms such as Infosys and Satyam Computer Services. Table 4.4 provides some examples of Chinese R&D operations of global ICT firms, many of which also engage in collaborative university research programmes.

Table 4.4. **Examples of foreign ICT-related R&D centres in China, 2005**

Company	Number of centres and researchers	Research
Alcatel (France)	Two R&D centres (Shanghai and Chengdu) with several hundred researchers. Cooperation with Chinese universities and research institutes	Next-generation communications solutions (4G, next-generation networks, triple play and optical transmission technologies)
Lucent (US)	Four Lucent China units, two Bell Labs branches and six joint Bell Labs laboratories with Chinese state entities	All-optical networks, next-generation internet IPv6, wireless communications, interoperability testing of integrated communication and software systems, 3G technologies including Code Division Multiple Access (CDMA)
Ericsson (Sweden)	One R&D institute with five R&D centres, the Ericsson China Academy in Beijing and one joint unit with Panda Communications Company (about 450 researchers)	Product development covering all network standards, overall technology management, 3G technical trials, standardisation/regulation, research and patent licensing
Intel (US)	Four R&D centres, engagement with over ten Chinese universities on joint projects (about 70 researchers)	Next-generation wired and wireless communication technologies, key technologies for future microprocessors and platforms, world-class platform technologies, chipsets and platform products, natural interfaces
Microsoft (US)	One centre, engagement with Chinese universities on joint labs and the University Relations programme (over 180 researchers)	Next-generation user interface, next-generation multimedia technologies, digital entertainment, wireless and networking technologies, Web search and data mining
SAP (Germany)	One centre (about 400 researchers)	Small and midsize businesses, SAP best practices, Linux solutions, supply chain management

Source: Company annual reports and press releases (latest update April 2006). Lucent and Alcatel announced their merger in March 2006.

At present, market-driven or adaptive R&D to support local production and sales appears to predominate for foreign as well as domestic companies (MOFCOM, 2005b)[22] with R&D intensity relative lower for foreign-owned firms (Motohashi, 2006). However, there is a shift towards research initiatives that tap the local pool of skills and knowledge among university-educated scientists and engineers, especially in regions with clusters of scientific institutions, Chinese universities and a large industrial base, such as Shanghai or Beijing (see Table 4.4) based on annual reports and MOFCOM, 2006f). The rise in Chinese graduates in science and engineering and increased Chinese funding for R&D (also as a share of GDP), especially in the areas of software and ICT services, is also attractive for foreign ICT firms. The speed of this development will mainly be determined by the Chinese science and technology base, the competitiveness of OECD economies in this respect and by how safe global ICT firms feel about transferring research and high-end ICT production to China without concerns for their intellectual property rights or technological imitations by Chinese firms.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Outward Chinese FDI: The "go-out" strategy

The Chinese government has recently begun to encourage Chinese companies to invest overseas (including mergers and acquisitions and conducting R&D abroad) to gain technology, brands and distribution channels. The "go-out" strategy encourages this through relaxed controls on overseas investment by releasing sector restrictions, abolishing the foreign exchange self-sufficiency requirements, and streamlining approval procedures (see OECD, 2006a, for a detailed assessment of these new FDI policies and calls for further reforms).

China's outward investment flow for 2005 is officially recorded as USD 7 billion, including reinvested earnings, with new equity investments at about USD 4.1 billion (MOFCOM, 2006g). This is about 10% of inward investment into China and still small as a percentage of global outward direct investment. Accumulated Chinese outward FDI reached more than USD 60 billion in 2005, about 24% of the stock of inbound investment, the majority of which went to Asian countries (MOFCOM, 2006e, 2006g; OECD, 2006a).[23]

While historically most Chinese FDI focused on natural resources – mostly mining and extraction and other purchases intended to secure supplies of raw materials for Chinese manufacturers – there is a shift to acquisitions of manufacturers with expertise in high-technology and market share abroad. In 2005 China's overseas direct investment was USD 1.2 billion in the manufacturing sector (including ICT-related firms), accounting for 29% of total equity investment, and USD 1.1 billion in the ICT services sector (Information transmission, computer services and software), accounting for 26.3% of total equity investment. The most visible signs of this trend in the past two years have been the merger of the Chinese electronics conglomerate TCL's television business with the TV business of France-based Thomson in 2004, Lenovo's acquisition of IBM's PC business in 2005, Alibaba's stake in Yahoo!China in return for Yahoo!'s purchase of approximately 46% of outstanding Alibaba stock in 2005, and Huawei's attempt to buy Marconi (telecommunications and information technology equipment and services) which Ericsson then took over in late 2005. In an interesting trend, Chinese ICT firms such as TCL, Lenovo, Huawei, ZTE are also extending their presence in central European countries, potentially using these countries as a low-cost access point to the European Union market while establishing "customising" or commercial centres in countries such as Hungary which are geographically well-placed as natural hubs.[24]

Chinese ICT firms are now also operating research units abroad, with some companies with firmly established global R&D networks, such as ZTE, Huawei (with, for instance, one centre in Bangalore, India, with more than 500 employees), and Haier, and others with small-scale research units in other countries that focus on technology monitoring and adapting products for local markets (Zedwitz, 2005).

The ICT supply side in China

Rapid increase in the production of ICT goods

The production of computers, integrated circuits and mobile telephones – mostly by foreign firms and for export – has increased dramatically since 1995 (Table 4.5) and exceeds the production levels of most OECD countries (Dedrick *et al.*, 2004; Huang and Qiao, 2005). Estimates show that China produced 81 million computers in 2005 (with a CAGR for 1998-2004 of 61%), of which 45.7 million were laptops, 21 billion integrated circuits in 2004 (CAGR 1998-2004, 42%), and 303 million mobile phones in 2005 (with a CAGR for 2000-04 of 45%). China's mobile phone output is expected to attain 340 million units in 2006, of which 250 million to be exported mainly by foreign-invested companies.[25] The increased production of computers and mobile phones by foreign and domestic firms in China has had a downward effect on local prices.

Table 4.5. **Chinese production of integrated circuits, micro-computers and mobile phones**

	Integrated circuits (billion units)	Micro- computers (million units)	Mobile telephone (million units)
2000	5.9	6.7	52.5
2001	6.4	8.8	80.3
2002	9.6	14.6	121.5
2003	14.8	32.1	182.3
2004	21.1	45.1	233.5
2005		80.8	303.7

Source: China Statistical Yearbook 1996-2005 and data releases from the Ministry of Information Industry (figures rounded).

StatLink: http://dx.doi.org/10.1787/302510383718

For integrated circuits, production is increasing steadily as more semiconductor plant capacity migrates to China. As of August 2004, more than a dozen foundries were operating in China and generated an approximate USD 1.5 billion in revenue in 2004 (PwC, 2004, 2005). Often noted is the appeal of the low cost of labour in many parts of China, but another equally important factor has been the previous migration of electronics production to China and the associated need for semiconductor suppliers to be close to customers such as original equipment manufacturers (OEM). Attractive tax, loan and land incentives are also cited as important.

However, as opposed to PC and mobile phone production and as reflected by the import data, the gap between China's domestic demand for and production of integrated circuits continues to increase despite the influx of foreign producers. At present, China's domestic manufacturers meet less than 5% of domestic demand (Semiconductor Manufacturing International Corporation, Annual Report 2005)[26] and domestic companies remain weak in chip designs based on own intellectual property rights (Analysys International, 2005; IFC, 2005). Also, Chinese firms still represent a small share of world production. Nearly all of the top 50 semiconductor companies by sales in 2004 were from the United States, Japan, Europe, Korea and Chinese Taipei.[27] However, Chinese semiconductor foundries are catching up; for example, the Semiconductor Manufacturing International Corporation with origins in Chinese Taipei had revenues of USD 648 million in 2005, with part of its sales going to North America and Europe.

Finally, China has become a major producer of telecommunication equipment (including mobile and optical telecommunications equipment), with increasing exports in this product category.

Value added of the Chinese ICT industry and the contribution of IT to economic growth

According to Chinese figures, value added of what Chinese data defines as the "information industry" (including electronics and IT goods) reached some USD 118 billion in 2004 (an increase of around 30% from 2003) and constituted 7.5% of GDP. The electronics

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

and information industry accounted for USD 71 billion and the communications industry for USD 47 billion (MII, 2005). While value added for communication services in the Chinese economy cannot be broken out, the value for post and telecommunication increased very rapidly from USD 13.6 billion in 1997 to USD 40.1 billion in 2003, and represented around 8% of value added in the services industry, up from 5% in 1997 (*China Statistical Yearbook,* 2005). The services industry accounted for about 32% of total value added in 2004, compared to about 70% in most OECD countries. Chinese ICT employment statistics for ICT hardware and services were not available in official Chinese sources (OECD, 2005b).

ICTs are shown to have already contributed to China's economic growth. For the period 1995-2003, it is estimated that ICTs contributed 0.63 percentage points to annual GDP growth (Jorgenson and Vu, 2005). While this figure is higher than average and above the contribution of ICTs to OECD economies such as France and Germany, it is still relatively low compared to China's average annual growth of 10%. Owing to the relatively low stock and use of ICTs in China, there is significant potential for further stimulating growth in China through additional ICT investment and use.

Rise of Chinese ICT firms: becoming global players?

Private ownership has increased substantially in the Chinese economy, and private firms now produce well over half of GDP and an overwhelming share of exports and new jobs (OECD, 2005a). Chinese ICT firms are now mainly privately held, as opposed to state-controlled, are often listed on the Hong Kong Stock Exchange and are internationally active. Still by 2006, most Chinese ICT firms are still small, in terms of revenue and employment, when compared to the most important global ICT firms (see Table 1.A2.1 in Chapter 1, which shows that only China Telecom is among the top 250 ICT firms ranked by revenue). According to the Ministry of Information Industry, large technological and management gaps between Chinese and foreign firms, weak innovative capabilities, too much reliance on foreign technology, and trade barriers are responsible for this situation.[28] A major challenge is to move from essentially "hosting" low-cost third-party manufacturers of foreign countries to developing Chinese providers of higher value-added products and recognised global brands. Access to (venture) capital is also a problem for Chinese ICT firms.

Despite the quasi-absence of Chinese ICT firms in the top 250 classification and these problems, the Chinese ICT industry landscape is changing rapidly, owing to the improved production and export capacities of ICT hardware firms of Chinese origin and an increasing number of ICT-related Chinese SMEs. Examples of Chinese ICT leaders include semiconductor companies (*e.g.* Semiconductor Manufacturing International), telecommunication equipment manufacturers (*e.g.* Huawei, ZTE Corporation) and Internet portals (*e.g.* Baidu, Alibaba/eBay partnership). This rise of Chinese ICT firms and their potential for becoming global players over the next decade is confirmed by a recent study which finds that among the few Chinese firms with strong globalisation potential a large share from the selected top 15 firms comes from ICT- and electronics-related sectors (IBM Institute for Business Value, 2006), and there have been recent purchases by Chinese firms of OECD-area ICT or consumer electronics/household equipment firms. Still, like Korean ICT firms in the 1990s (*e.g.* Samsung), Chinese companies will need to develop technological know-how, global brands and management skills.

Chinese national champions in IT and electronics

Table 4.6 presents the top ten Chinese providers of electronic products ranked by 2005 revenue and shows that TCL, Lenovo (formerly Legend Holdings), Huawei and ZTE are China's leaders in ICT goods. These companies operate internationally and have significant exports (MOFCOM, 2006h) while building an international presence based on their market strength in China.

Table 4.6. **Top 10 Chinese electronic product providers in 2005**

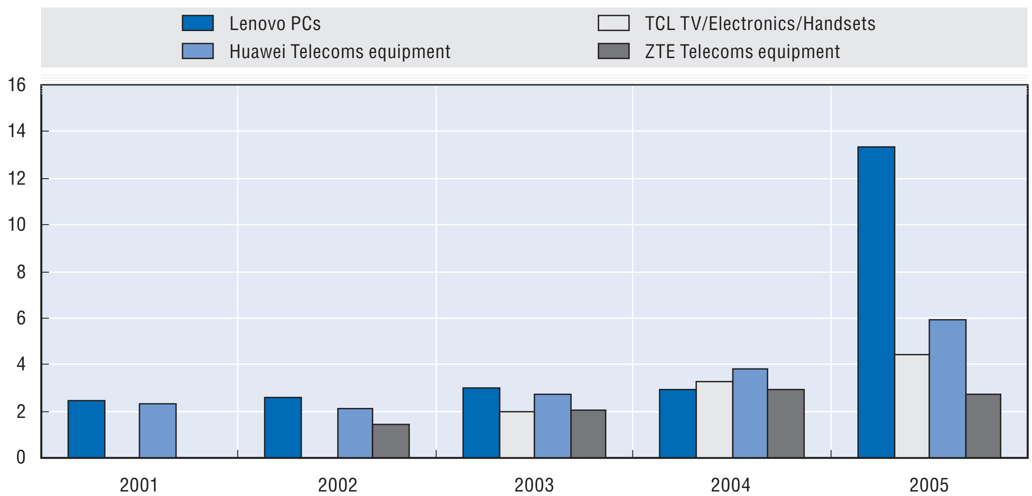
1. Haier Group	Consumer electronics, electronics, telecom equipments (handsets), and IT equipment (computers)
2. BOE Technology Group Co., Ltd.	Electronics and audiovisual products (monitors, TV)
3. TCL	Electronics, telecom equipments (handsets) and audiovisual products (TV)
4. Lenovo/Legend	IT equipment (PCs and notebooks)
5. Shanghai Video and Audio Electronics	Audiovisual products, IT/telecoms equipment
6. Huawei Technologies Co., Ltd.	Telecoms equipment
7. Midea Holding Co., Ltd	Consumer electronics
8. Panda Electronics Group Company	Consumer electronics and Telecoms equipment
9. Hisense Group	Consumer electronics, Audiovisual products (TV), IT/telecoms equipment
10. ZTE Corporation	Telecoms equipment

Source: Ministry of Information Industry (2006b).

Figure 4.7 shows revenue figures for the four major Chinese ICT firms. While ZTE's, TCL's and Huawei's annual revenue generally increased from 2000 to 2005, Lenovo's revenues decreased between 2003 and 2004 and picked up again in 2005.

Figure 4.7. **Revenue of selected Chinese ICT firms, 2000-04**

USD millions



Source: Company annual reports. Lenovo's annual revenue figures are provided from March to March (for 2004: from March 2004 to March 2005).

StatLink: http://dx.doi.org/10.1787/8504388637286

As a point of comparison, Lenovo's revenue was USD 2.9 billion in 2004 while Hewlett Packard had revenue of USD 80 billion and Dell of USD 41 billion (see Chapter 1, Table 1.A.8). After the takeover of IBM's loss-making PC unit, Lenovo more than quadrupled its annual revenue (USD 13.3 billion in 2005) and it now has about 21 000 employees, sales representations worldwide and a first quarter 2006 world market share for PC shipments of about 3.5% (as compared to 32.3% for Dell, 19.9% for Hewlett Packard). TCL, with annual revenue of USD 4.4 billion in 2005, has also been active in terms of international expansion through the purchase of Thomson's TV business and the joint venture with Alcatel (mobile handsets) in France. However, following these acquisitions both Lenovo and TCL experienced revenue losses and restructuring.

The 2005 revenue for Huawei Technologies (USD 5.9 billion) and ZTE (USD 2.7 billion) contrast with 2005 revenue for telecom equipment manufacturers such as Cisco (USD 24.8 billion) or Alcatel (USD 15.1 billion) (see Chapter 1, Table 1.A1.1). Huawei's overseas sales are significant and growing rapidly. Initially, Huawei, China's largest telecommunication and networking equipment manufacturer, concentrated on exports to developing countries, but it is establishing more and more sales offices in OECD countries. Over 3 000 of the group's 24 000 employees are overseas nationals, and 58% of its 2005 revenue were generated outside China. In addition to selling to Africa and South Asia, ZTE increased operations and sales in eastern Europe and in Central and South America.

Chinese software industry revenue and exports

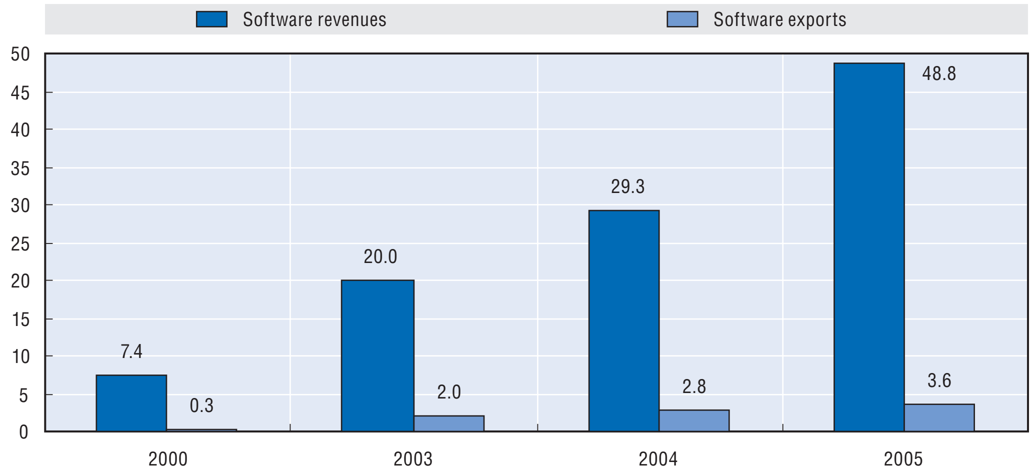
It is generally agreed that the Chinese software industry is small compared with its ICT hardware industry and less developed than software industries in other countries (*e.g.* India). Problems associated with the Chinese software industry, as perceived by the Chinese government, are a weak industrial base, lack of international competitiveness and thus few exports, which are mainly to Japan and Korea. Weak protection of intellectual property rights can also be a bottleneck to the development of the software industry in China. Further development of this industry is, however, a declared Chinese government policy objective.[29] High domestic demand, Chinese government procurement policies, improvements in the local skill base and the protection of intellectual property rights will foster this trend.

Figures on Chinese software industry revenue (both exports and domestic products) and exports vary widely, seem high or are not available from official sources. Figure 4.8 shows Chinese software industry revenue and exports based on data releases from the Ministry of Information Industry and the Chinese Software Industry Association. According to these sources, the revenue of China's software industry reached roughly USD 49 billion in 2005, a rise of 40.3% from 2004. According to official figures, growth in the software industry was higher, by 16.7%, than growth in the ICT industry as a whole. Foreign software producers (notably Microsoft, IBM, Oracle and Sybase) are said to have accounted for 65% of China's software market in 2004.[30] Still, the figure of USD 49 billion seems high compared to total revenue of USD 84 billion for the world's top ten software companies (see Chapter 1, Table 1.A1.5) and must be used with care.

The top five domestic software firms with sizeable and mostly growing revenues from 2001 to 2004 are the Shengyang Neusoft (revenues of USD 204 million in 2004), UFSoft (revenues of USD 119 million in 2004), Kingdee International Software Group (revenues of USD 56 million in 2004), China National Computer Software and Technology Service Corporation (comparable figures not available) and Langchao Universal Software (comparable figures not available). While not generally known, ZTE and Huawei are also very active in software production. Even though the top five Chinese software firms increasingly have a presence abroad (*e.g.* Neusoft in Japan and the United States), their

Figure 4.8. **Chinese software revenue and exports**

USD billions



Source: OECD based on data releases from Ministry of Information Industry and Chinese Software Industry Association.

StatLink: http://dx.doi.org/10.1787/542548714673

revenues are almost negligible when contrasted to leading international software producers (Table 1.A1.5 in Chapter 1) and small when compared to revenues of Indian software producers Tata Consulting Systems and Infosys (both about USD 2 billion in revenues in 2004).

China's total software exports reached USD 3.6 billion, a rise of 28.2% year-on-year. Compared with other ICT sectors, the Chinese software industry is not very export-intensive and is much smaller than its Indian counterpart, mainly because foreign software firms in China produce for the local market. While Chinese software outsourcing services are still relatively small and mostly focused on Japan, this market is expected to grow rapidly (IDC, 2006). According to the Chinese Software Industry Association, China has already become the largest overseas software outsourcing base for Japan.[31]

China is reported to have a dynamic open-source software (OSS) market, with the Chinese government actively supporting non-proprietary software (for example, with the establishment of government-backed Red Flag Linux). In spite of significant media coverage, reliable information on this phenomenon is hard to obtain, but industry sources point to the comparatively high level of penetration of OSS deployment in China (Kshetri, 2005). On the supply side, well-known international Linux vendors such as Novell and Red Hat but also other OSS players such as Hewlett Packard, Intel, Sun, and Oracle are active in China with Linux sales now reaching significant levels. Reported open source software clients are government or government-backed entities, such as the People's Bank of China.

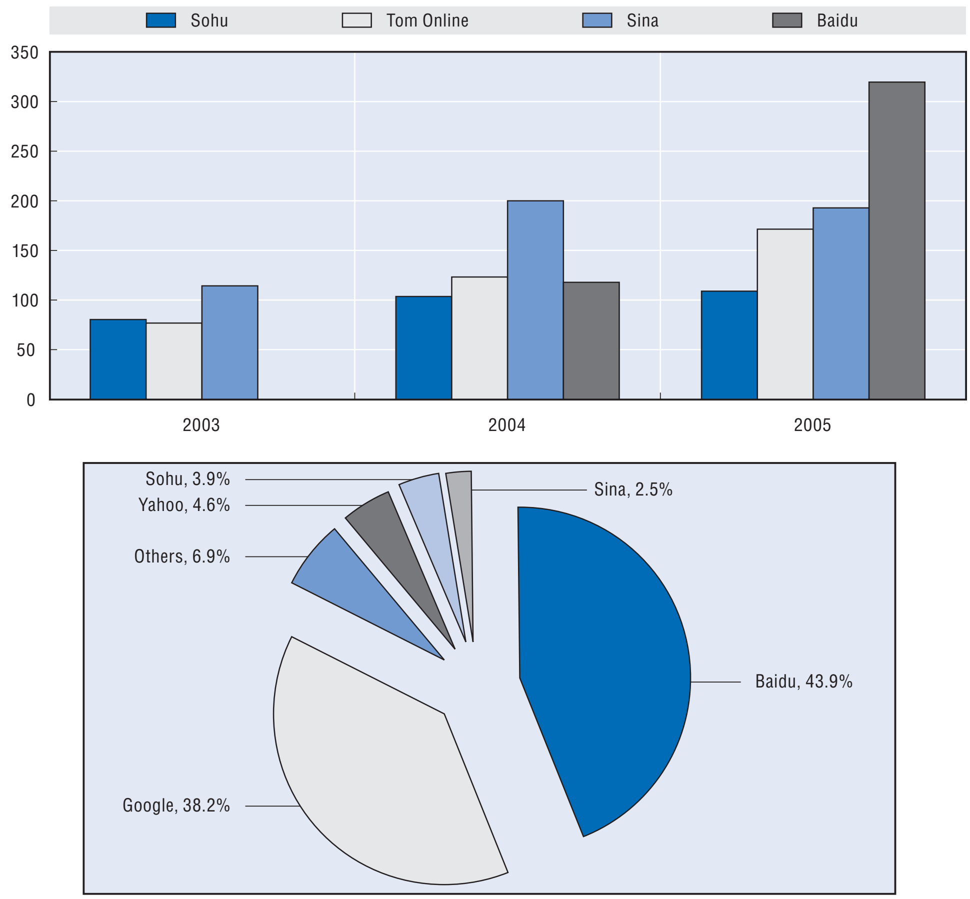
According to international software producers, the use of pirated software products in China leads to significant revenue losses. In an attempt to curb software piracy, in April 2006 the Chinese government has pledged to ensure that PCs are sold with pre-installed, officially acquired software.

Growing importance of Chinese Internet companies

The Chinese Internet market is expanding rapidly. Owing to lower technological entry barriers than in ICT goods manufacturing or ICT services, a significant number of Chinese Internet companies now compete very effectively against foreign Internet firms in China. Whereas Internet revenues are still relatively small as compared to the potential user base, large Chinese Internet firms have emerged. Some are listed on NASDAQ and they are beginning to report revenue increases and profits (CASS, 2006; Morgan Stanley, 2005). Online auctions and person-to-person commerce (through sites such as eBay, Taobao.com and Alibaba.com) are very popular.

In Figure 4.9, the upper panel charts the revenue of China's leading Internet companies and shows revenues generally increasing, some very rapidly. But these revenues are still small compared to those of OECD-area Internet firms. Whereas Baidu, the largest revenue generator in 2005, had about USD 320 million in revenue, the figure for Google is USD 6.1 billion and for Yahoo USD 5.3 billion (*i.e.* roughly 20 times bigger). In addition to the lesser Internet penetration and development, this is due to the mainly national focus of Chinese Internet companies. In terms of market share in China, however, they compete

Figure 4.9. **Chinese Internet firm revenue, 2003-2005 (above) and search engine market share in Beijing, 2005 (below)**



Source: Annual reports (upper panel) and China Internet Network Information Centre (CNNIC) (lower panel).

StatLink: http://dx.doi.org/10.1787/827681366000

vigorously with OECD-area Internet firms; for example, Baidu has a larger market share than Google in cities like Beijing (see Figure 4.9, lower panel) and Taobao.com a larger market share overall in China than eBay.[32]

Other noteworthy Chinese Internet firms include Dangdang (online book seller) and joyo.com, which are the leading electronic commerce sites (comparable to Amazon.com, which acquired joyo.com in 2005), and Taobao.com, which is a consumer-to-consumer electronic commerce and online auction site (comparable to eBay). Alibaba, now in a strategic partnership with Yahoo!, operates a large online business-to-business marketplace for both international and domestic trade (with a particular focus on SMEs), as well as a new online payment system.

Current and future Chinese ICT supply-side policies

The Chinese government has been encouraging the ICT supply side since the early 1980s by seeking to enhance the infrastructure, foster innovation (promotion of R&D, support for the development of domestic ICT firms), and encourage trade and FDI (Dedrick *et al.*, 2004).[33] These supply-side policies focused mostly on the development of the ICT goods manufacturing industry. Two recent Chinese policy plans – the 11th Five-Year National Plan for 2006-2011, deliberated by the Fourth Plenary Session of the 10th National People's Congress in March 2006,[34] and the State's Medium- and Long-term Development Plan of Science and Technology – lay the ground for Chinese ICT policy for the period 2006-10. In the area of ICT, the earlier focus on the supply side is maintained. However, future Chinese ICT supply-side policies will have the following new priorities.

- *Accelerating structural change in the domestic information industry.* The Chinese government is aware of the need to accelerate structural change in the domestic information industry and move away from pure ICT hardware assembly and production towards higher value-added ICT manufacturing, software (*e.g.* embedded software, middleware, information security products), ICT services (value-added network services, 3-G mobile communications), and information services.
- *Creation of national ICT champions to compete on global markets and abroad.* While China continues to promote openness to foreign firms and investment in the national ICT industry, there is also an explicit policy objective to encourage the development of Chinese ICT multinationals able to compete internationally. It is felt that Chinese firms need to increase their size and revenue in order to achieve economies of scale, to develop global brands and to improve management skills. While not a major focus of ICT policy plans, private venture capital and other financing will be crucial to the development of a Chinese ICT industry.
- *Improvement of domestic innovative capabilities.* To achieve the above objectives, China plans to increase domestic innovative capabilities in the ICT and other high-technology sectors (*e.g.* through increased investment in R&D and more domestically owned patents) and to decrease reliance on foreign technology, intellectual property rights and associated large royalty fees paid to industry consortia in OECD countries (*e.g.* for the production of DVD players in China[35]). Seen from a historical perspective, this is a new development in ICT policy and probably the most noteworthy ICT-related objective in the 11th Five-Year National Plan for 2006-2011. Reforms of Chinese education and R&D institutions will be crucial for increasing China's R&D capabilities (also see Gartner, 2006b).

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

- *Continued government support, government procurement and subsidies.* The government is actively pursuing and supporting new technologies. It seeks progress in the following technological areas: semiconductors/integrated circuits (especially the production of 90-nanometer and smaller integrated circuits), photoelectric displays (such as liquid crystal displays, LCDs), advanced computing and grid computing,[36] the development of IPv6 and next-generation networks, 3G wireless and a digital TV network, domestic software development (including the promotion of open source software through government procurement) and, finally, sensor networking (*e.g.* radio frequency identification [RFID] technology and standards).
- *Fostering Chinese ICT-related standards:* The development of indigenous standards for the ICT industry is seen as a strategic activity to develop technological capabilities and to increase China's share in intellectual property (see also Sigurdson, 2004). The most prominent examples of existing or planned standards are in the following areas: third-generation wireless communication (time division-synchronous code division multiple access, TD-SCDMA), encryption for wireless local area network equipment (wireless authentication and privacy infrastructure [WAPI]), video, digital video disc (DVD) and RFID.
- *Convergence and digital content.* China's ICT policy plans also consider the opportunities arising from increased convergence and digital content. They specifically mention the development of associated technologies (*e.g.* digital TV) and of the so-called cultural/creative industries (animation, advertisement, online games).

Beyond these new Chinese ICT supply-side polices, the Chinese government increasingly recognises the importance of the diffusion and use of ICTs to spur the industrialisation and development of other non-ICT-producing sectors (*e.g.* agriculture but also a modern Chinese services sector) (NBS, 2006). This move is characteristic of the shift in Chinese policy attention towards increasing ICT diffusion and use (following the principle that "informatisation leads industrialisation, and industrialisation promotes informatisation"[37]).

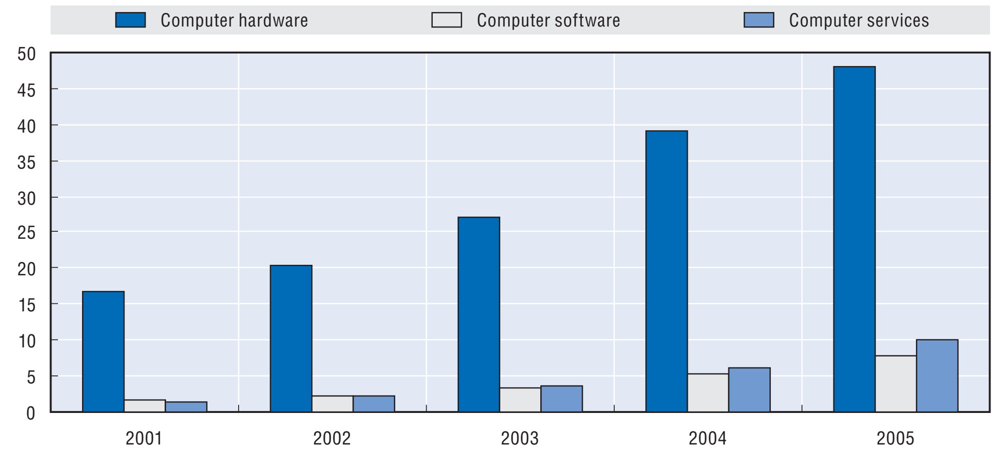
Chinese ICT demand and use

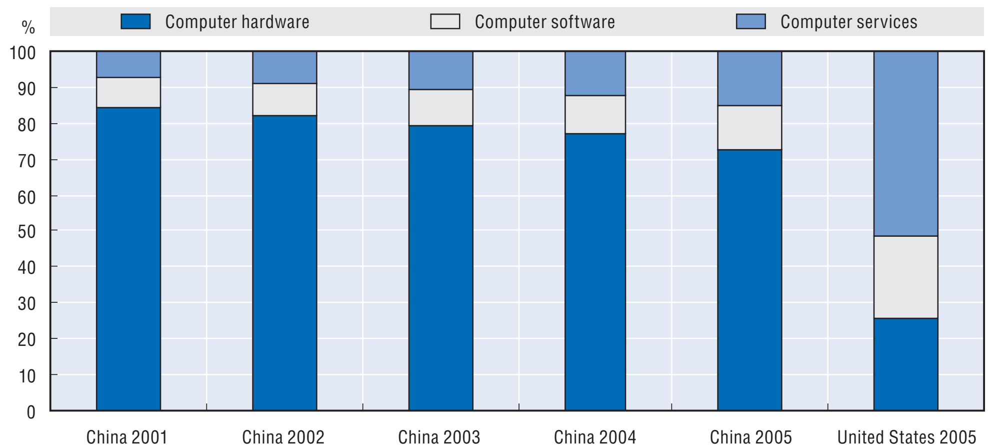
Significant growth in GDP, business ICT investments, rapidly growing annual per capita disposable income and Chinese demographics (with a large share of the Chinese population in the 30-40 year age group) all contribute to rising domestic demand for ICTs and increased efforts by domestic and foreign firms to service this market. Enterprises among the top 250 ICT firms (see Chapter 1) report China as a high-growth market. Sales in China are a main revenue driver and most global ICT firms plan to accelerate their operational expansion in China. PC and Internet penetration are growing fast and Chinese Internet users increasingly engage in creating Web pages, instant communication (messaging), online computer games and e-commerce.

China is becoming one of the most important ICT markets

Figure 4.10 shows the rapid rise of Chinese spending on computer hardware, software and services (excluding communications) and the structural differences in spending on these components in China and OECD countries as exemplified by the United States. China is already the world's largest mobile phone market and the second largest PC market. Demand for these products and for video, broadcasting and other communications

Figure 4.10. **Chinese ICT spending, 2001-05 (USD billions) (above) and distribution of Chinese and US ICT spending, 2001-05 (percentage) (below)**





Source: OECD based on WITSA data.

StatLink: http://dx.doi.org/10.1787/166047287710

products is forecast to increase in the run-up to the 2008 Olympic Games in China. The size and growth of the Chinese domestic market clearly sets it apart from the earlier ICT industry development trajectories of Japan in the 1980s or Korea in the last decade.

Including communication services, China was the sixth largest ICT market in 2005 at USD 118 billion (after the United States, Japan, Germany, United Kingdom and France), with annual growth of 22% a year since 2000 (one of the ten most rapidly growing economies and which are rapidly catching up with major OECD markets), although total spending in 2005 is still only about one-tenth of spending in the United States but about two and a half times the ICT spending of India (USD 46 billion). In general, ICT spending as a percentage of GDP is lower in China (about 4.5% of GDP in 2005) than in leading OECD economies (about 9% of GDP in 2005) but is catching up rapidly as Chinese firms increase their IT capital stock, especially in sectors outside manufacturing (OECD and Motohashi, 2005) and as household consumption increases. In 2005, spending on computer hardware was relatively high (third largest market at USD 50 billion, compared to USD 145 billion for the United States but only USD 10 billion for India) and represented about 70% of total IT spending (excluding communications) in China in 2005. Conversely, at slightly more than 25% of total IT spending, spending on software (seventh largest market at USD 7.9 billion, compared to USD 126 billion for the United States but USD 1.9 billion for India) and services (tenth largest market at USD 10 billion, compared to USD 287 billion for the United States but USD 5.2 billion for India) was much lower than the OECD average but generally higher than for India. In sum, the enterprise market for IT services and software is still relatively small (Gartner, 2006a), with the use of sophisticated business applications such as supply chain management, efficient resource planning, and knowledge management software – standard in most OECD firms – still rather undeveloped in Chinese firms. However, the expansion of the Chinese operations of global firms across all sectors is forecast to increase the IT service and software market in the near future.

China is the world's fastest-growing market for semiconductors and ranks as the world's third largest market, with USD 25 billion in annual sales in 2003 (11% of global chip demand in 2003).[38] It is expected to become the world's second largest market by 2010 (Semiconductor Industry Association, 2005). The demand for chips is driven by China's role as an ICT and electronics manufacturing hub.

The digital personal computer divide in China

In OECD countries, the PC has diffused quite slowly, in many cases requiring a decade for widespread adoption (OECD, 2004). In 2004 the number of households with access to a computer in OECD countries ranged from 86% in Iceland to 10% in Turkey.[39] In China, the PC penetration in urban households roughly doubled every two years between 1997 and 2003 (Table 4.7), with growth slowing somewhat between 2003 and 2004 (indicating stagnation at 30% of urban households). While the pace is rapid, it is not comparable to penetration of mobile phones which almost doubled every year until 2002 and reached about one mobile phone per urban Chinese household in 2004.

In 2004 roughly 58% of the Chinese population lived in rural areas, and boosting rural income is currently a key Chinese policy challenge. The urban/rural and regional PC penetration breakdowns for 2000-04 show a striking regional digital divide (Table 4.7). More detailed data show that whereas PC ownership rate is high in Beijing, Shanghai and Guangdong (Beijing 79 PCs per 100 urban households at the end of 2004) it is very low in the so-called western provinces (Ningxia, Xinjiang, Tibet) at 15-17 PCs per 100 urban households). The digital divide is less marked for mobile phones.

Table 4.7. **Penetration of durable consumer goods in urban and rural households at year end**

Units per 100 households

	1997	1999	2001		2003		2004	
	Urban	Urban	Urban	Rural	Urban	Rural	Urban	Rural
PC	2.6	5.9	13.3		27.8		33.1	1.9
Mobile phone	1.7	7.1	34.0	8.1	90.1	23.7	111.35	n.a.
Colour TV	100.5	111.6	120.5	54.4	130.5	67.8	133.4	75.1

Source: China Statistical Yearbook 1998-2005.

StatLink: http://dx.doi.org/10.1787/707766222622

As in OECD countries, income is a decisive factor in PC penetration. This is apparent when comparing available statistics on PC ownership and income in urban areas (Table 4.8).

Table 4.8. **PC ownership by income level, 2001, 2002 and 2004**

Units per 100 households

	2001	2002	2004
Lowest-income households	3.2	2.8	5.6
Low-income households	6.3	5.5	10.0
Middle-income households	12.5	17.8	30.0
High-income households	22.1	37.2	55.1
Highest-income households	26.0	53.8	74.3

Source: China Statistical Yearbook 2002-2005.

StatLink: http://dx.doi.org/10.1787/754858382147

Rising communications expenditures and growing Internet and broadband penetration

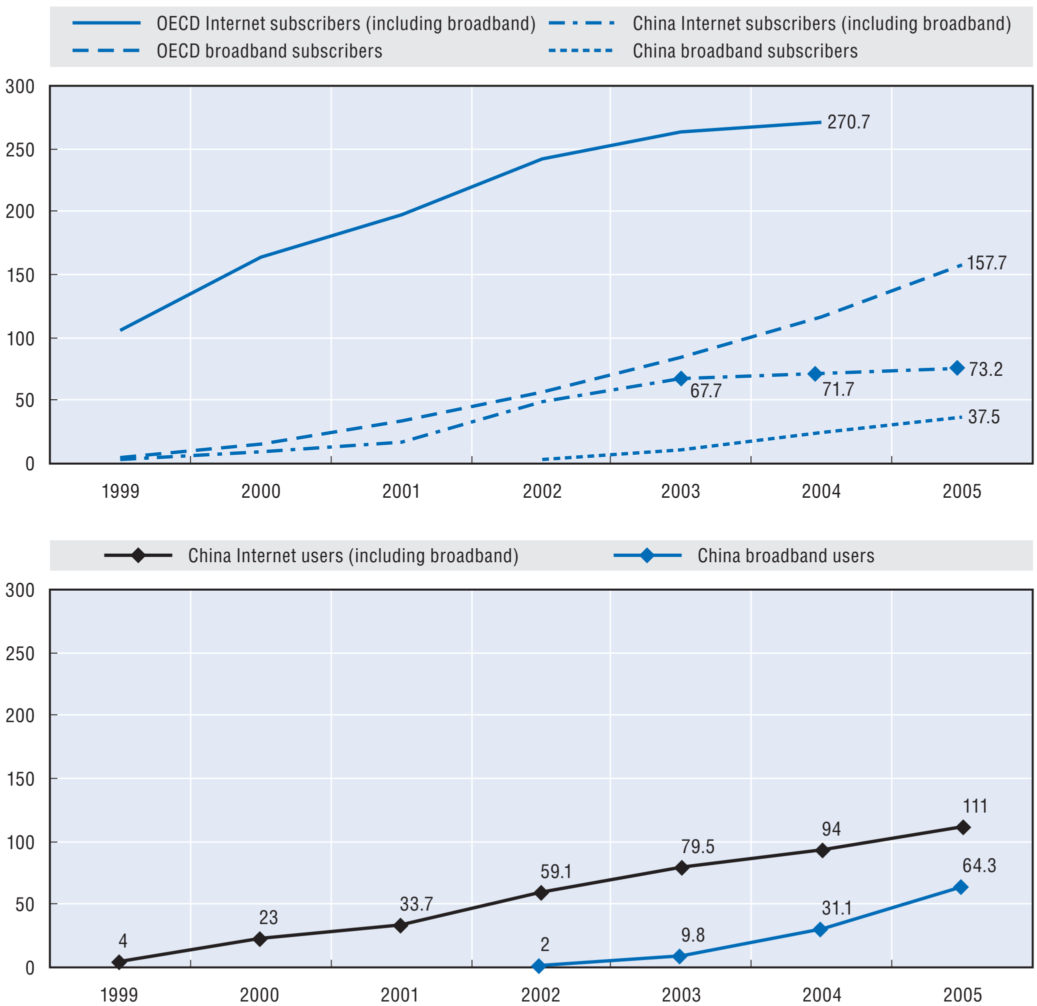
The share of communication expenditures in per capita annual consumption has increased significantly faster in China than other expenditure categories over the last 15 years, from almost no expenditure in 1990 to 6.3% in 2004, with average annual per capita spending of USD 59 in 2004 (*China Statistical Yearbook,* 1999 and 2005).

As in most OECD countries, the Internet and broadband have diffused more rapidly in China than the PC.[40] At the end of 2005, China had 37.5 million broadband subscribers (and 53 million broadband users), fewer than the 49 million broadband subscribers in the United States but more than the 22.5 million in Japan. There are about 158 million broadband subscribers in the OECD area (Figure 4.11, upper panel). China is said soon to overtake the United States in number of broadband subscribers. This seems realistic owing to the significant difference in population (United States: 300 million; China: 1.3 billion). The large size of the population and the absence of legacy infrastructure in China facilitate the necessary investment for telecommunications infrastructure, with some cities building new fibre-optic networks. However, Chinese statistics define broadband to include slower speeds than OECD statistics, and the majority of these lines offer relatively slower speeds. Furthermore, only roughly 3% of the total Chinese population were broadband subscribers at the end of 2005, compared to 14% of the population in the OECD area. The number of total Internet subscribers (including broadband subscribers) reached 73 million in 2005 (271 million in the OECD area). The slow growth in total Chinese Internet subscribers from 2003 to 2005 is surprising but may be due in part to existing subscribers migrating from dial-up to broadband.

At the end of 2005, China had 111 million Internet users (up from 94 million in 2004). The number of broadband users stood at 64.3 million and exceeded narrowband/dial-up users (51 million) (Figure 4.11, lower panel). By comparison, India only had roughly 35 million Internet users in 2004, even though its population of 1.1 billion is close to China's. Nonetheless, only 8% of the Chinese population are Internet users and only about 4% are broadband users, whereas in 2004, over half of all OECD countries had Internet participation rates of over 50% (OECD, 2005e). Moreover, the Chinese growth rate has slowed in recent years (it was 75.5% between 2001 and 2002 but only 18.1% between 2004 and 2005). Like PC penetration, Internet access varies greatly by region (main urban and rural areas). In Beijing and Shanghai, 28% and 26%, respectively, of the population have access but in Tibet and Guizhou only 3.3% and 2.8%, respectively. Attention to closing the digital gap between urban and rural populations will have to be an ICT policy priority. In China, the most prevalent reasons for not using the Internet are lack of knowledge on how to use computers and the Internet and lack of equipment.

Figure 4.11. **Internet and broadband penetration in China and the OECD area, 2001-2005**

Millions



Source: OECD Key ICT indicators, data releases by the China Ministry of Information Industry and the China Internet Network Information Center, the ITU World Telecommunication Indicators Database, and HU (2006). Figures are rounded. When possible, end of year (December) figures are used.

StatLink: http://dx.doi.org/10.1787/278462086431

The Chinese government has promulgated six new principles to spur Internet development. These are: gradual increase in the popularity of the Internet while reducing the digital gap among economic groups; enrichment of information resources and applications; enhancement of network and information security; enhanced international and regional co-operation on information security issues; content; and new applications.[41] At the same time, the Chinese government's control of Internet information accessed by its citizens and associated rules for domestic and foreign Internet service providers attracted significant attention in 2006.

Chinese Web sites and domain names

In December 2005, China had an estimated 7 million Web sites (growth of 3.8% between 2004 and 2005 and numbers had more than doubled since December 2001). Around 43% were registered under the .cn top level domain (Table 4.9), making the latter, with roughly 1.1 million names and growth of 154% from 2004 to 2005, the world's sixth most important top level domain. The Chinese government feels that the current Internet Protocol version 4 (IPv4) addressing system lacks sufficient addresses and therefore supports IPv6, which provides more addresses (Hu, 2006).

Table 4.9. **Total and .cn domain names in China, 2002-05**

	Dec. 2002	Dec. 2003	Dec. 2004	Dec. 2005
.cn domain names	179 544	340 040	432 077	1 096 924
Total Chinese domain names	940 329	1 187 380	1 852 300	2 592 410

Source: CNNIC (December 2002-January 2006).

StatLink: http://dx.doi.org/10.1787/845224235462

Who are the Chinese Internet users?

In China the Internet is most popular with well-educated young males, mostly students. As in OECD countries (except Finland and the United States), there is a gender gap in China which has narrowed over time. According to Chinese statistics, in late 2005, 58.7% of users were male (compared to 79% in 2000). In terms of occupations, students are the largest group of users (35.1% in December 2005), followed by employees (29.7%) but only 1.4% of peasants and farmers are users.

The age profile of Chinese Internet users has not changed much over time. The 18-24 year age group represents 29% of Internet users, compared to 7% of those over 40 years and only 0.6% of those over 60 years of age. Those under 35 years account for over 80% of Internet users. The number of elderly people in China will increase massively over the next few decades, and Internet use by those in older age brackets may soon become a Chinese policy priority. In December 2005, Chinese access to the Internet was mainly from home (71%), followed by the workplace (38%) and schools (19%) (more than one answer allowed). A large share of Chinese users access the World Wide Web in Internet cafés (27%), owing to low PC penetration and the increasing spread of Internet cafés. Measurement of mobile Internet access started in June 2002, but access through mobile phones and other mobile devices is limited (2.1% in 2004). Given that in 2005, PC penetration (especially in rural areas) is still low and that there were more than ten times more Chinese mobile phone subscribers (about 416 million as compared to 836.5 million in the OECD area) than Chinese broadband subscribers (37.5 million), there is significant potential for mobile Internet access.

Over the past two years, average weekly hours spent on line increased from nine to 16. In late 2005, average monthly costs for accessing the Internet (including ISP and telephone connection fees) were around USD 13 (in 2004 average monthly per capita income in Beijing, one of the most affluent regions was USD 158). As in OECD countries, education plays a role: 84% of Internet users have a high-school diploma (down from 97% in 2000) and 28.7% a bachelor's or master' degree (down from 51% in 2000).

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

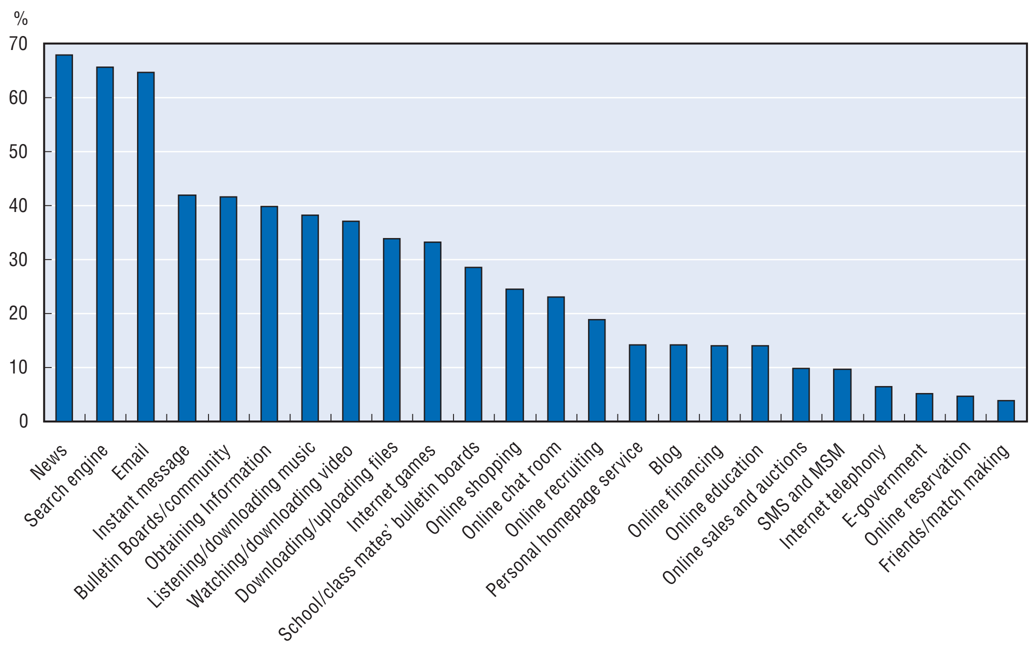
While income is positively correlated with Internet use in most OECD countries (OECD, 2004), it is difficult to establish the relationship between Internet use and income levels on the basis of Chinese statistics. Chinese statistics imply that individuals in the lowest income bracket (below USD 62 a month) constitute the most active and growing group of Internet users; this group likely includes students with little or no income.

Information and entertainment the primary Chinese use of the Internet[42]

Information and entertainment were the two main Internet uses in most recent years (Figure 4.12 and Table 4.A1.2). In a pattern similar to that in OECD countries, news, search engines and e-mail are the main uses. Listening to music, playing online games (see Box 4.2), downloading files, maintaining a personal homepage or blog, accessing weblogs and podcasts (*i.e.* via RSS feeds), and especially instant messaging, bulletin boards and other community features are also becoming popular (CASS, 2006). Voice over Internet Protocol (VoIP) and use of peer-to-peer (P2P) downloading software are also much in demand. Blogging has grown rapidly, with as many as 16 million Chinese bloggers and 100 000 new blogs per day (Xinhua, 2006). The most popular blog on the Internet is currently a Chinese one (Marks, 2006). The Internet is also increasingly used for online recruitment (see Chapter 6 for online recruitment in OECD countries). Companies such as ChinaHR (partly owned by Monster.com) face growing demand for their services.

Figure 4.12. **Services most frequently used, December 2005**

Percentage of total Chinese Internet users



Source: CNNIC (multiple selections allowed).

StatLink: http://dx.doi.org/10.1787/314744578766

Electronic banking services, online education and e-government seem less developed than in OECD countries. This is partly because Chinese Internet users are relatively young. It is also noteworthy that online shopping seems to interest less than a quarter of active Internet users (see the section below on electronic commerce).

Box 4.2. **Online computer and video games**

With its rapidly growing broadband penetration, China has the world's fastest-growing online games market with estimated revenues of USD 580 million in 2005.* The relatively low cost of playing online games in China is often cited as a reason for the significant uptake. Chinese players are mainly young males, mostly connecting over broadband and from Internet cafés or home. Today, board games (chess, etc.) are mainly in demand but there is an increasing interest in more complex role-playing and mobile (phone) games. In 2004, the top games were from Korea (49%), China (31%) and Chinese Taipei (14%) with fewer from other countries. Foreign companies cannot directly operate online gaming in China but need to partner with domestic firms.

Since 2004, the domestic Chinese games industry has developed rapidly, supported by low development costs and the aforementioned rule. Young Chinese development firms include Shanda Internet Development Interactive Entertainment, Kingsoft, Tencent Computer System, and Netease (some of them are listed on NASDAQ). The development of a local games industry is increasingly an objective of the Chinese government. At the same time, the government is increasingly concerned about possible addiction to online games and is monitoring "problematic content". Piracy of console games remains a problem in China.

* Excluding potential revenue from traditional video game console or handheld systems.

Source: 'The Game Market in China: China Online Games' DFC Intelligence Forecasts (14 September 2005); "China in Context: The Far East Markets TIGA China Opportunities Seminar", Howard Lee (27 April 2005); "The Current State of China Online Game Industry" (CCID Consulting, 2004); "Online Game Market in China: Analysis and Prospects" (iPark, Beijing, 2004); Online Game Market in China, US Commercial Services.

Table 4.10 presents the aspects of Internet use which users find most objectionable. Popup advertisements and viruses rank highest. Phishing and privacy seem less of a concern, possibly because of the fewer online transactions or because of cultural factors.

Table 4.10. **Aspects of Internet use which users find objectionable, December 2005**

Percentages

Popup ads and windows	22.1
Internet viruses	19.9
Online traps of fee charges	12.8
Hackers' attack (including Trojan programme)	11.7
Fake information	9.3
Spam	8.7
Cheating/tricking/phishing	6.1
Inappropriate information	5.1
Exposure of privacy	3.7

Source: CNNIC.

StatLink: http://dx.doi.org/10.1787/804163327202

Factors affecting Internet uptake and use include simple lack of interest (no need, no use) and barriers such as cost, skills, availability and convenience. Most importantly, the cost of Internet access, including the costs of terminal, network infrastructure, hardware and software, is currently still prohibitive for most Chinese.

Complete official Chinese statistics on connectivity and ICT use by Chinese firms are not yet available (see Introduction). New data from the Chinese National Bureau of Statistics are given in Table 4.A1.3. According to these preliminary statistics, more than half and sometimes up to three-quarters of Chinese firms surveyed in all sectors except mining are using the Internet and, depending on the sector, up to 50% of surveyed firms have a local area network (LAN)[43] Far fewer firms report having a Web site (the manufacturing sector leads with 28% of surveyed firms) or conducting e-commerce (the manufacturing sector leads with 18% of surveyed firms receiving orders online and 15% placing orders online). In descending order of priority, surveyed firms use the Internet for: e-mail, government information (including procurement), information on goods and services, other information search/research, transacting with government, customer service and to a minor extent delivering products.

Chinese electronic commerce: large potential

As for most countries, reliable official figures on the total value of Chinese e-commerce transactions do not exist.[44] There are several widely varying estimates of Chinese e-commerce transactions from public or private sources. Recently, the Chinese Academy of Social Sciences (CASS, 2006) estimated that the total value of e-commerce (business-to-business [B2B], business-to-consumer [B2C] and consumer-to-consumer [C2C]) grew by 58% from 2004 to 2005 to USD 69.1 billion.[45] Other official sources similarly suggest a growth rate of about 50% but put the total e-commerce value at about USD 92.5 billion (MOFCOM, 2006i). Given that most OECD countries do not provide figures on total e-commerce sales, the Chinese figures are difficult to compare but seem disproportionately high; for example, total online sales by Canadian firms in 2005 amounted to about USD 32.2 billion (Statistics Canada, 2006) and by Australian firms to USD 29.5 billion in 2004-05 (ABS, 2006).

According to official figures, Chinese online revenues are dominated by B2B e-commerce.[46] While official breakdowns are not available, it seems that 75-95% of Chinese e-commerce transactions are B2B (compared to 75-85% in most OECD countries; OECD, 2004). In China, B2B e-commerce solutions and industry platforms – with Alibaba, Hc360.com, and Global Sources leading – are quite successful. In OECD countries, however, most general B2B e-marketplaces of the late 1990s have disappeared (OECD, 2004). The success of B2B marketplaces in China can be linked to the historical absence of fully fledged national distribution systems to facilitate selling products from one province to another. As more private, rather than state-controlled, firms spring up, the Internet offers a good opportunity to sell across provinces. Furthermore, these B2B platforms are very much export-driven, as they are actively used by foreign firms purchasing goods made in China.[47] Many of these platforms are also geared to help Chinese SMEs to identify potential trade partners abroad.[48]

At roughly USD 3 billion in 2005, Chinese B2C and C2C e-commerce are quite small when compared to B2B.[49] By way of comparison, total retail e-commerce sales in the United States reached USD 86.3 billion in 2005[50] (Bureau of the Census, 2006) and USD 172 billion when including auctions and travel (Forrester, 2005). CNNIC surveys suggest that in 2005 around one-quarter of Internet users frequently shop online (up from 7.7% in 2000). In December 2004, 40% of Chinese Internet users stated that they had engaged in e-commerce in the last 12 months. Other surveys produce even higher numbers (CASS, 2006). These figures seem high compared to OECD countries, where about half of the Internet users in the most advanced countries shopped online in 2003 or 2004 (OECD, 2004). Likewise, the amounts spent seem high: according to the CNNIC survey, 43% of Internet users indicated that in the last six months of 2005 they had spent between USD 62 and USD 249 and 6.6% mentioned figures as high as USD 623. Various other reports note that, owing to lack of consumer awareness, of confidence in buying goods online, of trust in online purchases and an unreliable postal system, e-commerce is still rather unpopular with Chinese Internet users.

Still, available figures suggest that from 2003 to 2005 Chinese B2C and C2C e-commerce grew strongly and more rapidly than B2B. Most importantly, the size of the population, the present growth in Internet users and the current demographics (80% of Internet users are under 35) clearly show the large potential for future e-commerce development.

As in OECD countries, the products mostly bought by online shoppers are books, newspapers and other publications (47.2% of online shoppers reported buying these in the previous six months), audio and video products (CDs, DVDs) (34.4%), PCs and computer accessories (29.7%), clothes (21.9%), and mobile phones (18.2%) (Table 4.11 and Table 4.A1.4). Online auction and C2C e-commerce are also very popular (CASS, 2006).[51] The least popular products were food (4%) and financial products (2.4%). Growth was rapid from 2004 to 2005 in clothes, cosmetics, hotel reservations, office appliances and food. Barriers to purchasing on line were mainly worries about product quality (42.4% of online shoppers in December 2004) and security issues (34.3%) (Table 4.A1.5). In 2005, there were a growing number of consumer complaints about the low quality of online goods and after-sales services (CASS, 2006, based on Beijing Consumers' Association).

Table 4.11. **Top five goods purchased over the Internet by Internet users with shopping experience, during the last 12 months**

Percentages

	Dec. 00	Dec. 01	Dec. 02	Dec. 03	Dec. 04	Dec. 05*
1. Books and magazines	58.3	58.0	67.7	61.7	58.8	47.2
2. Audio-visual equipment and products	29.1	34.4	34.9	27.9	23.9	34.4
3. Computer appliances/PCs	37.5	33.7	29.9	32.4	34.2	29.7
4. Clothing	6.9	4.4	5.5	9.4	10.1	21.9
5. Communication appliances/mobile phones	19.9	15.5	12.5	13.9	13.7	18.2

Source: CNNIC (multiple selections allowed).

StatLink: http://dx.doi.org/10.1787/066522256064

Apart from the high costs of PC/Internet access and the relatively low per capita incomes, key problems for the development of e-commerce in China are payment (*i.e.* lack of credit cards or other means of paying safely on line, high credit card fees for cross-province transactions), transaction security and problems for delivery (unreliable postal system, poorly developed logistics industry). Anecdotal evidence shows that a large proportion of Chinese Internet users pay for products on receipt and do not rely on the postal system (express delivery, in-door delivery). However, recent months have seen progress in the area of payment, with co-operation between Chinese banks and the biggest e-commerce providers to improve online payment transactions and efforts by the major e-commerce providers to set up escrow-based payment systems or issue digital certificates for online payment. These developments may ensure that some of the barriers to e-commerce in China can soon be overcome.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Conclusion

China has established itself as a leading producer and user of ICTs. On the supply side, China has become one of the most important locations for ICT production and has been the leading exporter of ICT goods since 2004. Compared to countries such as Japan, Korea and Chinese Taipei, which have also built a significant ICT industry in the last 20 years, China has evolved differently by hosting foreign ICT firms or third-party contract manufacturers to conduct their final ICT product assembly in China. In recent years, however, the rapidly developing Chinese ICT market has triggered further investment by foreign ICT firms to satisfy the increasing domestic demand.

On the demand and use side, China is now the sixth most important global ICT market although it lags in the area of ICT services. For ICT firms from OECD countries, China constitutes a very significant market and potential source of future revenue, often compensating for declines in OECD markets. Steadily rising disposable incomes in China have led to increasing PC and Internet penetration and rapidly developing e-commerce activities, albeit from low levels. The sheer scale of the Chinese ICT market and its potential to serve as a self-supporting base for industrial development are a key difference compared with other countries that have climbed the ICT value ladder.

In spite of their limited size and technological know-how, the production and export capacities of Chinese ICT firms are developing rapidly, especially as providers of telecommunications equipment, semiconductors and Internet-related services. The Chinese ICT industry now faces the challenge of a successful transition from being low-cost manufacturers to becoming global providers of higher value-added products and services. First steps in this direction have been taken, with some ICT firms starting to sell successfully abroad and to develop known brand names. The Chinese government plans to encourage this trend with policies to increase domestic innovative capabilities in the ICT sector and to develop domestic standards, potentially complicating market access for foreign firms. However, challenging the technological leadership of already globalised ICT firms and competing against them on the global and even the Chinese markets, may prove difficult for Chinese firms. Nonetheless, OECD firms will need to develop strategies to maintain a competitive advantage in the design and production of higher value-added components and ICT end products, to avoid losing these segments of the globalised ICT value chain.

Finally, production of ICTs is not helping China to reap the full benefits of ICTs. On the one hand, OECD countries are benefiting from low-cost ICT assembly in China which is adding to lower global ICT prices and thus to increased ICT use and associated productivity gains across industries. On the other hand, ICT uptake in Chinese firms, their efficient integration in value chains and complementary innovations (*e.g.* organisational restructuring, investment in skills) are lagging. The widespread integration of ICTs offers OECD countries a significant competitive advantage that will persist if governments pay consistent attention to removing roadblocks to ICT production and use (especially in areas such as ICT services and digital content) and to facilitating ICT-related productivity increases across the economy and society.

Notes

1. There are three main sources of official ICT statistics in China: *i)* the Ministry of Information Industry for network infrastructure statistics as well as ICT hardware statistics and Internet usage

statistics (for the latter, especially the Internet use surveys of the China Internet Network Information Center (CNNIC), *ii)* National Bureau of Statistics for general statistical figures, including ICT hardware production and employment statistics, *iii)* Chinese Academy of Sciences for software sector statistics. The Ministry of Commerce of the People's Republic of China (MOFCOM) provides data relating to FDI and foreign-owned enterprises in China (including ICT-related firms). There are some coherency problems between different Chinese data sources.

When currency conversions from the Chinese Yuan (CNY) to US dollars are necessary the following exchange rate is used (USD 1 = CNY 8). Figures and growth rates are usually provided in current USD (N.B. Some growth is due to changes in exchange rates).

2. The "high-technology" category as defined in Chinese statistics includes the following industries: Aircraft and spacecraft, Pharmaceuticals, Office, accounting and computing machinery, Radio, TV and communications equipment, Medical, precision and optical instruments. The definition deviates from the OECD definition.
3. There can be significant discrepancies in bilateral trade data, with the importing trade partner reporting different import figures compared with exports reported by exporting trade partners (mirror statistics of the same bilateral trade flow, see Box 4.1). In this chapter when reporting exports and imports for China, the OECD uses data as reported by China.
4. See Gaullier *et al.* (2005) and Mann and Kirkegaard (2006). China's inward processing trade is commonly called "processing trade". According to China Customs' definitions, two types of inward processing trade exist under the customs bonded system and enjoy duty exemption. "Contractual inward processing trade" is the term used for export and import transactions, in which the imported inputs remain the property of the foreign supplier. For the "other inward processing", ownership of the imported goods as input is transferred to the Chinese producers, which are mostly foreign-invested enterprises.
5. This figure includes joint ventures or wholly owned foreign companies.
6. See "Imports and Exports of High-tech Products by Trading Form in 2003(01-07)", Department of Science and Technology, Ministry of Commerce, *http://english.mofcom.gov.cn/static/column/statistic/sciencetechnology.html/1* and MII report on the structure of electronics exports, *www.mii.gov.cn/col/col27/index.html*, both based on industrial microdata from the Chinese National Bureau of Statistics. Definitions do not correspond to the OECD definition of ICT but represent electronics/telecommunication industry exports or high-technology exports as defined by Chinese statistical agencies (see *www.mii.gov.cn/col/col27/index.html*). See also OECD (2005a).
7. Integrated circuits are the largest high-technology import according to the Chinese Ministry of Commerce. See MOFCOM, "Top Fifteen Imports of High-Tech Products", 8 October 2003, *http://english.mofcom.gov.cn/aarticle/statistic/sciencetechnology/200310/20031000133528.html*.
8. Intervention of the Semiconductor Industry Association in US-China Economic and Security Review Commission (2005).
9. Mainly Category 3: Electronics Design, Development and Production PDF ASCII WPD 11-18-05; Category 4: Computers PDF ASCII WPD 11-18-05; Category 5 (Part 1): Telecommunications PDF ASCII WPD 11-18-05; and Category 5 (Part 2): Information Security of the United States Control List in the Export Administration Regulations (*www.access.gpo.gov/bis/ear/ear_data.html*).
10. The authors refer to this as the "triangular trade pattern". According to this concept, Asian economies use China as an export base and instead of exporting finished goods to the United States and Europe, now export intermediate goods to their affiliates in China.
11. Through the 1990s, most technology-related direct investment of Chinese Taipei firms into China was prohibited by the government of Chinese Taipei, a situation that changed in 2002 (Cooke, 2004).
12. See also work at the Taipei-based research organisation, the Market Intelligence Centre.
13. The increased share of imports from China was particularly strong in telecommunication equipment (from 6.3% in 2000 to 39% in 2004) and in computer and related equipment (from 9.5% in 2000 to 43% in 2004).
14. These statistics are not comparable to OECD categories previously cited in the trade section. See also MOFCOM, "Imports and Exports of Hi-tech Products of China over US$370 billion in the First 11 Months", 14 December 2005, *http://english.mofcom.gov.cn/aarticle/newsrelease/significantnews/200512/20051201046233.html*.

15. MOFCOM, "Imports and Exports of Hi-tech Products in Jan. 2006 Made a Good Start", 14 February 2006; MOFCOM, "Export Volume and Value of Computer Products Increased in Jan.", 23 February 2006, *http://english.mofcom.gov.cn/aarticle/newsrelease/significantnews/200602/20060201564974.html*; MOFCOM, "Brief on China's Import and Export of Electromechanical and Hi-tech Products in the First 2 Months", 14 March 2006, *http://english.mofcom.gov.cn/aarticle/newsrelease/significantnews/20060-3/2006 0301679358.html* (Source: Network Center of MOFCOM).

16. Press release of the Ministry of Information Industry on the Chinese electronic information industry as cited in "Nearly 90% of China's electronic exports are from foreign ventures", *China News*, 15 April 2006.

17. See OECD (2006a) for more details on Chinese investment policies.

18. A majority-owned foreign affiliate is a foreign affiliate in which the combined direct and indirect ownership interest of all US parents exceeds 50 %.

19. Direct investment position: The value of direct investors' equity in, and net outstanding loans to, their affiliates. The position may be viewed as the direct investors' net financial claims on their affiliates, whether in the form of equity (including retained earnings) or debt. Source: Bureau of Economic Analysis.

20. However, this may also be due to subcategories such as broadcasting, publishing other than software publishing and telecommunications.

21. The OECD's Science, Technology and Industry Directorate (*www.oecd.org/sti/innovation*) is undertaking a study of the Chinese innovation system which includes detailed analysis of the globalisation of R&D.

22. MOFCOM, [ldquoe]R&D Center of Transnational Corporation in China Developing Fast', 13 February 2006, *http://english.mofcom.gov.cn/aarticle/newsrelease/significantnews/200602/20060201492961.html*.

23. Owing to measurement problems, Chinese data are likely to underestimate outward FDI flows.

24. The fastest route by sea from China to Europe is through the Adriatic Sea while train connections from China to the EU cross central European countries.

25. "Mobile Phone Output to Hit 340m Units This Year", *Xinhua News Agency* (17 March 2006).

26. Semiconductor foundries with an important role in China are Semiconductor Manufacturing International Corp (SMIC), Shanghai Huahong NEC Electronics, Hejian Technology, Advanced Semiconductor Manufacturing, Grace Semiconductor Manufacturing and CSMC Technologies.

27. "The US Challenge in Technology", by Byron Wien, Senior US Investment Strategist, Presentation to the Semiconductor Industry Association, 16 November 2005 at *www.sia-online.org/downloads/FAD%20'05%20-%20Wien%20Presentation.pdf*.

28. Based on a press statement by the Ministry of Information Industry in March 2006, cited by *ChinaTechNews* (6 March 2006) at *www.chinatechnews.com/index.php?action=show&type- =news&id=3643*.

29. Speech of Mr. Bo Xilai of MOFCOM at the Ministerial Summit on Global Cooperation in Software and Information Service and Entrepreneurs High Level Forum, 23 June 2005, *http://boxilai2.mofcom.gov.cn/aarticle/speech/200509/20050900339924.html*.

30. US Commercial Service, Computers and Telecommunications, Export Brief under *www.buyusa.gov/china/en/computers.html*.

31. Chinese Software Industry Association, Industry Section at *www.csia.org.cn/chinese_en/index/index.htm*.

32. A new study by Analysys International confirmed Taobao.com as the market leader in China's online consumer-to-consumer market, with a 57% market share *versus* a 34% market share for eBay China. See *http://resources.alibaba.com/article/2851/Independent_study_finds_Taobao_com_holds_57_market_share_in_China_s_Online_C2C_Market.htm*.

33. Apart from general initiatives in the area of science and technology, as of 1983 China launched various high-technology research and development programmes that are still operational (National High Technology Research and Development Programme of China 863 Programme in 1986 [for an update see *www.863.org.cn/english/annual_report/annual_repor_2001/200210090007.html*], the Torch Programme in 1988, the National Key Basic Research 973 Programme in 1997), with a particular focus on the "information industry". The aim of these programmes was to create an environment for the expansion of new high-technology industries by establishing development zones (national export bases – free trade zones or technology parks –

with tax incentives) to facilitate co-operation with foreign partners, develop engineering skills and know-how, and stimulate research with a focus on hardware. The manufacture of semiconductors and their further development has always been a policy priority of these programmes (Sigurdson, 2004). The information industry supply side also gained more attention in the Chinese five-year plans with the Ninth Five-Year National Development Plan, 1996-2000 calling for encouragement of the domestic PC industry andthe Tenth Five-Year Plan devoting much attention to the development of the information industry. China also undertook efforts to increase the informatisation of its economy. In 1993 the Chinese government launched the "Golden Projects" as a series of separate information infrastructure initiatives for developing the informatisation of the Chinese economy and building related administrative e-government capabilities. These related mainly to banking (Golden Card to create a unified electronic payment clearance system to allow the use of credit and debit cards), customs (Golden Customs to create paperless trading by automating customs checks, eliminating cash transactions for international trade and introducing electronic data interchange) and the tax system (Golden Tax to computerise the tax collection system).

34. A full translation of the plans provided by the Beijing Association of Enterprises with Foreign Investment at *www.mwcog.org/uploads/committee-documents/sFpXVlY20060405143955.pdf*. See also "China sets broad tech goals for 2006 and beyond", *Xinhua News Agency*, 11 January 2006.

35. Based on press reports quoted in Kshetri (2005).

36. China currently has three of the top 100 teraflop supercomputers (China Meteorological Administration, Chinese Academy of Science, Shanghai Supercomputer Center), see Top 500 supercomputer database at *www.top500.org/sublist/*. The Chinese goal is to further the creation of more teraflop computers while encouraging the development of the technologies needed for a petaflop computing system (supercomputer), building grid-based advanced computing platforms, and commercialising the production of teraflop computers.

37. "Informatisation" refers to the application of modern IT in agriculture, industry, scientific technology, national defence and social life, etc., employing information sources intensively and accelerating the national modernisation process (cited from NBS [2006] as presented at the OECD).

38. Testimony of George Scalise President, Semiconductor Industry Association before the US-China Economic and Security Review Commission "China's High-Technology Development" April 21, 2005, Palo Alto, California, at *www.sia-online.org/downloads/testimony_china_050421.pdf*.

39. "OECD Key ICT Indicators", *www.oecd.org/dataoecd/19/46/34083096.xls*. For Turkey the figure concerns only urban households.·

40. Internet penetration and Internet usage by individuals in China are captured through surveys of Internet users conducted by the China Internet Network Information Center (CNNIC). The survey is based on reporting by Internet service providers (ISPs) and on online and off-line surveys delegated to ISPs by CNNIC. The backbones of all Chinese ISPs go through a main backbone provided by the Chinese government. Because ISPs need to be approved by the government, it is relatively easy to carry out Internet-related surveys. However, the number of individuals surveyed varies greatly from survey to survey, contributing to uncertainty regarding the accuracy of the statistics.· Multiple answers are often allowed and the results are usually shown as percentages of Internet users. The data may not be comparable to OECD data.

41. Ministry of Information Industry, Jiang Yaoping, Deputy Minister at the China Internet Conference in Beijing (5 September 2005).

42. See OECD (2005b) for a qualification of the survey data of the CNNIC.

43. Sectors surveyed are mining, manufacturing, electricity, gas, construction, wholesale and retail trade, hotels and restaurants, transport, post and telecommunications, financial intermediation (including real estate) with roughly 500 responding firms in each sector and no breakdown by different size classes (*e.g.* large *versus* small enterprise).

44. No official e-commerce figures are collected in China. Data are released by private research and consulting firms, such as iResearch, and thus vary significantly. At times, Chinese government source quote the figures of these research firms.

45. China Internet Development Research Centre (CIDRC) under the Chinese Academy of Social Sciences. Most of the 2 300 questioned in the survey said they used the Internet for news and online games. The survey covered users in Beijing, Shanghai, Guangzhou, Chengdu and Ghangsha.

46. Wenjie Gu and Greg Shea, US Information Technology Office, provided comments on this section.

47. MOFCOM recently announced the launch of a global trade e-commerce platform ("TradeMatics") to facilitate international trade.
48. For Alibaba, see *http://resources.alibaba.com/article/1736/Chinese_E_Commerce_Sites_Allow_Small_Firms_to_Reach_Wider_Base.htm*.
49. Estimates for the Chinese B2C alone also vary widely with some sources suggesting USD 1 billion in 2004 (iResearch) and others roughly USD 0.5 billion in 2005 (Analysys).
50. Online travel services, financial brokers and dealers, and ticket sales agencies are not classified as retail and are not included in either the total retail or retail e-commerce sales estimates.
51. See also Analysys International's "China C2C Market Quarterly Tracker Q4 2005" at *http://english.analysys.com.cn*.

References

Analysys International (2005), *China IC Market Annual Report 2005-2006*, *http://english.analysys.com.cn*.

Ando, A. and F. Kimura (2003), "The Formation of International Production and Distribution Networks in East Asia", *NBER Working Paper*, n° 10167, December.

Australian Bureau of Statistics (ABS) (2006), *Australian Business Use of Information Technology, 2004-05*, survey released on 17 March.

Center for Strategic Supply Research (CAPS) (2006), *Technology and Organisational Factors in the Notebook Industry Supply Chain*, W. Foster, Z. Cheng, K.L. Kraemer and J. Dedrick, *http://pcic.merage.uci.edu/pubs/2006/foster2006.pdf*.

Chinese Academy of Social Sciences (CASS) (2006), *China E-commerce Market Survey Report*, Beijing.

China Internet Network Information Center (CNNIC) (1999-2006), Statistical Survey Report on the Internet Development in China (latest report from Jan. 2006 at *www.cnnic.net.cn/download/2006/17threport-en.pdf*).

Cooke, M.T. (2004), "The Politics of Greater China's Integration into the Global Info Tech (IT) Supply Chain", *Journal of Contemporary China*, Vol. 13, No. 40, pp. 491-506, August.

Bureau of the Census (US) (2006), *Quarterly retail e-commerce sales, 4th quarter 2005*, 17 February.

Dedrick, J., K.L. Kraemer and F. Ren (2004), *China IT Report: 2004*, September 2004, Personal Computing Industry Center, Graduate School of Management, University of California, Irvine.

Ernst, D. and B. Naughton (2005), "China's Emerging Industrial Economy – Insights from the IT Industry", paper prepared for the East-West Center Conference on China's Emerging Capitalist System. Honolulu, Hawaii, 10-12 August, draft at *http://eastwestcenter.org/stored/misc/Chinas_Emerging.pdf*.

Forrester (2005), "US eCommerce: 2005 To 2010, A Five-Year Forecast and Analysis of US Online Retail Sales", Forrester Research.

Gartner (2006a), "China's ICT Industry: Current State and Future Direction", 18 April.

Gartner (2006b), "Education, R&D Institutions Shaping the Chinese ICT Industry", 13 April.

Gaulier G., F.Lemoine, and D.Ünal-Kesenci (2005), "China's Integration in East Asia: Production Sharing, FDI and High-Tech Trade", CEPII, Working Paper No. 2005-09.

Hu, Q. (2006), "The Internet in China", Presentation of the China Association for S&T Internet Society of China at the OECD Workshop on "The Future of the Internet", March 2006, Paris.

Huang, S. and W. Qiao (2005), "The Development of China's Electronics Industry: Causes and Constraints", *China&World Economy*, Vol. 13, No. 3.

IBM Institute for Business Value (2006), "Prospects and Challenges for Chinese Companies on the World Stage", IBM Institute for Business Value and Fudan University, *www-1.ibm.com/services/us/imc/pdf/g510-6269-going-global.pdf*.

International Data Corporation (IDC) (2006), "China-based Off-Shore Software Development Market 2006-2010 Forecast and Analysis", Report CN221105N.

International Financial Corporation (IFC) (2005), "The ICT Landscape in the PRC Market: Trends and Investment Opportunities", March, IFC, Washington, DC.

Japan External Trade Organization (JETRO) (2005a), *White Paper on International Trade and Foreign Direct Investment (FDI) 2005*, Japan.

JETRO (2005b), "Japanese exports of IT products to US decline against backdrop of Chinese production", *www.jetro.go.jp/en/market/trend/special/pdf/jem0410-1e.pdf*.

Jorgenson, D.W. and K. Vu (2005), "Information Technology and the World Economy", *Scandinavian Journal of Economics*, Vol. 107, No. 4, pp. 631-650, December, *http://post.economics.harvard.edu/faculty/jorgenson/papers/03_sjoe430.pdf*.

Kshetri, N. (2005), "Structural shifts in the Chinese software industry", *IEEE Software*, July/August.

Lu, L.Y. and J.S. Liu (2004), "R&D in China: An Empirical Study of Taiwanese IT Companies", *R&D Management*, Vol. 34, No. 4, pp. 453-465, September, *http://ssrn.com/abstract=591621*.

Mann, C.L. and J.F. Kirkegaard (2006), *Accelerating the Globalisation of America: The Role of Information Technology*, Institute for International Economics, Washington, DC.

Marks, K. (2006), "Xu Jing Lei Tops the Technorati 100", 4 May, *http://technorati.com/weblog/2006/05/103.html*.

Ministry of Information Industry (MII) (2005), "Electronic Information Sector", *www.mii.gov.cn/mii/hyzw/tongji/2005051302.htm and www.world2006.hk/en/market/index.html*.

MII (2006a), *Report: Revenues of High-Tech manufacturing industry in China*, 18 April.

MII (2006b), *Report: Top ten Chinese electronic product providers in 2005, http://english.people.com.cn/200601/20/eng20060120_237032.html*.

The Ministry of Commerce of the People's Republic of China (MOFCOM) (2003), *China Foreign Investment Report*, Chapter 6, *http://english.mofcom.gov.cn/bizchina/6.pdf*.

MOFCOM (2004), "100 FIEs with Largest Exports for 2003", 27 September, *www.fdi.gov.cn/common/info.jsp?id=ABC00000000000017176*.

MOFCOM (2005a), *Import and Export Statistics by FIEs* 2005, 21 October, *www.fdi.gov.cn/common/info.jsp?id=ABC00000000000025931*.

MOFCOM (2005b), "2005-2007 investigation and research report on industry investment trends by transnational corporation in China", in conjunction with the Chinese Academy of International Trade and Economic Cooperation, *http://no2.mofcom.gov.cn/aarticle/chinanews/200503/20050300030744.html*.

MOFCOM (2006a), "High-Tech Product Export of about 300 Enterprises of China exceeded US$100 million", 21 February, *http://english.mofcom.gov.cn/aarticle/newsrelease/commonnews/200602/20060201547879.html*.

MOFCOM (2006b), "Brief on China's Import and Export of Electromechanical and Hi-tech Products in the First 2 Months of 2006", 14 March, *http://english.mofcom.gov.cn/aarticle/newsrelease/significantnews/200602/20060201499462*.

MOFCOM (2006c), "Imports and Exports of Hi-tech Products in Jan. 2006", 14 February, *http://sy2.mofcom.gov.cn/aarticle/chinanews/200602/20060201519050.html*.

MOFCOM (2006d), "Export Volume and Value of Computer Products Increased in Jan.", 23 February, *http://english.mofcom.gov.cn/aarticle/newsrelease/significantnews/200602/20060201564974.html*.

MOFCOM (2006e), "Foreign direct investment tops US$60b", data release, 16 January, *http://english.mofcom.gov.cn/aarticle/newsrelease/significantnews/200601/20060101367043.html*.

MOFCOM (2006f), "Multinationals hasten R&D establishment", 14 February 2006, *http://ag2.mofcom.gov.cn/aarticle/chinanews/200603/20060301669421.html*.

MOFCOM (2006g), "Statistics of China's Overseas Direct Investment in 2005", 16 February, *http://sy2.mofcom.gov.cn/aarticle/chinanews/200602/20060201518944.html*.

MOFCOM (2006h), "International Competitiveness of Chinese Hi-Tech Enterprises in 2005 Improved Rapidly", 21 February, *http://english.mofcom.gov.cn/aarticle/newsrelease/significantnews/200602/20060201551247.html*.

MOFCOM (2006i), "E-Commerce amounted to RMB740 billion in 2005", 24 April, *http://english.mofcom.gov.cn/aarticle/newsrelease/commonnews/200604/20060401990375.html*.

Motohashi, K. (2005), "IT, Enterprise Reform and Productivity in Chinese Manufacturing Firm", RIETI Discussion Paper No. 2005-E-025, *www.rieti.go.jp/jp/publications/dp/05e025.pdf*.

Motohashi, K. (2006), "R&D of Multinationals in China: Structure, Motivations and Regional Difference", RIETI Discussion Paper No. 2006-E-005, *www.rieti.go.jp/jp/publications/dp/06e005.pdf*.

Morgan Stanley (2005), "China Internet - Creating Consumer Value in Digital China, Technology Research Report", Equity Research Global, 12 September, *www.morganstanley.com/institutional/techresearch/China_Internet_091205.html*.

National Bureau of Statistics of China (NBS) (2005), *Statistical Communiqué of the People's Republic of China on the 2004 National Economic and Social Development*, 28 February, *http://english.gov.cn/official/2005-10/07/content_74725.htm*.

NBS (1996-2005), *China Statistical Yearbook,* China Statistics Press.

NBS (2006), "The Evaluation and Research of Informatization Level in China", paper presented by the International Statistical Information Center to the OECD Working Party on Indicators for the Information Society (3 May 2006).

OECD (2004), *Information Technology Outlook 2004*, OECD, Paris.

OECD (2005a), *Economic Survey of China*, OECD, Paris: short version at *www.oecd.org/dataoecd/10/25/35294862.pdf*.

OECD (2005b), "Status and overview of official ICT indicators for China", Directorate for Science, Technology and Industry, *STI Working Paper*, No. 2005/4, OECD, Paris.

OECD (2005c), "Trade in Communication Equipment", Chapter 10, *Communications Outlook 2005*, OECD, Paris.

OECD (2005d), *Reasons for the discrepancies in China's trade statistics with major partners: the particular role of the processing trade*, 6th International Trade Statistics Expert Meeting (ITS) and OECD – Eurostat Meeting of Experts in Trade in Services Statistics (TIS), 12-15 September, *www.oecd.org/dataoecd/51/6/35308958.pdf*.

OECD (2005e), *Science, Technology and Industry Scoreboard*, Directorate for Science, Technology and Industry, OECD, Paris.

OECD (2006a), *Investment Policy Review of China 2006: Open Policies towards Cross-Border Mergers and Acquisitions*, OECD, Paris.

OECD (2006b), "Trends and Recent Developments in Foreign Direct Investment", OECD, Paris.

PricewaterhouseCoopers (PwC) (2004), "China's Impact on the Semiconductor Industry", *www.pwcglobal.com/techforecast/pdfs/chinasemis_web-x.pdf*.

PwC (2005), "China's Impact on the Semiconductor Industry: 2005 Update", www.pwcglobal.com/techforecast/pdfs/ChinaSemis2005_x.pdf.

Reed (2005), *Yearbook of World Electronics Data 2005*, Reed Electronics Research.

Reed (2006), *Yearbook of World Electronics Data 2006*, Vol. 2: America, Japan and Asia Pacific, Reed Electronics Research.

Schindler, J.W. and D. Becket (2005), "Adjusting Chinese Bilateral Trade Data: How Big is China's Trade Surplus", *International Journal of Applied Economics,* Vol. 2, September, *www.federalreserve.gov/pubs/ifdp/2005/831/ifdp831.pdf*.

Semiconductor Industry Association (SIAA) (2005), Testimony before the US-China Economic and Security Review Commission, Hearing on China's High-Technology Development, 21 April.

Sigurdson, J. (2004), "China becoming a technological superpower – a narrow window of opportunity", Working Paper No. 194, The European Institute of Japanese Studies.

Statistics Canada (2006), "Electronic commerce and technology", *The Daily*, 20 April, *www.statcan.ca/Daily/English/060420/d060420b.htm*.

United Nations Conference for Trade and Development (UNCTAD) (2006), UNCTAD Investment Brief, No. 1.

US-China Economic and Security Review Commission (2005), Hearing on China's High-Technology Development, 21-22 April.

Walsh, K. (2003), *Foreign High-Tech R&D in China, Risks, Rewards, and Implications for US-China Relations*, Henry L. Stimson Center, *www.stimson.org/techtransfer/pdf/FinalReport.pdf*.

Walsh, K (2005), Testimony before the US-China Economic and Security Review Commission, Hearing on China's High-Technology Development, 21 April 2005.

World Trade Organisation (WTO) (2006), "World Trade 2005, Prospects for 2006", Press Release, Press/437, 11 April.

Xinhua News Agency (2006), "Chinese bloggers to reach 100 million in 2007", 6 May, *http://news.xinhuanet.com/english/2006-05/06/content_4513589.htm*.

Yang, Y. (2006), *The Taiwanese Notebook Computer Production Network in China: Implication for Upgrading of the Chinese Electronics Industry*, The Personal Computing Industry Center, University of California (Irvine), *www.pcic.merage.uci.edu/pubs/2006/TaiwaneseNotebook.pdf*.

Zedwitz, M. von (2005), "China goes abroad", in S. Passow and M. Runnbeck (eds.), *What's Next? Strategic Views on Foreign Direct Investment*, UNCTAD and Invest in Sweden Agency.

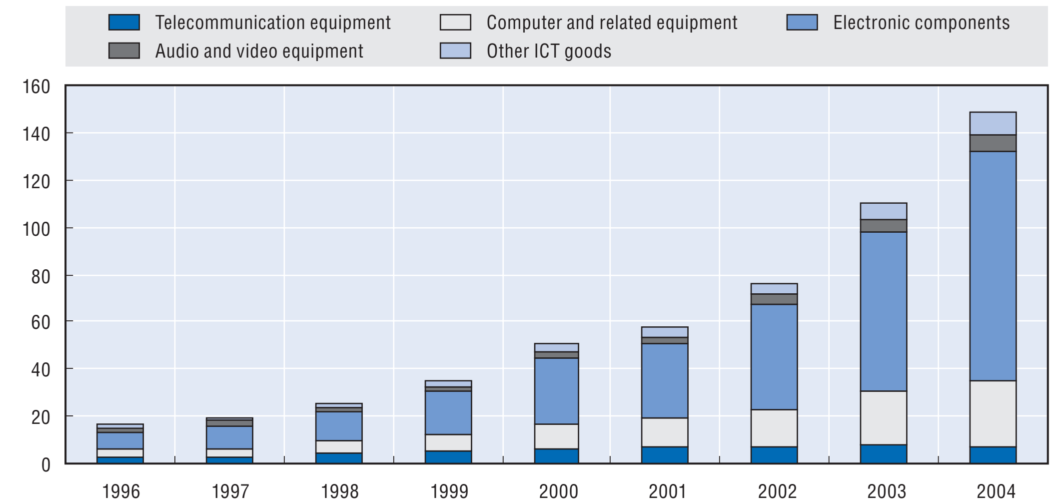
Zedtwitz, M. von (2006, forthcoming), *Connecting Science to Innovation*, Edward Elgar, Cheltenham.

ANNEX 4.A1

Figures and Tables

Figure 4.A1.1. **China's imports of ICT goods, 1996-2004**

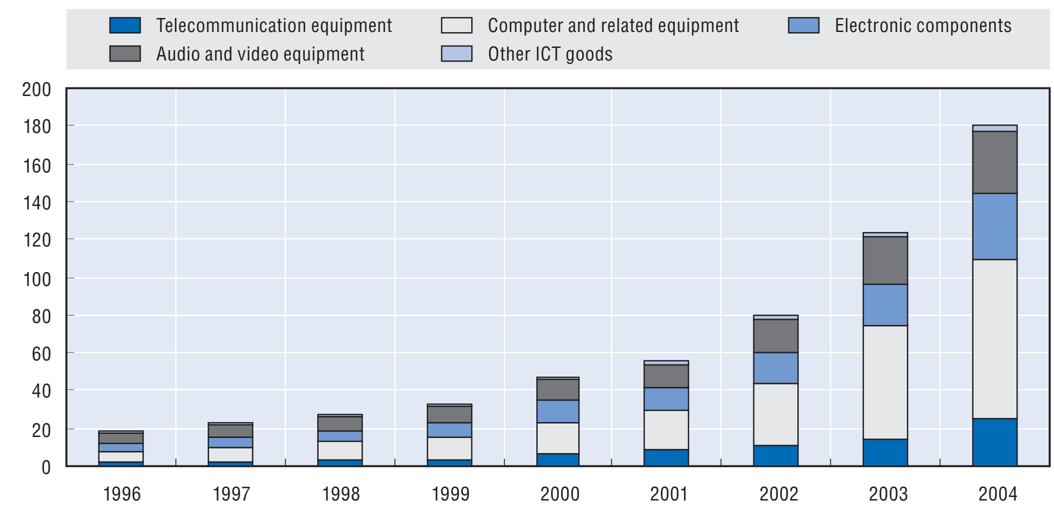
Current USD billions



Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/701484616060

Figure 4.A1.2. **China's exports of ICT goods, 1996-2004**



Source: OECD ITS database.

StatLink: http://dx.doi.org/10.1787/581710341568

Table 4.A1.1. **Share of foreign-invested enterprises (FIEs) in total exports and imports, 2002-05**

	FIE exports as share of total (%)	FIE imports as share of total (%)
2002	52.2	54.3
2003	54.8	56.2
2004	57.1	57.8
2005	58.3	58.7

Source: MOFCOM FDI Statistics; OECD (2006a), Table C.9.

StatLink: http://dx.doi.org/10.1787/302537353754

Table 4.A1.2. **Internet services most frequently used**

Percentage

	Dec. 99	Dec. 00	Dec. 01	Dec. 02	Dec. 03	Dec. 04	Dec. 05
News					59.2	62.0	67.9
Search engines	50.4	66.8	62.7	68.3	61.6	65.0	65.7
E-mail	71.7	95.1	92.2	92.6	88.4	85.6	64.7
BBS Community forum	16.3	16.7	9.8	18.9	18.8	20.8	41.6
Information gathering	39.3	44.7	46.7	42.2	47.2	49.9	39.8
Software download / upload	44.2	50.6	55.3	45.3	38.7	37.4	n.a.
On-line games	13.6	18.9		18.1	14.7	15.9	33.2
School/classmate BBS					15.7	14.8	28.6
On-line purchasing	7.8	12.5	7.8	11.5	7.3	6.7	24.5[1]
On-line chatting	25.5	37.5	22.0	45.4	39.1	42.6	23.1
Recruitment on-line					4.7	3.5	18.9
On-line banking				3.6	4.5	5.1	14.1
On-line education			11.8	8.9	6.2	6.3	14.1
Short messages			8.0	8.8	3.8	2.3	9.5[2]
VoIP			1.7	1.0	0.8	1.0	6.5
On-line ticket/hotel reservations				0.8	0.4	0.5	4.6
Video on demand				5.6	3.5	3.9	
On-line stock trading and information	8.5	10.9	7.4	5.5	3.7	3.4	
E-government				1.9	2.0	2.0	
On-line sales				1.2	1.2	1.6	
On-line auctions				0.9	0.8	0.7	
Informatisation (ERP, CRM, SCM)				1.2	0.8	0.6	
On-line hospitals				0.7	0.5	0.6	
On-line video conferences				0.3	0.4	0.4	

1. In 2005 this category is called Online shopping.
2. Includes multimedia messages as of 2005.

Source: CNNIC (multiple selections allowed).

StatLink: http://dx.doi.org/10.1787/123406211140

Table 4.A1.3. **Preliminary Chinese ICT usage indicators**

Results from May 2006, available sectors only, in % of responding firms

	Manufacturing	Wholesale and retail	Hotel and restaurant	Transport, post, telecommunication	Financial intermediation
Responding firms	**508**	**481**	**343**	**431**	**399**
Firms using the Internet	65	62	56	64	72
Firms with Web site	28	13	19	19	16
Firms receiving orders over the Internet	18	11	14	11	7
Firms placing orders over the Internet	15	10	8	8	4
Firms with a Local Area Network	38	38	38	48	74
Using Internet for email	56	51	42	55	59
Getting information from government	40	34	29	41	43
Getting information about goods and services	49	45	33	40	33
Other information searches or research	38	28	25	31	44
Transacting with the government	32	23	22	23	22
Providing customer services	31	20	24	24	37
Delivering products online	14	6	9	8	9

Source: Chinese National Bureau of Statistics, preliminary results of the 2006 ICT usage survey.

StatLink: http://dx.doi.org/10.1787/730014723082

Table 4.A1.4. **Goods bought over the Internet by Internet users with shopping experience during the last 12 months**

Percentage

	Dec. 00	Dec. 01	Dec. 02	Dec. 03	Dec. 04	Dec. 05*
Books and magazines	58.3	58.0	67.7	61.7	58.8	47.2
Audio-visual equipment and products	29.1	34.4	34.9	27.9	23.9	34.4
Computer appliances/PCs	37.5	33.7	29.9	32.4	34.2	29.7
Clothing	6.9	4.4	5.5	9.4	10.1	21.9
Communication appliances/mobile phones	19.9	15.5	12.5	13.9	13.7	18.2
Living and housing appliances/services	14.3	11.6	11.0	12.6	16.5	17.8
Products related to Internet games					12.8	17.4
Cosmetics				6.4	7.5	15.6
Photographic equipment (digital camera)	4.9	3.6	6.2	9.0	9.5	11.2
Family electrical appliances	8.4	5.6	7.1	6.3	8.9	
Sports equipment	6.9	4.4	4.7	6.3	5.9	8.4
Hotel reservations			4.3	3.4	3.1	7.4
Educational services	13.1	11.8	9.8	8.6	6.2	7
Tickets	8.5	9.7	7.7	6.6	5.2	
Gift services	16.4	14.7	12.7	12.3	12.7	5.7
Office appliances				3.1	3.5	5.4
Medical products and care services	4.4	3.1	2.7	3.1	2.8	4
Financial and insurance services	3.8	2.6	2.1	2.3	1.9	2.2
Food				1.6	1.2	2.4
Others	9.0	3.1	2.3	2.4	1.4	3.4

Source: CNNIC (multiple selections allowed).

StatLink: http://dx.doi.org/10.1787/161861444526

Table 4.A1.5. **Barriers to purchasing on line**

Percentage

	June 99	Dec. 99	Dec. 00	June 01	Dec. 01	June 02	Dec. 02	June 03	Dec. 03	Dec. 04
Product quality not guaranteed	34	36.5	32.0	33.0	30.2	36.9	39.3	40.0	42.1	42.4
Security not guaranteed	30	27.6	31.2	33.4	31.0	22.1	23.4	25.1	28.1	34.3
Unreliable information			5.9	6.0	6.3	5.9	6.4	7.0	6.7	7.3
Late delivery	6	9.3	9.9	8.7	13.9	10.2	8.6	7.1	7.5	5.3
Unattractive price	8	7.8	7.4	6.6	6.3	11.1	10.8	10.3	7.5	5.2
Inconvenient payment mode	22	17.7	12.6	11.5	11.8	13.0	10.8	9.9	7.4	5.1
Others		1.1	1.0	0.8	0.5	0.8	0.7	0.6	0.7	0.4

Source: CNNIC (July 1999-January 2005).

StatLink: http://dx.doi.org/10.1787/666172832711

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

ISBN 92-64-02643-6
OECD Information Technology Outlook 2006

Chapter 5

Digital Broadband Content: Developments and Challenges

Digital content is an increasingly important aspect of OECD economies as they shift their emphasis from manufacture of physical items to high-value intangibles. This chapter analyses developments in online games, music, scientific publishing, mobile and user-created content, discusses value chains and business models, analyses growth drivers, and draws horizontal lessons.

Introduction

Digital content plays an increasing role in OECD economies, which are shifting their focus from manufacture of physical items to high-value intangibles. Digital content is expected to provide new impetus for the digital economy, following and building on the infrastructure push that has provided widespread network access. Technological innovation and new forms of consumer demand and innovative use create opportunities for content creation and distribution, new or more direct forms of creative supply, and potentially improved access to knowledge and research. Digital content is now a major driver of telecommunications, information technology (IT) and electronics industries. At the same time, significant investments in the telecommunication and IT infrastructure are necessary to deploy content services.

The development and delivery of digital content is growing rapidly across a range of very different activities, reconfiguring existing ones (*e.g.* telephone handsets with online game capabilities, new business strategies for video downloading, the provision of government services over mobile devices) as new digital content developers and providers emerge. Digital content is also pervading sectors not previously considered content producers, and these may in fact prove much more significant than entertainment. Digital content development and delivery is increasingly common in:

- Content/entertainment industries, whose primary activity is the production and sale of content. These include publishing activities which produce content on physical supports such as books, journals, newspapers, software, audio and video products, all of which increasingly exist in digital form, as well as content services, such as audiovisual and broadcast services.
- Industries that are not content industries, but which increasingly produce digital content as secondary or ancillary activities, such as business and financial services.
- Social services (*e.g.* online education, health services), knowledge and cultural services (*e.g.* museums, libraries, broadcasting archives), research-related activities (*e.g.* digital research data) and government-related activities and public content (*e.g.* e-government, commercial re-use of public sector information).
- Content created by network users.

This chapter aims to improve the understanding of developments and challenges in the area of digital content, focusing on content and entertainment industries and to a lesser extent on network-user created content (see also Chapter 7, "Participative Web"). Content created as part of other activities, including business services, health and public sector information are treated extensively elsewhere (*www.oecd.org/sti/digitalcontent*; OECD, 2006a; 2006d). This chapter builds on studies of the digital broadband content sector for online computer and video games, music, scientific publishing and mobile content (OECD, 2005a, 2005b, 2005c, 2005d; Vickery and Wunsch-Vincent, 2005), part of the broader OECD project on digital broadband content, and draws on discussions and presentations from the OECD

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

conference on the future digital economy (2006a).[1] It provides an overview of these areas and describes the effect of digital content on industry structure and value chains, cost structures and business models, drivers of adoption, barriers to digital content development, delivery and use, and impacts of the development and delivery of digital content.

Evolution of digital content industries

Digital content industries are very dynamic and are the most rapidly growing segments of many established industries. Unfortunately, aggregate data are not available for all industries to enable cross-country comparisons. Estimates for digital content applications suggest that global interactive entertainment software sales will increase from USD 18 billion in 2005 to about USD 26 billion in 2010 with a total interactive entertainment market of around USD 42 billion (DFC Intelligence, 2005b; Online Publishers Association, 2006; Parks Associates, 2006). US consumers spent USD 2 billion on narrowly defined paid online content in 2005, up 15% from 2004, and entertainment (including digital music), research and games were among the leading content categories (Online Publishers Association, 2006). Projections suggest US consumer spending on online entertainment (games, music, video services) will increase from USD 2.4 billion in 2006 to USD 9 billion in 2010 (Parks Associates, 2006). Specific industry factors, such as the launch of the newest generation of game console systems, are likely to affect growth positively, and advanced mobile content services are also dynamic as content becomes an important component of mobile and wireless network services.

Content industries are migrating users to commercial digital content applications, with varying degrees of success. Along content value chains, new industry partnerships and selling arrangements are being experimented with as a way to adapt content to different delivery platforms (PC, mobile, online), to meet consumer demand (including interactivity), and to identify effective business models. New types of content have developed (*e.g.* online games) or are displacing traditional entertainment (*e.g.* television). While offline sales revenue is still essential for all industries, online sales are increasingly important and new business models are at early stages and take time to develop.

On the infrastructure side, and supporting the distribution of digital content, OECD countries had 158 million broadband subscribers at the end of 2005, equivalent to 14% of the OECD area population (Figure 5.1), and 271 million Internet subscribers. This infrastructure is increasingly ubiquitous and is being used for a wide range of digital content applications, including games, music, video and research.

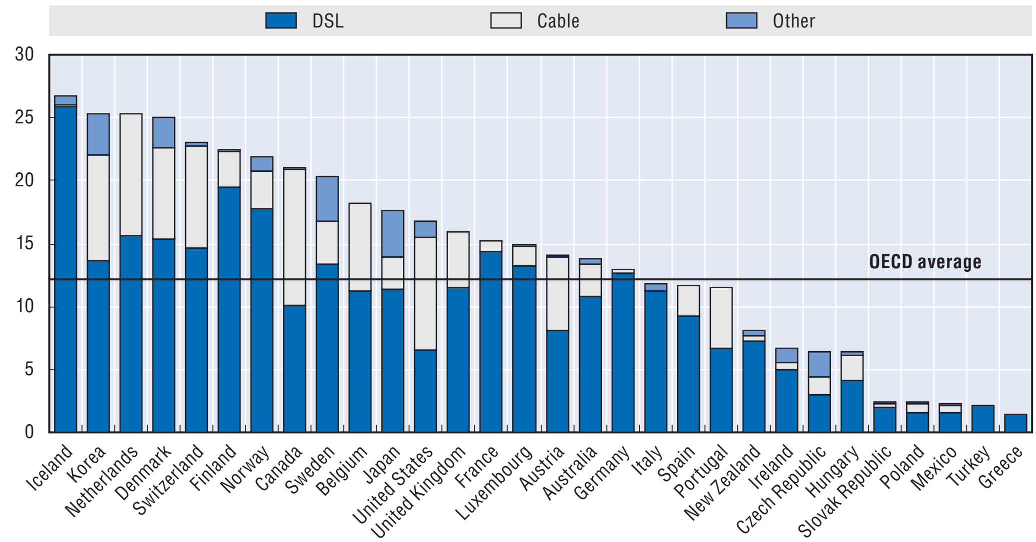
Computer and video games

Development

The computer and video game industry is a young industry whose rapid growth is underpinned by technological developments. The global video game market was estimated at USD 25.4 billion in 2004, and was projected to increase to USD 54.6 billion by 2009 (OECD, 2005a; Parks Associates 2005c).[2] Recent data for the United Kingdom show similar trends, with sales of interactive entertainment software of around GBP 1.35 billion (approximately EUR 1.97 billion) in 2005 (ELSPA, 2006). The most important regional markets for the games industry are Asia and the United States, with a games market in the United States of USD 11 billion in 2004, and computer and video game software sales of USD 7.3 billion in 2004 (CEA, 2005; ESA, 2006). The United States is the biggest market (39%

Figure 5.1. **OECD broadband subscribers per 100 inhabitants, December 2005**

OECD broadband subscribers per 100 inhabitants, by technology, December 2005



StatLink: http://dx.doi.org/10.1787/266425563301

of global sales), followed by Japan (15%) and the United Kingdom (12%), closely followed by Germany and France (ELSPA, 2006). US and EU games revenue in 2001 had already surpassed film box office ticket sales (but not total film industry sales, which are increasingly derived from other sources), and the turnover of the industry has been projected soon to be higher than that of the recorded music industry (DFC Intelligence, 2004; ISFE, 2006).

The industry is increasingly seen as strategic by major media, Internet and consumer electronics firms. It is also seen as an overall contributor to growth and employment. In the United States, for instance, direct and indirect contributions of computer and video game software to the nation's gross national output are estimated to have exceeded USD 18 billion in 2004 (Crandall and Sidak, 2006); in the United Kingdom the computer and video game industry is estimated to directly employ over 21 000 people with employment growing since 2000 (ELSPA, 2006). Online computer game development is highly R&D- and innovation-intensive, and game programming and design are highly skilled occupations. New, more sophisticated games with online capability are also a key driver for IT hardware sales as they require high-performance personal computers and advanced graphics. Finally, game software is increasingly used in non-game applications such as education (Behrendt, 2003), health care, advertising and defence.

The industry has four leading companies, Sony, Nintendo, Electronic Arts and Microsoft (DFC Intelligence, 2005a) and a large number of much smaller firms. As the industry matures, companies grow and absorb smaller operations; in markets such as the United Kingdom consolidation has halved the number of developers as the costs and risks of producing games for more complex consoles have increased (ELSPA, 2006). In the computer games industry the established business model is the sale of hard-boxed games. Until recently, online and wireless games were a relatively small part of overall sales (6.4% and 3.4%, respectively, in 2003). The console offline (73%) and PC offline markets (17%) were the main segments. This is changing rapidly as interactive online games become available. A new industry which arose with the Internet and broadband and more connected video game systems, the online games industry does not have to deal with legacy systems and structures and has successfully developed ways of protecting intellectual property. There is also a trend towards online games for PCs and consoles: new games are released with some online capabilities, and it is expected that nearly all will become at least in part online. Market expansion is coming through the development of online network technology, diversifying content and developing large-scale online games.

Recent projections suggest that the market for online game services will rise from USD 3.4 billion in 2005 (with subscription-only revenue from online games of USD 2 billion in 2005) to over USD 13 billion in 2011 (DFC, 2006a, 2006b; IGDA, 2005), including wireless games. Over 50% of online game subscription revenue in 2005 came from Asian countries outside Japan, notably Korea, China and Chinese Taipei (DFC, 2006a, 2006b). Revenue of Korean firms such as NCSoft and Nexon and the Chinese firms Shanda and Netease is derived mainly from online games (see Box 4.2 in Chapter 4).

The leading online game category is expected to remain the high-end, massively multiplayer online games (MMOGs) which appeal to a fairly small portion of the total user base, although the industry is aiming to produce a wider variety of games to appeal to new audiences and broaden markets. Meanwhile, MMOG and casual games generate the most online revenue. However, they do so with very different audiences and business models. Further, as consoles are increasingly Internet-enabled, online delivery may become the major distribution channel, replacing packaged goods delivery, with online products (multiplayer and mobile online games) accounting for larger market shares (DFC Intelligence, 2005c; Parks Associates, 2005c).

Online capabilities and broadband are changing the established value chain from developer to publisher to distribution as the industry shifts from packaged goods to a service industry. The role of the distributor, and in some cases the retailer, is being taken by publishers either directly or via Internet service providers (ISPs) and game Web sites. This can be described as "disintermediation" due to digital delivery of games or through direct access to online multiplayer games. At the same time ISPs acting as content aggregators and multi-game Web sites and portals acting as retailers are new online distributors ("re-intermediation"). Developers and publishers are well placed in the new value chain, and the new intermediaries (portals and possibly ISPs) may also move back into game publishing and development. For online games, specialised software (middleware) firms have been providing some support for developer/ publishers.

The spread of broadband is driving new distribution mechanisms and business models. New online-enabled revenue models include retail purchase, subscription fees, pay-per-play, advertising and new services including selling and/or renting digital objects and players. The most successful emerging model is the "pay monthly" subscription model (*e.g.* subscription-based access to premium casual games), but it is expected that most computer game companies will have to rely on a mix which includes advertising and support services to increase revenue. MMOGs currently rely almost entirely on subscriptions while casual games obtain revenue from advertising, digital distribution (downloading) and, increasingly, subscriptions. Significant changes in revenue models may occur if and when micropayments are more widely available for mass-market customers.

On the demand side, consumer demographics, income and preferences will structure the growth and shape of the industry. In the European Union 16-to-24 year-olds are the largest group of Internet users playing and/or downloading games or music (Eurostat),[3] and this pattern holds for all OECD countries. However, among Internet users, online computer and video games is spreading to other age groups, including the 29-40 and older age groups (Pew, 2006a; ESA, 2006). According to industry figures, half of all Americans play video games although not all of them on line (ESA, 2006).

Barriers to development include availability of network infrastructure, the challenge of sustaining creativity and innovation as R&D costs rise, and market structures in which developers carry a large share of the risk of new product development, lack of skills and management challenges and financing issues, and the legal and payment infrastructure for enabling games software to be sold by producers and used by consumers. The policy framework affecting the industry includes R&D and technology; market and skills development; intellectual property rights (IPRs) and piracy issues; online business conditions including broadband quality and coverage, micropayments, standards and taxation issues; and social dimensions including culture, age and content issues regarding games in education.

Outlook

The online game market has begun to take shape with the generations that have grown up with broadband and interactive entertainment. While Asia (including China) is expected to be a strong market for online games, North America and Europe are also expected to grow. The growth of the console games market depends on the cycle of new game consoles; new game consoles are arriving in 2006 and 2007 with improved online capabilities (PlayStation 3, Xbox 360 and Wii from Nintendo). While the PC has been the dominant platform for online games, these new consoles with sophisticated online capabilities are likely to be a key driver for growth, but a steady stream of new online games with more advanced features is necessary to sustain it. In addition, with an estimated 2 billion mobile phone users worldwide in 2005, mobile games with online connectivity are expected to be an important growth driver. Finally, the use of online computer game and video software and applications in areas such education, health and other non-game environments remains promising.

Music

Development

In 2005, global retail music sales were USD 33 billion; however, global CD album sales were down 6% in value and 3.4% in units. The United States, Japan and the United Kingdom were the largest markets and per capita spending was highest in Norway and the United Kingdom (IFPI, 2005c, 2006; OECD, 2005b). The industry has four major firms: Warner Music, Universal Music Group, EMI Recorded Music and Sony/BMG Entertainment. After a period of sustained growth, the music industry experienced a pronounced fall in overall revenue (by 20% from 1999 to 2003). The downturn during this period was not uniform in all OECD countries. While the United States, France and the Netherlands experienced large declines, the United Kingdom experienced steady or growing sales.

Broadband presents opportunities and challenges for music and the impact of digital distribution is high on both the supply (artists, music industry) and the demand side (new

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

music consumption, consumer choice, network users as content creators). The digitisation of music, changing ways of listening, the diversification of delivery platforms and sharing are likely to have increased the time listening to music. Digital music and other content are also drivers for technology markets, including consumer electronics and PC manufacturers. However, the unauthorised downloading of copyrighted content over the Internet has raised considerable concerns. Finally, the potential impact of online music on artists and their recognition, on the industry business model and value chain, and on users seems significant.

The music industry has had difficulty in working out how to use the potential of low-cost digital delivery to provide low-volume music tracks to consumers while ensuring adequate revenue streams to develop new artists and protect the intellectual property of established ones. Nonetheless, digital delivery is currently the fastest-growing channel for music, and Internet and mobile phone delivery has grown rapidly since 2003. The music industry is licensing content to new online ventures and also taking legal action against unlicensed and unauthorised use and increasing consumer awareness of digital piracy.

In 2005, global digital music sales nearly tripled from USD 380 million to 1.1 billion and from 160 to 470 million single units, led by the United States, Japan, the United Kingdom, Germany and France (Table 5.1; see also Digital Music News, 2006).[4] While the share of online music is still small (about 6%), it was zero in 2003. Digital music is characterised by rapid entry of new providers and a fast-growing supply of available tracks. For some record labels, such as Warner, digital sales accounted for 11% of revenue for the first quarter of 2006. In Japan digital has already made up for the decline in physical sales. In the medium term, overall demand for music may be increased through digital distribution and new forms of music consumption.

Table 5.1. **Top 10 digital music markets, Internet and mobile phone sales, 2005**

	Digital sales as % of total music sales	Total digital market (million USD)	Digital sales by channel (% of digital sales)	
			Online	Mobile
United States	9	636	68	32
Japan	7	278	9	91
United Kingdom	3	69	62	38
Germany	3	39	66	34
France	2	28	47	53
Italy	4	16	31	69
Canada	3	15	71	29
Korea	n.a.	12	42	58
Australia	2	7	41	59
Netherlands	2	5	82	18

Source: IFPI (2006), Total world music sales statistics, March.

StatLink: http://dx.doi.org/10.1787/227486253230

Total digital sales are split roughly equally between music sold over the Internet and music sold to mobile phones, with Japan and continental Europe leaning towards mobile rather than Internet sales (IFPI, 2006). In 2005 when mobile sales took off, ringtones were the largest segment of the mobile market, accounting for roughly 90% of sales. Mobile music now accounts for approximately 40% of record company digital revenue (based on IFPI figures, see also OECD, 2005b). But other mobile music formats, such as full track downloads to mobile and music videos, are growing fast. New handsets enable the hosting of the software of online music providers (including music storage, ringtone capabilities) and portable subscription-enabled mobile phones will encourage this trend.

On the Internet, new business models are mainly built around digital download/ pay-per-track, streaming subscription models and portable subscriptions. Per-track downloading and payment (*à la carte* business models) still dominate; Apple's iTunes accounts for 86% of global sales, with a billion songs sold up until February 2006. Although music labels favour variable pricing, Apple will continue to deliver its uniform, 99 cent price for paid downloads as part of its renewed agreements with music record labels in 2006. The other main competitors are Napster, Yahoo!, Microsoft's MSN and RealNetworks, and many other online music services have emerged. By the end of 2005, there were 335 sites offering over 1 million tracks on line worldwide (IFPI, 2006). Some music services are experimenting with providing users with new ways to search for music; for example, Napster allows its users in the United States to stream full tracks in its catalogue up to five times at no cost. It is not clear whether the pay-per-track model will be successful for stand-alone online music services and record labels, and the impact of purchasing individual songs as opposed to albums on artists and the creative supply of music remains uncertain.

The creation of an online music store requires the digitisation of content, the clearing of rights, the settling of technological issues, including digital rights management (DRM) systems, the creation of online music storefronts, secure billing systems and delivery networks. Thus, the digital music value chain is different in some ways from the traditional one but certainly not less complex. Importantly, there is a new set of companies that were traditionally not involved in the distribution of music. These are firms that have always had links to the content industries (*e.g.*, the consumer electronics industry) and are now moving upstream, but also those that were traditionally not related to the distribution of music (*e.g.*ISPs, consumer brands). Furthermore, the new digital music value chain produces an array of new digital intermediaries (*e.g.*digital rights clearance, software, DRMs, online billing).

Different strategies are being adopted by participants as they try to integrate upwards or downwards in the value chain. In their move to becoming triple-play providers (voice, broadband and TV content), network operators are moving into more value-added services, such as the provision of content and information. There have also been efforts to integrate some of the different functions along the value chain (from the creation of content to the devices used to listen to music, often with proprietary standards, *e.g.* by Apple and Sony). Digital music and the rise of portable audio players are also redefining the boundaries between PC, software, mobile handset, content and consumer electronics.

In the new digital model, artists, record companies and publishers have so far retained their creative roles. Direct sales from artists to consumers or purely online career building are still rare. Nevertheless, the Internet allows new forms of advertising and other financing possibilities that lower entry barriers for creation and distribution. The music discovery process is also changing, with digital delivery altering the market conditions of artistic start-ups. Established distribution networks gave the big record companies a significant competitive advantage, but (smaller) independent labels may be able to move more quickly in reaction to technological change. Nonetheless, digital distribution is a complex and far from costless delivery channel and entails building a multitude of new business relationships (including potentially for artists).

A major challenge is to reduce online piracy and to develop business models that are attractive to consumers and provide revenue streams from the creation and legitimate distribution of original recordings. Other barriers to development include the lack of standards (music format and DRM standards), differing and hard-to-understand usage rights, incompatibilities between content and playing devices, difficulties associated with securing rights for online music distribution which are complicated by cumbersome licensing processes for different national territories (*e.g.* for a pan-European release). Business and government efforts to facilitate licensing are ongoing (*e.g.* in the United States via a blanket licensing process for clearing sound recording rights). Interoperability between digital music and playing devices has also been on the agenda in some OECD countries (France, Norway, Sweden, Denmark and Japan).

Outlook

There will be continued development of subscription-based business models, such as those of Rhapsody and Napster, which increased their worldwide user base to 2.8 million in 2005, and, increasingly, subscription-based streaming radio. Subscription services were previously mainly limited to the United States, but they have increasingly developed in Europe and elsewhere. Advertisement-based business models and trials with legal peer-to-peer services (*e.g.* iMesh) are also being tested. Communities such as MySpace.com and marketing on these networks are becoming more important to users when searching for music. Some independent artists are achieving visibility from Internet marketing and distribution (*e.g.* through sites such as Indiestore.com which sells music of unsigned bands), a trend that is likely to continue.

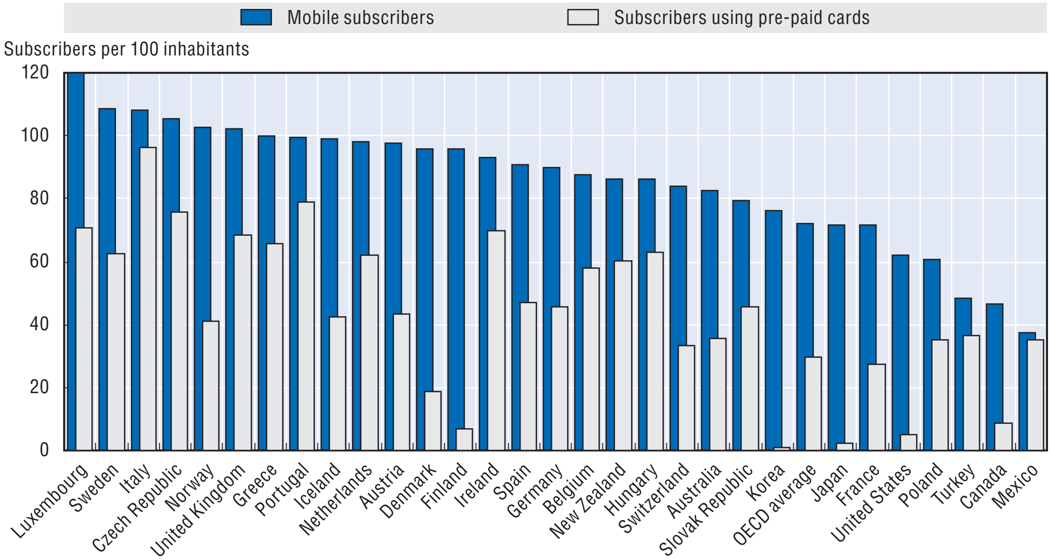
Mobile content

Development

Digital content sales via mobile devices are increasing, and this is a dynamic sales channel, particularly for music and games (OECD, 2005d). A central driver is the very large user base of mobile subscribers, with mobile phones surpassing 2 billion worldwide in mid-2005, or equivalent to nearly one third of the estimated world population (ITU World Telecommunication Indicators Database). Figure 5.2 shows the penetration of mobile phones in OECD countries, with an OECD average of over 70 mobile subscribers per 100 inhabitants. Earlier generation wireless networks have seen increasing demand for content such as ringtones, music downloads and simple games, and broadband wireless networks, particularly 3rd generation (3G), provide the bandwidth necessary to deliver increasingly sophisticated content. Technologies crucial for enabling broad dissemination of content, including marketing, distribution and billing technologies, are increasingly available and will encourage further development of mobile content.

Mobile content, developing from a low base, is expected to be a major driver of growth for the telecommunications and media industries. Voice communication revenue is growing slowly owing to competition and market saturation in many countries, and attention is shifting to mobile content, in part owing to experience in lead markets such as Japan and Korea. Popular mobile content includes ringtones, music, video clips, and wallpaper and personalisation services.

Figure 5.2. **Mobile subscribers and pre-paid card users per 100 inhabitants, OECD countries, 2004**



Source: OECD ICT Indicators database, 2006.

StatLink: http://dx.doi.org/10.1787/865832616682

Except in Japan and Korea, the most popular content for mobile phones continues to be ringtones and wallpapers. However, music downloads, video content and such other data-rich digital content as mobile TV are increasingly available. Games are increasingly developed for mobile platforms and are shifting from fairly simple embedded games to more complex interactive and multiplayer mobile games. Other content includes video, enterprise and information and location services (digital maps and related services) and gambling.

Estimates on current and future sales of mobile content vary, although almost all agree on the large potential. For example, one study of users in Europe, Asia-Pacific, North and South America projected the market for mobile downloads to be EUR 7.6 billion in 2006, with 60% of mobile users spending regularly on mobile content (TNS, 2005). Others project the mobile content industry (including messaging) to be worth USD 42.3 billion by 2010 (Informa Telecoms and Media, 2006), and high growth has been projected for mobile TV (see Box 5.1).

No single dominant mobile content value chain has emerged, and it is likely that different ones will prevail for different types of mobile content, reflecting the differing nature of content industries, different market structures and competitive conditions, and different policy frameworks for different types of content. Participants are vying to control various parts of a complex and changing value chain and to establish "ownership" of large numbers of users. These include content developers, content aggregators, mobile operators, handset manufacturers and other companies that offer enabling technologies. Mobile portals provide many of these capabilities and occupy a central position. Currently, most users obtain content from their mobile operators' branded mobile portal, with content coming from providers with whom the mobile operator has an established relationship (operator as content broadcaster and gatekeeper to the consumer). Business models for mobile content are still developing but the two most familiar ones are subscription and pay-as-you-use; advertising-based models are still rare.

Box 5.1. **Mobile TV: who pays?**

Mobile TV is being developed and trialed in many countries. 3rd generation (3G) telephony is now available in almost all OECD countries and has sufficient bandwidth to allow mobile video applications despite the limitations of its point to point ("unicast") architecture. Broadcasting technologies ("multicast" or point to many points, such as Digital Video Broadcast and Digital Multimedia Broadcast) are being made available for mobile. Hybrid architectures are being developed that use unicast cellular technologies (3G) for on-demand services and a back channel for interactive services and multicast technologies for live or near on-demand video content applications. A wide range of video-based services is becoming available and interactivity is developing, but mobile TV is still a niche market, except in Korea and Japan.

Large scale trials suggest that average viewing times may be as little as 30 minutes per month, but interested users are willing to pay. Successful established TV programmes appear to have the best potential, including popular series and live TV, particularly news and sports. Mobile TV is expected to complement traditional TV by allowing viewing away from home, for example when commuting. In terms of business models, traditional TV is a mix of subscription, advertising, revenue sharing and other transactions. Mobile TV will probably follow this structure but advertising revenue potential is more limited, and pay-TV subscription-based systems are the most likely development. However in most countries mobile TV applications are yet to be developed and who pays, and how, are key to successful development.

Achieving the forecasted high growth is slowed by the fact that access to 3G services and mobile content is still confined to early adopters. Relatively few users subscribe and use services such as video. In the United States, only 10% of mobile subscribers download a ringtone each month, and fewer than 4% download games, although text messaging is used monthly by around 33% (based on data from M:Metrics). It remains a challenge to adapt and package content to suit mobile platforms and to increase interactivity and sharing. Slow consumer demand has also been attributed to what is perceived as high-priced content, and lack of transparent price information can leave customers unsure of total costs, owing in part to data transfer costs. Mobile payments are also an issue. Users are unwilling to provide information such as credit card details for one-off transactions, but micropayment and prepaid card models have been slow to develop, and there are security issues and fears of fraud.

Outlook

The overall potential is high and content other than music and games is likely to become increasingly important. Possible futures include a shift away from the established operator-centric content distribution models; as new technologies are introduced, the position of operators may change. Examples include new entrants such as mobile virtual network operators (MVNOs) which aim to differentiate their markets by providing exclusive content,[5] as in the case of Amp'd Mobile. New consumer-to-consumer (C2C) relations are also likely along with peer-to-peer functions (recommending content to others and being able to deliver directly) and development of user-generated content beyond the already very popular photos and images. This will require further deployment of broadband wireless, and infrastructure policies for broadband, wireless and spectrum are essential to ensure that network developments keep pace with, and provide a platform for, the content being transmitted. Competition is also necessary to ensure that mobile content is not restricted to certain technological platforms. Payment and micropayment systems and associated policies need to specifically consider mobile content markets.

Scientific publishing

Development

Scientific publishing has some distinctive characteristics compared with the three entertainment-based industries above (see OECD, 2005c, for a fuller discussion). Most importantly, research outputs are essential for innovation and have an important impact on growth. The efficiency of the system for diffusion of, and access to, research results and data is an important contributor to overall technological advances and economic performance. The scientific publishing industry is mainly but not exclusively involved in the production of academic and educational journals and books. The core science, technology and medicine publishing market was estimated at USD 7-11 billion in 2003 (OECD, 2005c; European Commission, 2006; EPS, 2004; Simba, 2004). OECD country expenditures on R&D were USD 687 billion in 2004 (current purchasing power parities, OECD, 2005e).

Three different kinds of institutions publish science and research content: *i)* commercial, for-profit publishers, such as Reed Elsevier, Blackwell and John Wiley are to varying extents involved in publishing research content; *ii)* membership-based societies which are mainly interested in scholarship and its dissemination, such as the American Chemical Society, the Institute of Physics Publishing and the European Physical Society; *iii)* institutional publishers which are frequently related to universities, research centres, schools or international organisations, such as Oxford University Press and the United Nations.

As for media and publishing in general, this industry was an early adopter of ICTs, e-commerce, digitisation and digital delivery, and it has used various forms of electronic publishing for almost 30 years. Most research and technical information is now delivered electronically, changing the roles of and interactions between authors, publishers, intermediaries (libraries, sales entities) and end users. Features of the adoption and use of digital content in scientific and research publishing include digitisation and digital delivery, the changing role of large and small publishers, high transaction costs for small publishers and distributors in the more complex value chain and changing roles of intermediaries, development of open access and open archive models, and a continuing if not greater role for libraries and institutional and business users of research results.

With digitisation and the pervasive adoption of digital delivery by publishers and the research community, the roles of traditional distributors of research results are evolving, particularly since the advent of open access and open archive models, the development of new hybrid models for access to knowledge, and as established publishers experiment with complex publication unbundling and bundling strategies. There are also considerations of the benefits of spreading research results widely because of the public good dimension of scientific content and its importance for future research and for tertiary education. For producers of research content, the main objective is usually to disseminate results as rapidly and widely as possible and achieve recognition within the research community. This is a different incentive structure from that of the entertainment industries.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Research is built on the exchange of knowledge and collaboration, and researchers look to the publishing system for three main things: speedy dissemination, economical access and quality (*i.e.* peer review by other experts). With the increasing volume and rapid evolution of research and the development of high-speed communications systems, the traditional scholarly journal model is under increasing strain to deliver this combination. As a result, alternative models, especially open access (OA) or new forms of licensing, have evolved.

There are two primary forms of open access. In the first, known as open access publishing, journals grant access to articles immediately upon publication; one example is the Public Library of Science (PLoS). Second, there is open-access self-archiving, whereby authors make copies of articles they have published openly accessible, such as in a database or repository. Both open access publishing and open access archiving have attracted a substantial share of research results. For example, there are over 2 200 journals at the Directory of Open Access Journals and over 7.5 million articles available in the OAIster repository, many of which are scientific in nature (Directory of Open Access Journals, 2006, OAIster, 2006). Open access journals often publish solely on line, thereby saving the costs of paper publication.

Funding models vary, but subsidisation dominates; generally the institution or research body with which the author is associated funds the publication, but grants and donations contributed directly to the publisher or archive are also used to cover costs. There is thus a question of the viability of these financial models, as it is unlikely that all research publication can be subsidised. Hybrid open access journals are experimenting with new forms of access and determining cost and revenue models, and recent evidence has suggested that articles published as open access from the start had a higher impact than articles not published as open access, which researchers had "self-archived" on other Web sites (Hebden, 2006). A growing number of commercial and institutional publishers make back files freely available after a specific period of time (delayed open access), enabling those who desire the most up-to-date research to pay for it while allowing public access to less recent research that is still of use to researchers and scholars.

A major issue for open access journals and repositories is establishing and maintaining high standards. Traditional publishers have invested in quality assurance, and the cost of peer-reviewed articles in established highly ranked journals is high. Thus, while access to OA journals and articles may be "free", the cost of establishing and maintaining quality, actual publication and dissemination is not. Another potential issue is that authors who publish papers may not list their articles on open access repositories, resulting in a lack of efficient localisation or aggregation.

Many government and private funding bodies and an increasing number of individual research organisations and institutions have started to mandate or encourage open access or special rules on data, *e.g.* publishers should not claim ownership of data associated with journal articles and are encouraged to make data included in articles retrievable and re-usable.

Outlook

Pricing and payment models are evolving and continue to present challenges to the organisation of delivering research results. The effect that open access will ultimately have on the scientific publishing industry has yet to be determined. While there are potential problems regarding funding, maintaining high-quality standards and content aggregation, OA may very well be an influential subset of research publishing. Traditional publishers are increasingly concerned that the creation of OA repositories and journals may replace paid journal subscriptions, thus posing a threat to their current business models. Databases alone may not suffice, though, because there is still value in the journal's function of selecting and collecting articles of interest and relevance to a particular community. In the case of such repositories, there may be other ways of adding value such as by linking articles and providing better metadata, search functionality and enhanced imagery. There is also a major role for establishing and implementing digital content standards that will enable more efficient classification, archiving, retrieval and use (*e.g.* digital object identifier and metadata standards).

User-created content

New forms of expression (users as content creators) have developed with the rapid spread of high-speed broadband (see OECD, 2004a for a previous assessment of individual and household Internet use). It has become easier to post content on the Internet; many sites provide ways to create Web pages and blogs which often require no programming skills (*e.g.* Blogger). Furthermore, digital cameras and mobile phones and steep decreases in the cost of home video and music editing have made it easier to produce content which can be put on line directly. The popularity of photo-sharing sites such as Flickr.com and video-sharing sites such as YouTube, with community-based properties, illustrates this growth. Podcasts and audio files, often created by individuals, which may be downloaded and subscribed to, have also contributed (see Chapter 7). Yet despite the popularity and apparent contribution to creativity and cultural values of user-generated content, its size and impact and whether it is an enduring phenomenon or an ephemeral fashion are still unclear.

Users contribute content to Web sites, keep online diaries and blogs, and share photos and artwork. Younger people are more active; for example United States online teenagers aged 12-17 were active content creators, with more than half of all teenagers involved in such activities in 2004 (Pew, 2005). In early 2006 in the United States, 35% of all Internet users (around 48 million people) reported having posted content to the Internet (having a blog or own Web page, working on group blogs or Web pages, sharing self-created content such as a story, artwork or video), and 42% of home broadband users (around 31 million people) had posted content to the Internet, with sharing own creations on line being the most popular activity (36 million Internet users). The distribution was fairly even by income group, but was more frequent among young home high-speed users (Pew, 2006b).

One very popular development involves the blogs and other interactive online communities which are part of the participative Web, with blog numbers and postings increasing very rapidly (see Chapter 7; Pew, 2004, 2005 and data from Technorati). Social networking sites enable users to interact with others, join communities, and create and share content. MySpace, the most popular of these sites, has nearly 80 million registered users (Waters and van Duyn, 2006) and is one of the five most visited sites on the Internet (Alexa, 2006).

It is very uncertain how the participant digital economy will develop. A central issue is the "value" of this content and whether amateurs contribute high-quality work that can compete with professional content. An example is the free online encyclopaedia Wikipedia, which has currently more than 3.8 million entries (Wikipedia, 2006a) in

230 languages (Wikipedia, 2006b). Anyone can contribute articles and edit existing entries; nearly 10 000 new articles are added daily (Wikipedia, 2006c). The project also has successful user take-up; it is among the 20 most visited Web sites (Alexa, 2006). However, as anyone can contribute articles on any topic and as there is no formal editing process, a much debated issue is the actual value of its content.

A comparison of the quality of Wikipedia's with Britannica's coverage of science found that, although Wikipedia contained more mistakes (on average four *versus* three for Britannica) and had other shortcomings, the online collaborative encyclopaedia still performed relatively well (Giles, 2005).[6] Wikipedia can also update rapidly information which may be particularly useful in the fields of technology and current events. Another example is free software collaboration, with volunteer programmers contributing to various software projects such as those on SourceForge. Anyone can modify the source code of this software, and popular programmes such as the FireFox browser and the Linux operating system were produced in this way.

The relation between producers and users changes as users become content creators. This is relatively straightforward when users are the original creators. For example, specialist services such as Scoopt and Spy Media are developing for user journalists to negotiate their content rights (Twist, 2006). A more difficult question arises when user-created content is a mix of original and existing material. In some cases, the underlying copyright is disregarded and copyright holders are not compensated directly. At the same time, a growing number of creators are choosing to make their content available under flexible licences such as Creative Commons, thereby enabling outside parties to share and/or remix their work. There are many outstanding issues associated with the rapid rise of user-created content and its impacts, whether there are unnecessary bottlenecks to creativity and use, and how and in what forms this content will continue.

Changing industry structures and value chains

Radical changes in content industries and their value chains due to digitisation and digital delivery include new competition across platforms and industries, cross-industry convergence and alliances between digital content producers (television, cinema, music, games and other content producing-industries), Internet portals, IT firms and consumer electronics firms. The interests of participants are often radically different, especially between network operators and content owners, but also those of new participants such as portals and search engines. Different kinds of convergence are shaping the market: content convergence (telecommunications, broadcasting, video on demand and Internet Protocol TV (IPTV) delivered to PCs and other devices over the Internet, business convergence (telecommunications, broadcasters and triple play services), network convergence (unified networks for telecommunications and broadcasting) and terminal convergence (with different terminals being used for the same reception or the same terminal for different transmissions).

Different firms are increasingly involved in content distribution (*e.g.* telecommunications firms, ISPs, portals, mobile operators, etc.); distributors are increasingly packaging content themselves (pay TV and free TV operators are creating branded video on demand [VOD]) and mobile TV services, IPTV operators are creating branded subscription VOD services, and mobile operators are creating branded TV/VOD services); distributors create or commission enhanced content (content for mobile services); content owners are extending or creating distribution brands; and the role of search engines is increasing.

Impact of digital content

Because industry characteristics, market structures and competition vary, no single simple value chain has emerged for content industries. Firms that are able to expand services to a wider audience are likely to realise economies of scale and scope, as initial product development is costly while subsequent distribution tends to have low marginal costs.

Four structural trends can be identified across digital content industries:

- Established value chains are changing, particularly at the distribution level.
- This has resulted in disintermediation and frequently re-intermediation as old (physical) distribution mechanisms are replaced by new (digital) ones.
- New intermediaries are often participants in established value chains.
- Transformations are increasing further up the value chain in content development and access.

Content industries all still rely heavily on revenue from traditional sales, but a large and increasing range of products is available on line or via mobile platforms. Digital content services are sold directly to consumers via firm Web sites (games, music), and publishers deal directly with libraries (scientific publishing). But disintermediation, whereby producers bypass all intermediaries (wholesale or retail) to sell to end users, has not taken place to the extent initially expected.

In general, with the notable exception of retailers, many traditional participants remain important players in altered value chains. For small retailers, the role of traditional stores has been challenged, but larger physical retailers have often successfully expanded services to become online as well as offline intermediaries (*e.g.* Virgin Megastores). ISPs, mobile operators and specialised content distribution portals (*e.g.* HighWire Press) are increasingly important, and established firms in other sectors (Starbucks in music, Coca Cola in games) have entered some digital content markets as new intermediaries. Re-intermediation involves different participants, and it also requires, for example, DRM and payment providers, content marketing, rights acquisition and management, advertising, billing management, and access management.

Relations between network service providers, technology suppliers and content providers are changing, possibly moving towards more complex relations within value chains. Intermediaries such as ISPs that have successfully entered distribution have moved up the value chain towards content development. Network operators also increasingly play new upstream and downstream roles, for example in supporting games distribution, and evidence suggests that a higher share of online content sales of games goes to developers and publishers than previously.

New products

The online environment also offers possibilities for providing different and improved products to customers. Initially, there was no product adjustment; physical products were offered on line, but it was possible to offer a wider variety of products and content than physical retail stores. Moreover, products themselves have changed to varying degrees

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

(*e.g.* massively multiplayer online games). Value-adding features (*e.g.* reader ratings, links to related work, different search possibilities) are also increasingly provided on scientific content sites.

To some extent digital content products are complements to established products; in the games industry, for example, they may add to an existing traditional game and provide additional information or the possibility to play with other players that are online. However, they frequently become substitutes, as in the case of scientific articles which can be downloaded rather than searched for in a library. Access to news has also changed with younger people consulting online sites rather than physically printed products. This suggests that, especially for younger people, digital products substitute for offline products. Moreover, some are neither complements nor substitutes but new products made possible by technological progress, *e.g.* interactive games.

Cost structures and business models

New technologies, particularly broadband, are challenging established business models and value chains, with some content areas more successful in developing successful new models than others. For example, the speed of technological and business innovation in the new online games industry has been faster than in other established entertainment industries. While online music services have developed, film and video services are still, for various technological, business and other reasons, scarce.

There is still considerable flux between subscription-based and advertisement-supported business models. While "on-demand" delivery is increasingly common, possibilities include pay-per-track and pay-per-play (*à la carte*) models, subscription-based models (sold in package) and/or advertisement-based business models. The selling of logos, ringtones, and merchandising linked to content is also part of the new business models. Online games companies increasingly generate revenue by item sale and co-promotion partnerships with global brands. There is also the potential (for example in music and publishing) to shift to the "long-tail" business models enabled by digital distribution and make available back catalogues and specialist items with relatively lower sales volumes. Digital technology also enables content creators to charge different consumers different access prices. Online sellers can gather and share large amounts of information about their customers and price accordingly, although this raises consumer resistance and privacy issues.

Subscription and pay-per-use pricing are both popular. Subscription models, whereby users pay a certain fee to access content over a specific time period, are generally used for complex games and scientific journals. In the United States, subscription services were the dominant form of payment for all digital content in 2004. Single-item payments accounted for only 15.4% of content sales. However, pay per item is increasingly popular with users for downloads of music and similar entertainment content (Online Publishers Association, 2006). There is also some evidence that music users favour single-track purchases; a 2005 survey found that 40% of respondents wanted to buy individual songs and only 8% preferred subscription services (Parks Associates, 2005a). Further, pay-per-item pricing has been popular for mobile content purchases. One of the challenges for the wider success of pay per use is that it depends on the existence of suitable (micro)payment mechanisms.

One of the commercially most successful digital content business models has been developed by the games industry. Users pay a monthly subscription fee to participate in large-scale online interactive evolving games. The very high user uptake of games such as the World of Warcraft and Korean online games has demonstrated that these models can work. The music industry has also experimented with different pricing models, but for many music download services margins from per-track sales are still low.

In scientific publishing there is considerable debate over providing free access to research publications and repositories, sometimes through author-pays models. Much scientific research is publicly funded, and there is increasing pressure to make results freely available. Recognised quality control mechanisms such as peer review will be important for successful take-up of free online sources.

Online advertising

Online advertising is beginning to account for a significant share of advertising revenue, a shift that is putting pressure on traditional business models. Advertising's role in providing free entertainment will probably not change, *i.e.* consumers are unlikely to pay directly for all content. However, mass marketing is being replaced by targeted and sometimes interactive advertising, with placements in films, television programmes, games and even blogs becoming more common. More transparent ways of paying for advertisements will develop as advertisers gain a better sense of the value generated from advertising.

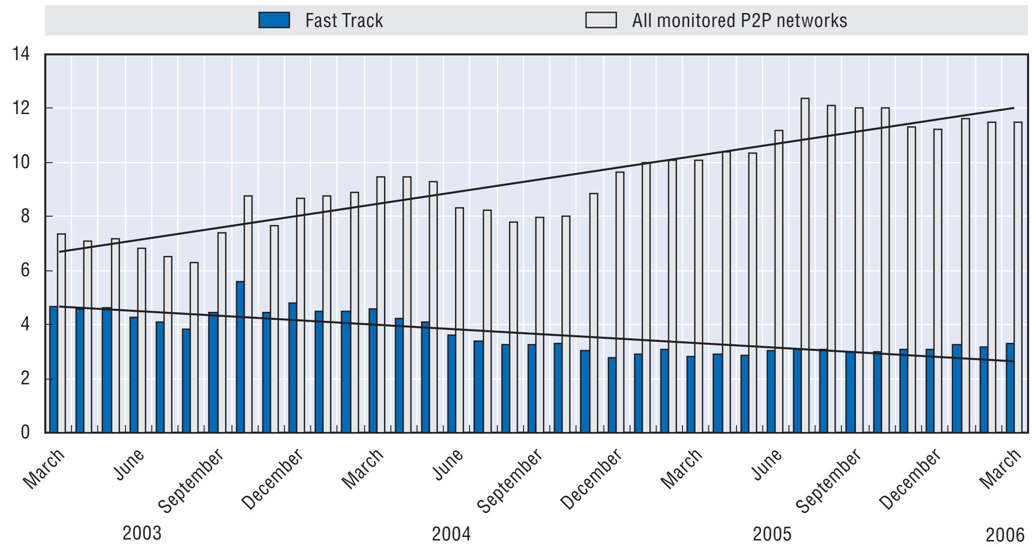
Advertising still represents a relatively modest share of content industries' revenue. Advertisements have been integrated into online games, but currently for less than 10% of console games (*The Economist*, 2005a). Games are also specifically designed for advertising purposes. About USD 90 million was spent by US firms on such advertising in 2004, and large firms such as Coca Cola have increasingly invested in their development. It has been projected that spending on Internet advertising will increase, and online music and games are seen as interesting alternatives to traditional advertising (*e.g.* Parks Associates, 2005d). With some exceptions (*e.g.* medical journals) similar opportunities do not generally arise for scientific content.

Monetisation of peer-to-peer networks

Peer-to-peer (P2P) networks open new opportunities for commercial and non-commercial content production and delivery (OECD, 2004b). Content, Internet service and technology providers are looking increasingly at ways to "monetise" P2P networks (EITO, 2006). This involves using P2P networks in legitimate ways rather than for unauthorised downloading of copyrighted works.

Available data suggest that the use of P2P networks is on the increase. The number of simultaneous P2P users on all monitored networks rose to 11.5 million in March 2006, up from 7.3 million in March 2003 (Figure 5.3).[7] At the same time the world's P2P users on FastTrack file-sharing networks (distributed networks, such as used by KaZaA, with a decentralised base, not relying on central servers or master lists of files) peaked in October 2003 at about 5.6 million and have since fallen to less than one-third of all P2P users in March 2006. This shows a clear shift away from fast-track networks such as KaZaA towards networks such as eDonkey, eMule, Torrents and other non-fast-track networks (confirming the trend noted in OECD, 2004b). There has also been a shift to use of P2P networks which are less easily tracked (Karagiannis *et al.*, 2004) and the sharing of video files is increasing.

Figure 5.3. **Global use of peer-to-peer network (fast-track and all monitored networks), measured in simultaneous audience at peak volumes (in millions), March 2003-March 2006**



Source: OECD, based on BigChampagne data. Trend lines added.

StatLink: http://dx.doi.org/10.1787/212066538340

In terms of the distribution of P2P users, 66% originate from the United States. Germany accounts for 5%, France for 3.5% and Canada for 3.2% (Table 5.2; note that less popular sites and some Asian sites may not be tracked). When weighted by population, the share of simultaneous P2P users in OECD countries has increased significantly from 2003 to 2006. Luxemburg appears to have the most intensive per capita use (roughly 12% of total population at peak times and 7% on average), followed by Iceland, Finland, Norway, Ireland and the United States. On average, 1% of the OECD population is logged on to a P2P network (four times the value in 2003). If the data were weighted by number of Internet users rather than by population, average use of P2P in the Internet user population would be higher.

The majority of files traded are audio files (Figure 5.4). Nevertheless video and other files, including software, make up 35% of total files exchanged, and their share has significantly increased. Downloading of video files has become faster and simpler, and the film industry is increasingly looking at ways to contain unauthorised downloading of film content.

Figure 5.4 shows the breakdown of file use for the popular P2P network, KaZaA, for individual OECD countries. Germany had the highest share of video files downloaded via fast-track networks (close to 40% of the total), followed by Italy (37%), Belgium (33%), Norway (31%), Canada (30%) and the United Kingdom (29%). From 2003 to 2006, the percentage of video downloads has slightly increased in all OECD countries (except Iceland). Australia and Norway rank first in terms of percentage increase.

Table 5.2. **Distribution of simultaneous P2P users in OECD countries, peak use April 2006**

Percentage of all users and percentage of the total population (value for 2003 in brackets)

	P2P users in country	April 2006 (%)		Users in total population (%)
1. United States	7 601 324	66.2 (55.4)	Luxembourg	11.7 (0.4)
2. Germany	549 749	4.8 (10.2)	Iceland	7.6 (0.1)
3. France	406 430	3.5 (7.8)	Finland	3.7 (0.2)
4. Canada	365 991	3.2 (8)	Norway	2.7 (0.3)
5. United Kingdom	363 557	3.2 (5.4)	Ireland	2.6 (0.1)
6. Austria	203 361	1.8 (0.5)	United States	2.6 (0.9)
7. Spain	202 821	1.8 (1.1)	Austria	2.5 (0.3)
8. Finland	195 110	1.7 (0.2)	Hungary	1.9 (0.02)
9. Hungary	189 403	1.7 (0.1)	Belgium	1.6 (0.4)
10. Belgium	167 588	1.5	Czech Republic	1.5
11. Czech Republic	154 496	1.3	Slovak Republic	1.3
12. Norway	121 919	1.1	Canada	1.1
13. Ireland	107 116	0.9	Switzerland	0.9
14. Italy	82 232	0.7	Denmark	0.8
15. Japan	81 676	0.7	Germany	0.7
16. Slovak Republic	72 654	0.6	France	0.7
17. Switzerland	64 956	0.6	United Kingdom	0.6
18. Poland	55 042	0.5	Spain	0.5
19. Luxembourg	52 859	0.5	Portugal	0.4
20. Australia	48 416	0.4	Sweden	0.3
21. Denmark	41 853	0.4	Australia	0.2
22. Korea	37 856	0.3	Netherlands	0.2
23. Portugal	37 491	0.3	Greece	0.1
24. Mexico	30 217	0.3	Poland	0.1
25. Sweden	26 864	0.2	Italy	0.1
26. Netherlands	26 813	0.2	New Zealand	0.1
27. Iceland	22 142	0.2	Korea	0.1
28. Greece	16 148	0.1	Japan	0.1
29. Turkey	7 405	0.1	Mexico	0.0
30. New Zealand	5 558	0.0	Turkey	0.0
OECD countries	**11 339 047**	**98.8**	**OECD average**	**1**

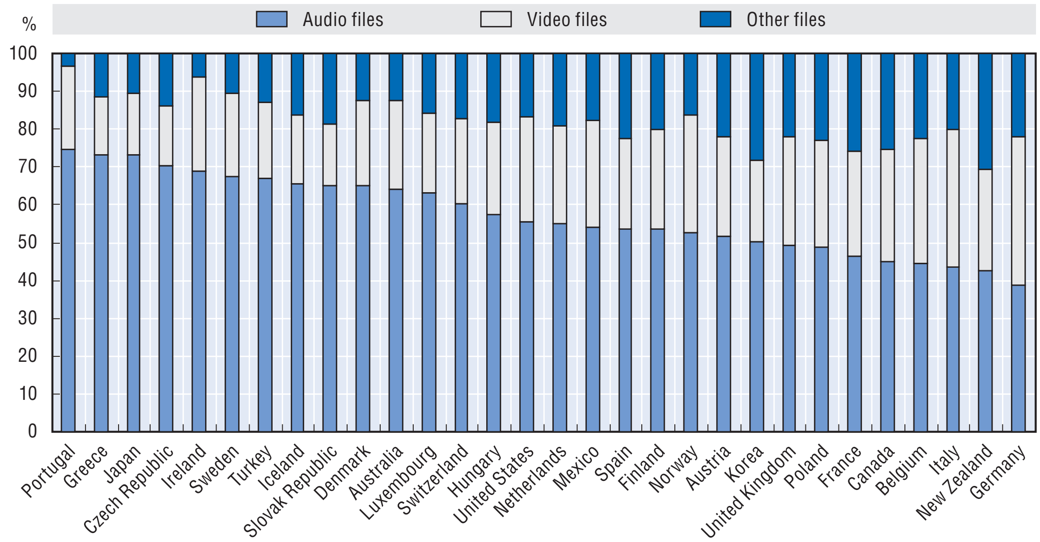
Source: OECD based on BigChampagne data.

StatLink: http://dx.doi.org/10.1787/214784537714

In addition to the rise of legitimate online content provision (notably for online music but increasingly for video content), a series of court judgements against unauthorised file-sharing services in late 2005 and 2006 in the United States, Australia, Chinese Taipei, Korea and the Netherlands, legal proceedings against P2P users who have engaged in unauthorised uploading or down-loading of copyrighted content, and educational campaigns have all contributed to changing the market for digital music and consumer attitudes to unauthorised file sharing. Record industry associations such as the IFPI are announcing progress in the battle against unauthorised file-sharing of copyrighted material.

Content, Internet service and technology providers are beginning to develop commercial P2P networks and shift towards P2P technology for distribution. Warner Bros., for instance, is planning to license content through BitTorrent, marking the first distribution arrangement involving a major film studio. Links to films and television shows will be positioned in the BitTorrent.com Web site, and protected files will be transferred

Figure 5.4. **File format breakdown for OECD countries, based on FastTrack data, March 2006**



Source: OECD based on BigChampagne data.

StatLink: http://dx.doi.org/10.1787/502058274412

using the BitTorrent file-sharing protocol. In the United Kingdom, the BBC has negotiated terms with independent feature film, TV and animation companies for its P2P-based iPlayer service. This will allow programmes owned partly by the BBC to be shown on the iPlayer service immediately after they have been broadcast and up to seven days later (Faultline, 2006). Previously, the period for viewing broadcast works over the Internet was shorter, to protect DVD and other later service revenues (for more examples see EITO, 2006).

Drivers of digital content development and delivery

Various factors have stimulated the development of digital content; among the most important are technological developments, new products, changing access and higher efficiency and greater demand.

Technology

The development of digital content has increased with the wide diffusion of broadband and the growing potential user base for high-quality content. Technology has been the motor for new content development by many content industries and by individual creators. These developments include (OECD, 2005a, 2005c; Darlin, 2006):

- Rapid spread of broadband and its global scope, deployment of optical fibre and new and next-generation networks (Digital Video Broadcasting – DVB-H/T, 3G/UMTS, Wi-Fi/Worldwide Interoperability for Microwave Access – Wimax), and the move to ubiquitous sensor networks (including radio frequency identification, RFID).
- Shift to Internet-protocol-based content distribution which is independent of time, device used and location, is subscriber-centric and allows for a high degree of interactivity and personalisation.
- Development of digital television (both satellite-based and Digital Terrestrial Television), XM satellite radio, new digital projectors and video downloading.

- Spread of new hand-held user devices and the expansion of wireless networks (including portable broadband services and portable broadcasting services such as Digital Multimedia Broadcasting, DMB) and mobile applications.
- The multiplicity of viewing device formats and resolutions, particularly mobile and portable ones.
- The "virtual living room" which connects different home entertainment devices as PCs, DVD players, hi-fi, games consoles and TV so that any can be used to view content stored on any other.
- Development of content protection and delivery systems, new security standards, authentication, accounting, and clearing technologies.
- Also important are industry agreements on common standards to enhance interoperability; however, more traditional distribution channels, such as broadband Internet connections, will remain important.

The creation of content is increasingly R&D- and innovation-intensive. In addition to the artistic and business risks inherent in different kinds of content creation, such as film production or complex media-rich applications, it also requires creative R&D input. The computer games sector draws on leading-edge R&D in areas such as imaging and interactivity. On the platform and delivery side, the design, format, accessibility, and searchability of Web sites and documents are of major importance. Online content delivery necessitates technologies for content packaging and management; compression and encryption technologies (*i.e.* codecs); digital asset, content and rights management; content distribution networks (including mobile services and digital broadcasting); payment systems; and new hardware. Audiovisual content and technological and business applications for the "new digital living room" and "ubiquitous networks" involve the development of open and interoperable platforms and delivery technologies. Technological tools (*e.g.* DRM, watermarking, fingerprinting, encryption) to assure secure and safe access to content and privacy are often required.

Suitability of content for digital delivery

Not all content is equally suitable for digital delivery and not all access platforms are equally appropriate for different types of content. Urgency, immediacy, mobility, file size and using devices are among the factors determining suitability. For example, it may not be very convenient to access large journal articles or data collections on small mobile devices; a physical copy may be preferable. Similar considerations may apply to other types of content, but technological developments and rapid improvements in network quality increasingly reduce these difficulties.

Low marginal cost of duplication and delivery of digital content and presentation in accessible formats which can be stocked, manipulated and searched more readily are among the reasons for the increasing push towards content digitisation in areas that were previously considered unsuitable. The digital environment makes it possible to address a wider audience than corresponding offline sales, and there are usually fewer constraints on physical space for stocking and distributing products. For example, if scientific content can be efficiently provided on line, there are cost savings over physical delivery and storage. Technology has also facilitated the production of creative content; for instance, musicians can record songs by using personal computers without the need for a recording studio.

Demand and use

Digital content development and delivery provides more personalised products, more flexible access to content and greater possibilities for interaction. For example, as many users want to access content while on the move, this has driven the development of mobile information services, interactive quiz shows and comedies as well as news. Most of those who use online news sites tend not to buy offline newspapers. Users increasingly want to listen to their favourite music wherever they are, find quickly the scientific papers they require and be able to interact with others while playing games. Interactive media are supplanting traditional entertainment media and the "long-tail" effect spreads the availability of niche products by reducing the cost of stocking and accessing digital products with small sales volumes.

Users are also specifically interested in customisable and interactive tools. They have been challenging established distribution arrangements, and new mass distribution and inter-community trading has grown, along with new forms of use and user-created content. They engage in new forms of consuming news and accessing information, participate in online games as part of a social network and seek to be part of a virtual community with similar tastes. In the traditional entertainment model, the creator of the content is in the middle and the audience is at the edge, but a more complex set of structures and content flows is developing.

In the United States, younger age groups typically use more online services than older generations (*e.g.* for their source of news), and they represent an important share of consumers of online video and computer games as well as of other entertainment content (Pew, 2006a). In Europe playing games and downloading music tracks were most popular among those aged 16-24 and increasingly less of interest to older generations (see Table 5.3; and Demunter, 2005). They are also more active creators of digital content than other age groups and there are differences across countries, with the Asian market one of the most important for mobile content.

Table 5.3. **Proportion of Internet users playing/downloading games and music, by age group, selected European countries 2004**

Percentage

Age group	Denmark	Germany	Finland	Sweden	UK	Greece	Austria	Poland
16-24	49.2	51.6	80.5	56.6	62.1	74.2	38.6	68.9
25-34	28.5	25.6	64.4	31.5	39.9	51.1	18.7	39.2
35-44	21.8	15.7	46.4	23.9	39.4	42.6	12.1	30.6
45-54	15.2	14.8	40.3	19.0	28.1	37.7	8.9	27.3
55-64	10.9	10.6	30.3	12.4	28.3	24.0	11.6	22.3
65-74	12.5	:	36.5	18.6	:	17.2	10.3	4.4
16-74	24.5	23.9	53.9	28.3	40.3	55.2	19.1	48.5

Source: Eurostat, Community survey on ICT usage in households and by individuals.

StatLink: http://dx.doi.org/10.1787/472627008165

Challenges to digital content development and delivery

Challenges for the digital content industries include finance, skills, market structures, infrastructure of various kinds, interoperability, regulatory frameworks and digital piracy.

Venture capital and financing issues

Production costs and investment risk are rising rapidly for some content development activities (especially audiovisual content such as films and games), and the development of digital content enterprises may encounter funding shortfalls. On the demand side, this is due in part to the intangible nature of content products and difficulties in assessing unknown markets and risk, and on the supply side to a lack of specialised expertise among finance and venture capital providers. In the games industry, it is also due in part to publishers that want partly or fully developed products before they sign contracts with developers, and this places a heavy financial burden on small firms that self-finance their development.

The high and rising cost and sophistication of content production has implications for the business environment and access to capital. Investment in a film or other content production is a risky undertaking, as there are significant sunk costs in audiovisual production, with no certain returns and strong possibilities of failure.

Skills and awareness

Skills and human capital development are crucial for all content industries as their rapid evolution requires up-to-date skills and the ability to adjust quickly to new developments. Games development requires skilled designers and programmers with specific skills, and there have been considerable mismatches between demand for and supply of skills, especially in this area (OECD, 2005c). This has been particularly challenging for smaller businesses, and similar issues have arisen in other industries. At another level, consumers need to be sufficiently aware of and able to use the Internet and other digital devices.

Market structures

Development of digital content services requires co-ordination of a wide range of industry participants (including creative artists, hardware and software firms, distributors, ISPs, mobile phone providers), some of which have not previously worked together. At least three different conditions have to be fulfilled. First, there must be an infrastructure that is adequate for the services and to which users have access. Second, suitable technical products must exist. Third, content services must satisfy consumer demand. Further up the value chain, established participants such as broadcasters, movie studios and other producers of entertainment have to be involved. It is unclear whether participants will agree on the conditions for entering such arrangements and optimising digital content product development and delivery. It may be that established industry participants want to ensure dominant positions in future e-content markets. They often demand very large shares of overall revenue for their services, and agreements are therefore difficult, particularly between network service providers with few competitors (despite entrants in other distribution systems such as cable services) and content providers which restrict content to certain established platforms. Recently, however, there has been an increase in industry partnerships to develop and deliver digital content.

Infrastructure for digital distribution

Digital distribution channels need to have in place:

- Technologies that protect digital works and appropriate DRM schemes. The challenge is to develop robust DRM programmes and technologies that ensure both that unauthorised copying is not possible, and that they do not inconvenience users, are inflexible or negatively affect service users.
- Adequate, efficient and secure payment systems (including micropayments). These would encourage a wider diversity of profitable business models, for example purchase of single music tracks, game plays or journal articles.
- Adequate protection of consumer information and privacy.
- It is important for providers of digital content to have systems that efficiently host and aggregate large amounts of content. It also has to be easy for consumers to access content and to update information and content offers. Additional requirements for successful portals include the use of efficient marketing tools which draw attention to the site, as in the case of physical retailers.

Infrastructure for micropayment systems

To pay for access to or download of single content items requires an effective and secure payment and authentication system, and the absence of reliable, widespread low-cost micropayment systems is therefore seen as a problem (OECD, 2006b). For example, fees for a USD 0.99 music download may exceed 25%. Credit card companies have minimum transaction charges even for micropayments, and micropayment models are not yet widespread, although payments via mobile phone billing or prepaid phone cards are possible in some countries. More appropriate regulation may be needed to accommodate the development of efficient payment systems by non-financial institutions which might play an important role. In Norway, for example, the government encourages micropayment systems and Japan has also been supporting the use and popularisation of "automatic payment systems". Cross-border payment remains a further problem.

Basic processes for end-user identification, authorisation and payment must also be in place. There must be a mechanism for identifying the customer, recognising the device used, and authorising the end user to access a subscription or download single-use items.

Interoperability and standards

To develop competitive and efficient content markets requires a wide variety of interoperable and compatible standards for content and hardware. However, a range of different proprietary and incompatible formats, networks, services and consumer devices may hamper development of online content distribution (OECD, 2005b, 2006a). For digital music and mobile content in particular incompatible audio codecs, DRM formats and hardware devices reduce use possibilities. These differences make it difficult if not impossible to mix content from different services (de Lussanet and van Veen, 2005). There are also considerable lock-in effects owing to *de facto* standards. With vertical integration, lock-in may raise entry barriers for small and innovative players. There have recently been a number of initiatives in areas that would benefit from greater standardisation and interoperability, such as T-Mobile. supported by Universal Music, Sony Music, Warner Music and major mobile handset manufacturers to develop a standard platform for mobile music.

While there are benefits to adopting standards, there are also potential costs, as they may inhibit later innovation and limit possibilities for product differentiation. Because governments do not have the experience and technological or other foresight to pre-select standards in fast-moving areas, initial market experimentation is likely to be necessary to develop the best approaches. However, governments can provide frameworks for co-operation and can encourage business, experts and standards organisations to work together to develop better standards. The new Korean content growth strategy, for example, includes efforts to create digital content standards (including for DRM, e-learning) and enhanced co-operation with the International Organization for Standardization (ISO).

Digital piracy and file-sharing

The advent of digital technology creates major opportunities but also challenges for digital content. Extensive piracy may be an important impediment to creating and strengthening legitimate services for distributing copyrighted content on line. According to IFPI data, by the middle of 2005, 900 million music files were available on unauthorised networks and Web pages (IFPI, 2005b). Illegal P2P music file-sharing has had an impact on content industries and may have deterred the development of additional digital content. In the face of increasing piracy, OECD governments have worked to promote the protection of IPRs through legislation (national law and international treaties), enforcement and increased criminal sanctions, and awareness/education campaigns (including youth education programmes).

There is an ongoing debate about how important illegal file sharing will be in the future. It has been argued that authorised content services such as Apple's iTunes Music Store are the model for extensive authorised downloading (Nagel and van Kruijsdijk, 2005). However, other evidence suggests challenges remain. For example, in a survey of United States teenagers, more than four in five of those who downloaded music files agreed with the statement that music downloading and file sharing were easy and that it was unrealistic to expect people not to do it (Pew, 2005). The games industry has successfully developed products that are not easily copied, such as massively multiplayer online games which are not static so that there is no point to downloading a version at any specific time. Similarly, the provision of more advanced services (including the possibility of customising access to content and monetising P2P networks) by other industries may also limit illegal file sharing.

Digital rights management

Adequate protection mechanisms are a common challenge for digital content industries. DRM technologies provide three basic functions: *i)* they encrypt content to allow access only to authorised users; *ii)* they provide licence systems which control access to content and what can be done to the content; and *iii)* they provide authentication mechanisms to identify users (Schrock, 2004). Effective DRM technologies are seen as a means of enabling digital distribution of content, and, through their ability to create various ways to access content, they may facilitate the development of products tailored to consumer demand (*e.g.* the right to purchase time-limited access to songs) and increase consumer choice, satisfaction and overall economic welfare if price discrimination expands markets.

An enduring challenge for DRMs is to be sufficiently robust to ensure that digital content cannot be subjected to unauthorised copying or unintended uses. To this end, many governments, by signing World Intellectual Property Organisation (WIPO) treaties, have pledged to create "adequate legal protection and effective legal remedies against the circumvention" of technological protection measures such as DRMs.

Implementing DRM systems has proved challenging as the increased use of DRM technologies has raised a number of consumer issues [e.g. problematic limitation of usage rights or inadequate disclosure and impacts on privacy, see, for example, Beuc (2004) and the UK All Party Parliamentary Internet Group (2006); actions against anti-piracy software on music CDs; and academic research (Gasser, 2004)].[8] OECD work has also analysed the disclosure issues raised by technically-imposed restrictions on the use of digital content (OECD, 2006e). Further research may be needed to throw light on the impact of DRM technologies on consumers, technological innovation and the effectiveness of DRM in protecting intellectual property rights holders. Market forces (*e.g.* consumer purchasing behaviour) and content and technology providers' growing experience with DRMs may address some of these issues and become more sophisticated, more flexible and provide support for innovative business models.

Impacts

Digitisation, development of new digital content products and digital delivery have led to changes for producers and consumers of entertainment and scientific content. This section focuses on some of the economic impacts on digital content industries. However, these direct effects underestimate spillovers on the wider set of industries whose primary purpose is not the generation or distribution of digital content, and across society. Moreover, if new digital delivery and access mechanisms improve and facilitate research activities, this will have additional impacts on economic growth. Games innovations such as new imaging technologies, high-speed interactivity, and touch feedback can also have important applications in other sectors (KPMG for the Danish Ministry of Culture, 2002; OECD, 2005a).

Changing value chains

Changes in value chains have affected participants differently. For record labels and other content developers, digital content delivery has required adjustments to sell products to a wider set of users. The online environment gives artists and other content creators the possibility to make their content widely available and gain greater visibility, but so far few artists have been discovered on the Internet, despite some recent music successes (see below). ISPs and major Web portals have greatly benefited. Traditional intermediaries have been challenged by developments in the digital content industry, but some traditional distributors have successfully reshaped themselves to take advantage of new markets. Providers of infrastructure services (*e.g.* DRM technology and payment methods providers) will benefit from further developments regardless of how value chains change.

Hardware and services

Digital content industries are drivers for consumer electronics and PC manufacturers owing to consumer demand for constantly improved hardware and devices that enable them to access content, play increasingly complex games, download music and video, and combine these attributes with greater mobility. Revenues from PCs and consumer electronic devices are sometimes larger than those from sales of related digital content. Further, if hardware products have network economies, providers of content and hardware products have a mutual interest in providing as much content as possible for a particular hardware product. Developments in content also have an impact on mobile handsets, as users will purchase new models with improved access to such digital content (*e.g.* games and video). Consumers will also be more interested in home networking if they are active users of digital content (Parks Associates, 2005b; CEA, 2005).

Internet and creative supply

New ways of creating, distributing and accessing content can affect creativity by opening up new commercial and non-commercial content creation and distribution channels, by interaction between creators, users and consumers, by lowering barriers to entry and driving down creation and distribution costs, by expanding markets and uses in ways that favour creativity and diversity, and by developing niche markets (OECD, 2006a). In the music industry, the potential of the Internet means that artists can package, present and distribute differently than in the past. In spite of the possibility of online distribution, traditional content industry firms, such as music publishers and record companies, often retain their key role in content creation and distribution. They provide essential services as producers, for tour planning and support, marketing to reach consumers, and negotiations with Internet-related service providers (*e.g.* firms such as Nokia, Vodafone, Verizon, Yahoo!, and AOL). Small independent producers play an important role, often in fragmented markets (language, culture), and, with low overheads and fewer sunk costs, they may have fewer problems breaking free from old business models.

Horizontal lessons

Although there are major differences between individual industries, there are also some common lessons. First, wider diffusion of broadband Internet has increased possibilities for the growth and development of digital content industries and innovative products. These developments have significantly challenged existing value chains. Specifically the position of traditional distributors has undergone changes (both disintermediation and re-intermediation), and more changes are also likely further up the value chain. Moreover, various new and traditional business models are being tested in the new environment; they range from subscription to pay-per-use, and the role of advertising is changing markedly in some content areas. In scientific publishing, access contributes effectively to information and data circulation and use and is a core issue.

Furthermore, the trend towards greater mobility is likely to have a major impact on digital content. As users increasingly use interactive tools and create different sorts of online content it is necessary to develop support infrastructure, including payment methods, DRM software, security, privacy and consumer protection. Overall the development of digital content has broad spillovers in related electronic and infrastructure industries and a strong impact on other industries because it changes how they deliver their content, with effects throughout the economy.

Government roles: Market participants create and develop digital content value chains and business models but governments play a major role in developing general "enabling factors" for the creation (*e.g.* creative environments, ICT skills) and use (*e.g.* ensuring widespread access to broadband) of digital content (see Chapter 8, and OECD, 2006c).

Governments act as facilitators, remove impediments to investment and create an appropriate business environment by addressing market failures that hamper R&D, innovation, access to capital, education and the development of skills. The development of non-discriminatory framework conditions can reduce barriers to entry and improve competitive conditions (especially for new and smaller firms). Competitive markets for content and telecommunication services are crucial for broadband take-up and content diffusion and use. Many OECD governments have developed a focus on digital content and/or related creative/content industries, either with overarching digital content policy frameworks (such as the UK's Digital Strategy/Digital Content Forum) or with programmes specific to certain digital content industries and/or applications (OECD, 2006c).

The public sector has a major role as producer and user of digital content and applications. On the producer side, this includes public sector information that can be commercially re-used and public sector educational, cultural (museums, archives), and other content for which public good and spillover arguments support a major government role. Governments also participate in or support the development of and digital access to content (*e.g.* archives of public broadcasters). On the consumer side, governments can support demand by improving access and diffusion of information in areas such as online health and education (OECD, 2006d).

Conclusion

The games, music, scientific publishing and mobile content industries have very specific and different characteristics, but digital content is increasingly important and is the major driver of growth for all of them. The rise of digital content markets has challenged established non-digital value chains and new digital value chains are increasingly complex and diverse. In downstream distribution, disintermediation and re-intermediation have both occurred, and new value chain participants have entered as new intermediaries or to supply infrastructure services. New business models are being experimented with, including subscription (games) and pay-per-use (music). Advertising is becoming less important in some areas (mobile TV) and more important in others (search). In scientific publishing more direct forms of free (to the user) access are developing.

Continuous improvements in technology for networks, software and hardware, including mobile and wireless services, have been important for the development of more advanced digital content. A further driver has been the fact that many of these industries' products are suitable for digital delivery, thus enabling online distribution to improve market access and lower costs. One of the main challenges is improved co-operation as production of digital content requires agreements among participants, including content developers, device manufacturers and distributors. To succeed, suitable and cost-efficient infrastructure services, including payment systems and DRM technologies, have to be in place and content interoperability and compatibility issues resolved.

For users, more, and more diverse, content is available on line than off line, and innovative new products provide customised services with greater interactivity. An increasing number of users are also becoming digital content creators (see Chapter 7), and although it is unclear whether this is a long-term development or an ephemeral fashion, it is stimulating content development and industry behaviour. Furthermore, developments in these industries have major spillovers into non-content industries and wider impacts across the economy. Finally, governments have a role to play in developing general "enabling factors" for the creation and use of digital content, maintaining a supportive business environment as well as a major role in producing and using digital content (see also Chapter 8).

Notes

1. The OECD and Italian Minister for Innovation and Technologies, International Conference on "The Future Digital Economy: Digital Content Creation, Distribution and Access", Rome, Italy, 30-31 January 2006; details available at: *www.oecd.org/sti/digitalcontent/conference*.
2. The video games market reflects consumer spending on console games (including handheld games), PC games, online games, and wireless games. The category excludes spending on the hardware and accessories used to play the games.
3. *http://epp.eurostat.cec.eu.int/cache/ity_offpub/ks-np-05-040/en/ks-np-05-040-en.pdf*.
4. United States: 353 million single tracks downloaded (up from 143 million) (Nielsen SoundScan); United Kingdom: 26.4 million single tracks downloaded (up from 5.8 million) (OCC); Germany: estimated 21 million single tracks downloaded (up from 6.4 million) (IFPI Germany); France: estimated 8 million single tracks downloaded (up from 1.5 million) (SNEP).
5. See *www.mobilein.com/what_is_a_mvno.htm*. For an example see Amp'd Mobile *http://get.ampd.com/*.
6. See *The Economist* (2006), "Encyclopaedia Britannica takes on Nature", 30 March for a criticism of the study.
7. BigChampagne provides data on country-specific use of P2P networks, their evolution and determinants of use. It does so by indexing and searching shared folders on P2P networks and tracks some 50 million search queries a day to determine the activity and origin of P2P users. The data show the activity and origin of P2P users logged on to a given P2P network. BigChampagne began monitoring Napster in 2000 and now covers the most popular networks, including FastTrack (KaZaA, Kaza Lite, iMesh, Grokster, etc.), eDonkey, Direct Connect and all Gnutella-based client, as well as ScourExchange, AudioGalaxy, Morpheus, etc. However, it does not track less popular P2P sites, such as Soribada in Korea or FileRogue in Japan, or smaller ones in other OECD countries.
8. See also the INDICARE project at: *www.ivir.nl/publications/helberger/INDICAREStateoftheArtReport.pdf*. For analysis of the impact of Online Music Stores on user rights, see the Berkman Center's case study, "iTunes: How Copyright, Contract, and Technology Shape the Business of Digital Media"; and "British Music Fans Experience Digital Frustrations", digitalmusicnews.com (26 April 2005).

References

Alexa (2006), "Global Top 500", *www.alexa.com/site/ds/top_sites?ts_mode=global&lang=none, accessed 8 June*.

All Party Parliamentary Internet Group (2006), "Digital Rights Management", Report of an Inquiry by the All Party Internet Group, *www.apig.org.uk/current-activities/apig-inquiry-into-digital-rights-management.html*.

Behrendt, W. (2003), "Dossier on Digital Games and Learning – Paradigms, Markets and Technologies", EP2010, September.

Beuc (The European's Consumers' Organisation) (2004), "Digital Rights Management", BEUC/X/025/2004, *www.beuc.org*.

CEA (Consumer Electronics Association) (2005), "Digital America 2005", *www.ce.org/Press/CEA_Pubs/819.asp*.

Crandall, R. and J. G. Sidak (2006), "Video Games: Serious Business for America's Economy", Brookings Institution and Georgetown University Law Center for the Entertainment Software Association (ESA).

Darlin, D. (2006), "Data, Music, Video: Raising a Curtain on Future Gadgetry", *New York Times*, 2 January.

Demunter, C. (2005), *Statistics in Focus*, Eurostat, European Communities.

DFC Intelligence (2004), Review: Themis Report on Online Gaming 2004, at: *www.dfcint.com/game_article/jan04article.html*.

DFC Intelligence (2005a), "Top Video Game Companies Generate Annual Revenue of 25 Billion According to DFC Intelligence", Press Release, 22 March.

DFC Intelligence (2005b), "DFC Intelligence Releases New Market Forecasts for Video Game Industry", Press Release, 29 June.

DFC Intelligence (2005c), "Interactive Entertainment Industry to Rival Size of Global Music Business", Press Release, 9 November.

DFC Intelligence (2006a), "The Online Game Market Forecast", Report, March.

DFC Intelligence (2006b), "The Online Game Market", Report, June.

Digital Music News (2006), "Paid Downloads Enjoy Record Sales Week in US", January, available at: *www.digitalmusicnews.com/010905dload*.

Directory of Open Access Journals (DOAJ) (2006), www.doaj.org/, accessed 10 June 2006.

European Information Technology Observatory (EITO) (2006), "Peer-to-Peer (P2P) networks and markets", Part 2, EITO 2006.

Electronic Publishing Services (EPS) (2004), "STM Book Publishing: A Sector in Crisis?", EPS Focus Report, London, May.

Entertainment Software Association (ESA) (2006), "Essential Facts about the Computer and Video Game Industry, 2005 Sales, Demographics and Usage Data", May.European Commission (2006), *Study on the Economic and Technical Evolution of the Scientific Publication Markets in Europe,* Final report, DG Research, by Dewatripont, M. *et al*., Brussels.

European Leisure Software Publishers Association (ELSPA) (2006), "Record Sales for Games Market", ELSPA Press Release, 9 January.

Faultline (2006), "BBC Closes out Deal for Showing UK TV over P2P. Ground-breaking PACT", 8 June.

Gasser, U. (2004), "iTunes: How Copyright, Contract, and Technology Shape the Business of Digital Media – A Case Study", June 2004, Berkman Center, Harvard University, *http://cyber.law.harvard.edu/media/uploads/81/iTunesWhitePaper0604.pdf*.

Giles, J. (2005), "Internet Encyclopaedias go Head to Head", *Nature*, published online14 December.

Hines, M. (2005), Verizon Adds Disney to TV Package, *Eweek.com*, 21 September.

Hebden, S. (2006), "Open-access research makes a bigger splash", *SciDev.Net*, 17 May.

International Federation of the Phonograms Industries (IFPI) (2005a), *IFPI online music report 2005*, IFPI, London.

IFPI (2005b), *IFPI Network: The Newsletter of the International Recording Industry*, October.

IFPI (2005c), *The Recording Industry World Sales 2005*, London, 22 March.

IFPI (2006), *IFPI Online Music Report 2006*, IFPI, London.

Informa Telecoms and Media (2006), "The Mobile Content Industry", *www.informatm.com*.

International Game Developers Association (IGDA) (2005), "2005 Mobile Games White Paper", presented at the Game Developers Conference 2005 by the IGDA Online Games SIG.

Interactive Software Federation of Europe (ISFE) (2006), "The Economics of Gaming", *www.isfe-eu.org/*.

Karagiannis, T., A. Broido and M. Faloutsos (2004), "Is P2P dying or just hiding?", University of California at Riverside, mimeo at *www.caida.org/publications/papers/2004/p2p-dying/*.

KPMG for the Danish Ministry of Culture (2002), The Interactive Culture Industry: Background Paper, June, *http://ep2010.salzburgresearch.at/knowledge_base/kpmg_2002.pdf*.

de Lussanet, M. and N. van Veen (2005), "Mobile Music Needs a Tune-Up", Forrester Research, 13 September.

Nagel, B. and J. van Kruijsdijk (2005), "Online Media Needs to Mix Carrots with Sticks – UK Net Users are Willing to Pay Reasonable Prices for Legal Content", Forrester Research, 2 December.

OAIster (2006), *http://oaister.umdl.umich.edu/, accessed 10 June* 2006.

OECD (2004a), "Use of ICTs by Individuals and Households", Chapter 4, *OECD Information Technology Outlook 2004*, OECD Paris.

OECD(2004b), "Digital Delivery", Chapter 5, *OECD Information Technology Outlook 2004*, OECD Paris.

OECD (2005a), "Digital Broadband Content: The Online Computer and Video Game Industry", DSTI/ICCP/IE(2004)13/FINAL.

OECD (2005b), "Digital Broadband Content: Music", DSTI/ICCP/IE(2004)12/FINAL.

OECD (2005c), "Digital Broadband Content: Scientific Publishing", DSTI/ICCP/IE(2004)11/FINAL.

OECD (2005d), "Digital Broadband Content: Mobile Content – New Content for New Platforms", DSTI/ICCP/IE(2004)14/FINAL.

OECD (2005e), *Main Science and Technology Indicators*, 2005/2.

OECD (2006a), OECD and Italian Minister for Innovation and Technologies International Conference on *The Future Digital Economy: Digital Content Creation, Distribution and Access*, Rome, Italy, 30-31 January, *www.oecd.org/sti/digitalcontent/conference*.

OECD (2006b), "Online Payment Systems for E-Commerce", DSTI/ICCP/IE(2004)18/FINAL.

OECD (2006c), "Digital Broadband Content: Digital Content Strategies and Policies", DSTI/ICCP/IE(2005)3/FINAL.

OECD (2006d), "Digital Broadband Content: Public Sector Information and Content", DSTI/ICCP/IE(2005)2/FINAL

OECD (2006e), "Report on Disclosure Issues Related to the Use of Copy Control and Digital Rights Management Technologies", DSTI/CP(2005)15/FINAL.

Online Publishers Association (2006), Online Paid Content: US Market Spending Report, March.

Parks Associates (2005a), "Consumers Not Receptive to Music Subscriptions", Press Release, 10 February.

Parks Associates (2005b), "Adoption of Digital Content Drives Home Networked Storage", Press Release, 8 March.

Parks Associates (2005c), "Online Gaming Revenues to Triple by 2009", Press Release, 14 December.

Parks Associates (2005d), "Internet Advertising Spending to Double its Share by 2010: Interactivity and Targetability Are Key Merits for Winning Ad Formats", Press Release, 10 December.

Parks Associates (2006), "US On-demand Internet Content Revenues to Approach 9 Billion by 2010", Press Release, 17 January.

PEW (2004), "Content Creation Online", Pew Internet and American Life Project, 29 February.

PEW (2005), "Teen Content Creators and Consumers", Pew Internet and American Life Project, 2 November.

PEW (2006a), "Generations Online", Report, 22 January.

PEW (2006b), "Home Broadband Adoption 2006", Report, 28 May.

Schrock, J. D. (2004), "Digital Rights Management – In Search of New Directions", Accenture.

Simba (2004), "Global STM Market Analysis and Forecast 2003", Simba Information, Stamford, Connecticut, *www.simbanet. Faultline (2006)com/publications/report_gstm.htm*.

The Economist (2005a), "And Now, a Game from our Sponsor", 9 June.

TNS (2005), "Consumer Demand for Mobile Content", research carried out for Logicacmg (6 July), at *www.logicacmg.com*.

Twist, J. (2006), "The Year of the Digital Citizen", *BBC News Web site*, 2 January.

Vickery, G. and S. Wunsch-Vincent (2005), "ICT Use in Services and the Growth of Digital Content Services", in *Enhancing the Performance of the Services Sector*, OECD, Paris.

Waters, R. and A. van Duyn (2006), "MySpace Seeks Link with Google or Microsoft", *Financial Times*, 23 May, *http://news.ft.com/cms/s/b2f9a994-e9e0-11da-a33b-0000779e2340.html*.

Wikipedia (2006a), "Wikipedia:About", *http://en.wikipedia.org/wiki/Wikipedia:About, accessed 8 June 2006.*

Wikipedia (2006b), "Wikipedia Statistics", 10 May, *http://stats.wikimedia.org/EN/Sitemap.htm, accessed 8 June 2006.*

Wikipedia (2006c), "Wikipedia Statistics: New Articles per Day", *http://stats.wikimedia.org/EN/TablesArticlesNewPerDay.htm accessed 8 June 2006.*

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

ISBN 92-64-02643-6
OECD Information Technology Outlook 2006

Chapter 6

ICT Skills and Employment

ICT skills and employment are driving forces for technological development and growth, but there has been relatively little consistent cross-country analysis. This chapter analyses recent developments in the supply and demand for ICT-skilled employment, with ICT specialists now making up around 4% of total employment and ICT users around 20%. The shares of both are increasing in almost all countries. Many business functions and services are increasingly location-independent, and the occupations potentially affected by ICT-enabled distance work and offshoring of services are analysed. Internet recruitment is also considered as it potentially has important implications for the efficiency of labour markets.

Introduction

ICT skills are a driving force for technological development and growth. More generally, ICT literacy and basic skills have become an integral part of modern life. In spite of their importance, there has been relatively little consistent cross-country analysis of ICT skills and employment owing to differences in definitions, classifications and data sources as well as their rapid evolution. To help fill this gap, this chapter provides an overview of various aspects of the development of ICT skills and employment. It examines recent developments, presents indicators of ICT-skilled employment[1] and considers whether the demand for ICT skills is evolving. The discussion then turns to the means of supplying ICT skills, as workers with the appropriate ICT skills are increasingly important for maximising gains from the adoption of new technologies. Next it considers two trends which the increasing pervasiveness of ICTs has facilitated: Internet recruitment and distance work. Because ICTs also affect the tradability of certain types of services and business functions, making these activities increasingly location-independent, with potential impacts on employment (also see Chapter 3), this chapter looks at employment that is potentially affected by ICT-enabled offshoring of services and the types of tasks that can be automated or digitised.

Measuring ICT-skilled employment

ICT-skilled employment represents a significant share of total employment and appears to be growing in many segments. It can be measured in various ways. This section looks at measures of the share of ICT specialists and ICT users in total employment (see Box 6.1 for

Box 6.1. **Defining ICT specialists and ICT users**

Three categories of ICT competencies are distinguished:

1. *ICT specialists,* who have the ability to develop, operate and maintain ICT systems. ICTs constitute the main part of their job.

2. *Advanced users*: competent users of advanced, and often sector-specific, software tools. ICTs are not the main job but a tool.

3. *Basic users*: competent users of generic tools (*e.g.* Microsoft Word™, Excel™, Outlook™, PowerPoint™) needed for the information society, e-government and working life. Here too, ICTs are a tool, not the main job.

Thus, the first category covers those who supply ICT tools (hardware and software), and the second and third categories those who use them. This chapter uses the first category for the narrow measure of ICT-skilled employment, and the sum of all three categories for the broad measure of ICT-skilled employment.

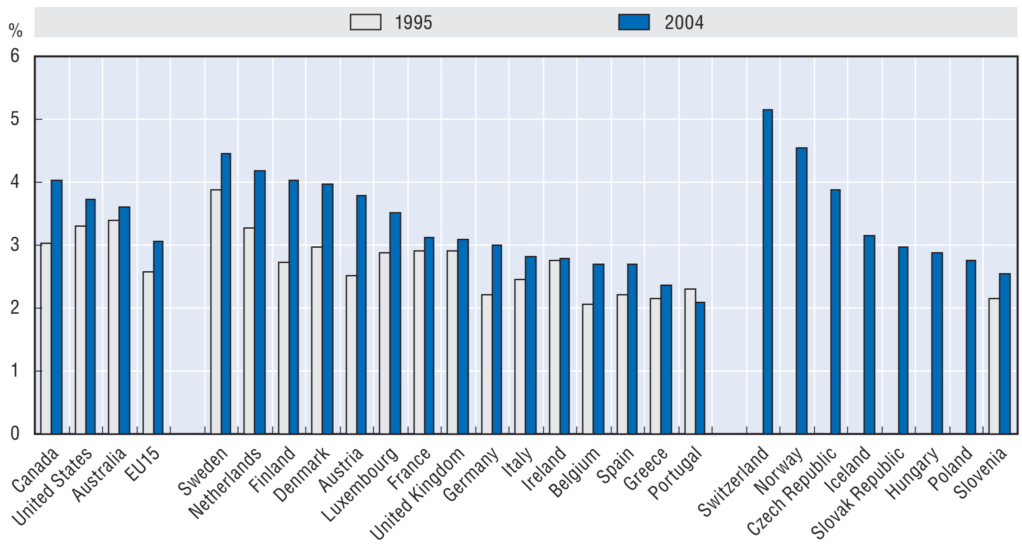
It appears that, increasingly, ICT specialists are expected to have ICT specialist as well as other skills, including "business" skills. Similarly, non-ICT related professions increasingly require at least basic ICT user skills.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

definitions).[2] These measures are presented on a cross-country basis in Figures 6.1 and 6.2. A measure of the share of ICT specialists and users among the unemployed is given in Figure 6.3.

ICT specialists account for around 3-4% of total employment in most countries (Figure 6.1). In all countries for which data are available, except Portugal, the share of ICT specialists increased between 1995 and 2004. Within the EU15, Sweden had the largest share of ICT specialists in total employment in both 1995 and 2004 (the shares of Switzerland and Norway were even higher). Belgium had the smallest share in 1995 and Portugal in 2004. The trend is rising in almost all countries, although the levels for non-European countries are not directly comparable with those for European countries as the classifications were not harmonised.

Figure 6.1. **Share of ICT-related occupations in the total economy, narrow definition,[1] 1995 and 2004[2]**



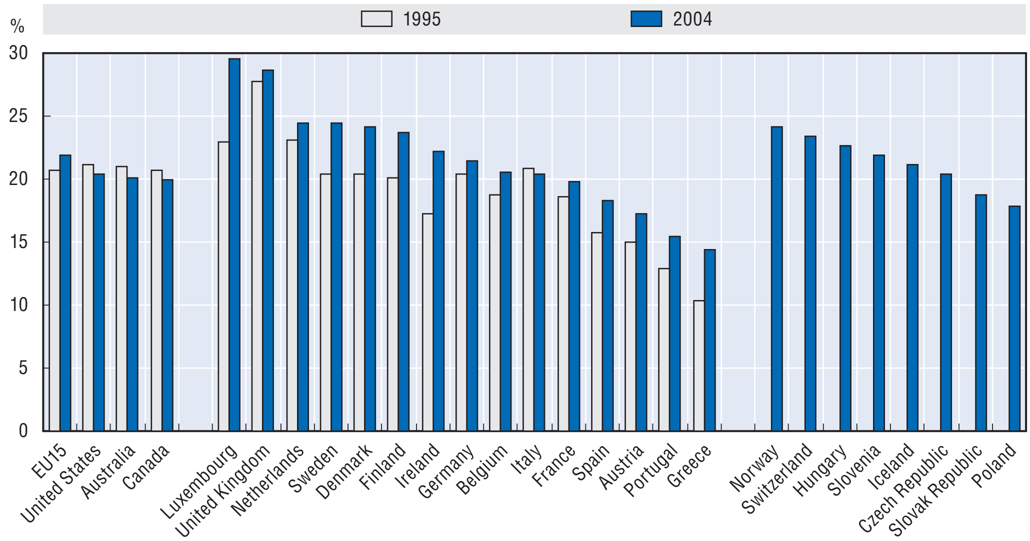
1. Narrow definition based on methodology described in OECD (2004a, Chapter 6) and van Welsum and Vickery (2005b The shares for non-European countries are not directly comparable with shares for European countries as the classifications were not harmonised: For some estimates classification changes have occurred. The EU15 aggregate does not contain estimates for missing years – when a full data set was not available, countries were omitted from the EU15 aggregate.
2. Except: Australia, Finland and Sweden 1997 instead of 1995; Portugal 1998 instead of 1995; Ireland 1999 instead of 1995; Austria, Canada 2003 instead of 2004.

Source: Based on EULFS, US Current Population Survey, Statistics Canada, Australian Bureau of Statistics.

StatLink: http://dx.doi.org/10.1787/841078224732

In 2004, ICT producers and ICT users combined (*i.e.* the broad definition in Box 6.1) accounted for 20-30% of total employment in most countries. Countries such as Denmark, Finland, Sweden and the United Kingdom, with a relatively high share of ICT specialists, also had a relatively high share of broadly defined ICT-skilled employment (Figure 6.2). Most countries experienced an increase in the share of broadly defined ICT-skilled employment (except Portugal in the EU, and Australia, Canada and the United States). Within the EU, the United Kingdom had the largest share of broadly defined ICT-skilled employment in 1995 and Luxembourg in 2004, and Greece the lowest in both 1995 and 2004. However, the ICT content of occupations may differ across countries, even when the data are in the same classification. Thus, for any occupation, the degree of ICT usage in the United Kingdom, for example, could be significantly different from that in another country, such as Portugal.

Figure 6.2. **Share of ICT-related occupations in the total economy, broad definition,[1] 1995 and 2004[2]**



1. Broad definition based on methodology described in OECD (2004a, Chapter 6) and van Welsum and Vickery (2005b). The shares for non-European countries are not directly comparable with shares for European countries as the classifications were not harmonised. Includes estimates where classification changes have occurred. The EU15 aggregate does not contain estimates for missing years – where a full data set was not available, countries were left out of the EU15 aggregate.
2. Except: Australia, Finland and Sweden 1997 instead of 1995; Portugal 1998 instead of 1995; Ireland 1999 instead of 1995; Austria, Canada 2003 instead of 2004.

Source: Based on EULFS, US Current Population Survey, Statistics Canada, Australian Bureau of Statistics.

StatLink: http://dx.doi.org/10.1787/660164882845

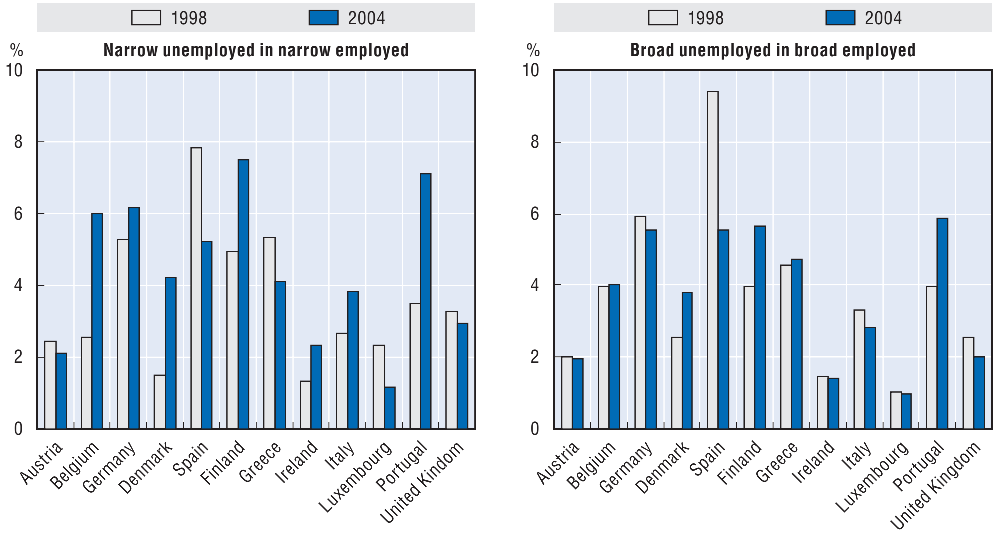
Given the increasing importance of ICT skills and employment in the economy, ICT-skilled unemployment may be expected to be relatively low. This can be measured by looking at the ratio of unemployed to employed under the narrow and broad measures. An increase in the ratio represents a relative worsening of the employment position of these categories. The left-hand side of Figure 6.3 shows the ratio of unemployed to employed ICT specialists in 1998 and 2004 for 12 European countries. The results vary, with ICT specialists relatively worse off in seven out of 12 countries. The broad measure of ICT users is shown on the right-hand side. Their relative position deteriorates in only four out of 12 countries.

How are skills needs evolving?

The discussion of ICT skills is often set in the context of a presumed shortage of ICT skills, usually specialist skills. However, it is quite difficult to find tangible evidence of such shortages. Because skills needs evolve rapidly and shortages may be short-term and resolved fairly quickly, they may not appear in official data, which usually have a relatively important time lag. Surveys within the profession trace monthly and quarterly changes, often by tracking advertised and/or notified job vacancies. This is illustrated in Box 6.2 with an example from the United Kingdom, which shows very large annual shifts in demand for different job titles and for particular skill sets.

The public and private sectors appear increasingly to require a mixture of skills. Thus, it is often no longer enough to have "only" ICT specialist skills. Instead, a combination of technical and other types of skills is demanded, *e.g.* management, project management,

Figure 6.3. **The relative importance of unemployed ICT specialists and ICT users, selected countries, 1998 and 2004**



Note: As the employed and unemployed are not drawn from the same reference population, it is not possible to show levels. Instead their relative shares are calculated as an indication of the relative importance of certain occupations among the unemployed relative to the employed. Ireland 1999 instead of 1998. Austria and Germany 2003 instead of 2004, Luxembourg 2002 instead of 2004.
Source: OECD, based on EULFS.

StatLink: http://dx.doi.org/10.1787/150858886538

business, sales, marketing. Three examples illustrate this idea. First, Table 6.1 shows the job categories listed under the heading "IT jobs" on two online recruitment Web sites. Some of the main headings already suggest a broader skills range than ICT specialist skills. The job titles suggest that skills required in addition to ICT specialists skills include sales, business development, management, marketing, and "people" or "contact" skills. CEDEFOP (2004) also highlights the need for a combination of ICT specialist skills and other skills, *e.g.* behavioural and personal skills (especially when there is contact with clients, which is increasingly the case), and e-business skills.

Table 6.1. **IT jobs categories**

From *www.careerbuilder.com/*: IT jobs		
AS/400 Jobs	Executive Jobs	Systems Design Jobs
Business Analyst Jobs	Internet Jobs	Technical Writer Jobs
IT Consulting Jobs	Legacy Systems Jobs	IT Training Jobs
Database Jobs	Tech Management Jobs	Unix Jobs
Data Warehouse Jobs	Network Jobs	Unix Administration Jobs
Desktop Support Jobs	IT Operations Jobs	Web Development Jobs
Entry Level Technology Jobs	Project Manager Jobs	Windows Development Jobs
ERP Jobs	Quality Assurance Jobs	
From *http://mycareer.com.au*: IT and telecommunications jobs		
Bus/Systems Analysis	Management	Tech Writing and Desk, Pub.
DB Dev and Admin	Network/Systems Admin	Testing and QA
Hardware Engineering	Project Management	Training
Helpdesk and Desktop Supt	Software Development	Web Development
Information Architecture	System Architecture	Other IT and T

Source: *www.careerbuilder.com/* (last accessed 20 January 2006) and *http://mycareer.com.au* (last accessed 10 February 2006.

The third example, taken from www.monster.co.uk/, another online recruitment site, illustrates the point further by looking at examples of actual job offers listed under the main IT-related job categories (Table 6.2). These also show that a mixture of skills is often demanded.

The main ICT specialist skills expected to be in demand over the next few years are in the following areas: enterprise architects, business analysts/relationship managers, security, Web services, Linux/open source, agile programming, business intelligence/Web-enabled analytics, and business process modelling (Forrester Research[3]). Again, many of these categories require a combination of "pure" ICT specialist skills with other types of skills. A slightly broader indicator of potential future demand for ICT specialist skills comes from the US Bureau of Labor Statistics. Among the top 30 fastest-growing occupations covered in the 2006-07 *Occupational Outlook Handbook 2004-14*,[4] six are directly ICT-related: network systems and data communications analysts (2nd position), computer software engineers, applications (5th), computer software engineers, systems software (8th), network and computer systems administrators (11th), database administrators (12th), and computer systems analysts (25th). For each of these, a bachelor's degree is listed as the most significant source of postsecondary education or training.

Box 6.2. **ICT specialist skills in the UK**

According to the SSL/Computer Weekly Quarterly Survey of Appointment Data and Trends[1] (January 2006), there has been a slowdown in the UK ICT jobs market. The number of jobs advertised in the fourth quarter of 2005 fell compared to the number advertised a year earlier (–6%), the first decline in two years. Salaries across the ICT job market increased by 4%. There also appears to be a marked increase in salaries in jobs for which demand has been strong .

Salary and demand changes by job title

Job title	Average salary offered 2005Q4 (pound sterling)	% change from average salary offered 2004Q4	Job title	Change in demand by job title between 2005Q4 and 2004Q4
IT director	91 040	2	Management	–3
Management/systems consultant	69 246	19	Systems	14
Projects manager	50 158	7	Development	–2
Systems developer	39 354	6	Programmers	–2
Database administrator	37 721	2	PC Support	–13
Systems administrator	34 213	2	Technical Support	–1
Systems analyst	33 490	5	Software engineering	–2
Web designer	31 084	0	Database	0
Programmer	28 762	12	Networking	34
Operator	24 205	2	Operations	–27
PC support	21 046	4	Web specialists	19

Looking at demand by sector, the biggest increase was observed in the media and publishing sector (+19%), followed by banking and finance (+6%), software houses (+5%), and electronics and communications companies (+4%). The public sector, distribution and retail and the manufacturing sector all registered a decrease in demand.

Box 6.2. **ICT specialist skills in the UK** *(cont.)*

Among the top 25 IT skills, the biggest increases in demand between 2004Q4 and 2005Q4 were registered for C#, Cisco, ASP, C, and .net, as shown in the table below. Windows 2000, SAP, Unix, Oracle and TCP/IP saw a decline in demand.

Top 25 IT specialist skills in demand in the United Kingdom in 2005Q4

position 05Q4	Skill	% change	Position 04Q4	position 05Q4	Skill	% change	Position 04Q4
1	SQL	10	1	14	J2EE	4	11
2	C	35	5	15	TCP/IP	–1	13
3	Office	11	2	16	Linux	18	20
4	Java	6	3	17	HTML	9	19
5	C++	13	6	18	Cisco	56	28
6	Oracle	–1	7	19	SAP	–11	17
7	Unix	–8	9	20	Embedded	16	22
8	SQL server	16	9	21	Exchange	9	21
9	.net	30	10	22	Windows 2000	–22	18
10	C#	73	15	23	Windows XP	–	–
11	Visual Basic	2	8	24	UML	4	24
12	ASP	38	16	25	Object oriented	7	26
13	XML	6	12				

1. The survey is based on advertisements for IT professionals on the Web and in the trade press, as well as daily and Sunday newspapers.

Source: Computer Weekly, February 2006.

Table 6.2. **Examples of job offers under IT related job categories**

Computer Services: *e.g.* Microsoft Consultant; IT Helpdesk Support; SAP Retail Systems – Technology Consultant; Document/Web Management Consultant; Graphic Design and Digital Production Assistant
Computer Hardware: *e.g.* Installation Manager; Sales Executive; Internal Sales Executive; Business Development Executive; Senior Server/Network Analyst; Unix/SAN Field/Customer Support Engineer; Electronic/Electrical Diagnostic Tester
Computer Software: *e.g.* Technical Consultant – Java C++; Software Developer; Java/J2EE Developer; Business Development Manager – Software; Manager – Software Engineering; Software Engineer – Visual Basic, COM, SQL and .Net; Senior Embedded Software Engineer – Embedded C, Assembler and Device Drivers; Firewall Engineer; Analyst/Programmer
Information Technology: *e.g.* SAP FI/CO Consultant; Project Manager; PC/LAN Technology Support Analyst; New Business Development – IT/Audio Visual Solution Sales; IT Support Assistant; Technical Information Security Officer
Internet, eCommerce and New Media: *e.g.* PHP Developer; Key Account Manager; e-Business Consultant; Integration Engineer; Web Designer; Internet / Web Application Developer; Sales Executive; Billing Process Manager; .NET / C# Developer; BizTalk with knowledge of .NET, C#, Visual Basic (VB), C++, ATL / STL, COM / COM+, BizTalk, SharePoint, Commerce Server; Online Marketing Manager

Source: www.monster.co.uk (last accessed 10 February 2006).

One consequence of this development is that the competencies needed for many specialist ICT jobs both in the private and public sectors will become increasingly complex, thereby reducing the feasibility of routinising the tasks involved and thus the scope for digitisation and/or automation. At the same time, these jobs may become more difficult to offshore.[5] However, more basic tasks that can easily be routinised can also more easily be offshored, unlike basic maintenance work, for example, which requires a physical presence. Surveys find that many IT employers increasingly offshore basic development and programming work and more junior jobs. *Computer Weekly* (February 2006) reports that "a two-speed" economy for specialist IT skills is developing in the United Kingdom, with demand for basic IT skills declining and demand for IT professionals with business skills increasing. Skills that are in short supply include project management, business understanding and multimedia skills.

Cisco's Networking Academy Programme is an example of the increased flexibility that the private sector is thought to offer for supplying ICT skills training. It is already piloting a new curriculum in order to respond to increased business skills demands for ICT specialists.

Supplying ICT skills

Given the growing importance of ICTs both at work (in the private and public sectors) and in people's daily lives, the means of supplying ICT skills has received increasing attention. ICT specialist skills and basic ICT skills are supplied in different ways. Basic skills generalise fairly naturally with the diffusion of ICTs: people need to master basic ICT use, have computers at home, and children use computers at school and at home. For ICT specialist skills, there are essentially four ways of supplying them and meeting skills needs (OECD, 2004a): through formal education, various forms of training, immigration of people with the right skills, and outsourcing/offshoring activities for which skills needs are not being met. The possibility of increasing distance work could lead to greater labour market participation by certain groups, *e.g.* women and/or people in remote areas, provided they have the required ICT skills. Attracting more women into ICT education and careers could also relieve some of the pressures on supply.

Overall, relatively fewer women than men tend to obtain science and technology degrees, and ICT degrees in particular. However, it is generally thought that ICT-related degrees will become more multidisciplinary as skills needs evolve. This may be a way to attract women into more specialised ICT-related professions. At the same time, it is likely that non-ICT degrees will increasingly have ICT-related components, given the widespread use of ICTs in many fields of study and in many professions. Women may also become more ICT-skilled in this way.

Basic ICT skills: ICTs in schools and familiarity of 15-year-olds with ICTs

With ICTs diffusing rapidly throughout the economy, at home, at school and at work, people acquire basic computing skills at an increasingly young age, through day-to-day use of computers, for example through email, chatting, surfing the Internet and games. Young people leaving the education system in OECD countries can be expected to have at least some basic ICT skills and familiarity with computers and software applications acquired at school and at home, as shown in Table 6.3 (OECD, 2006a[6]).

Overall, access to computers in schools has increased in most OECD countries but access and use is still fairly limited in some (OECD, 2006a). Furthermore, even though access at school is more widespread, 15-year olds tend to use computers more frequently at home. While some 44% of students use computers frequently at school, an average of nearly 75% use computers at home several times a week in OECD countries (and in Canada, Iceland and Sweden as much as 90%). Greece, Mexico, Poland, the Slovak Republic and Turkey are the OECD countries in which 15-year olds, particularly those from disadvantaged backgrounds, have the least access to computers at home.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Table 6.3. **Percentage of students reporting how well they perform routine tasks, Internet tasks and high-level tasks on a computer (OECD average)**

	I can do this very well by myself	I can do this with help from someone	I know what this means but I cannot do it	I don't know what this means
Routine tasks				
Open a file	90	7	2	1
Play computer games	90	7	2	1
Start a computer game	86	10	3	1
Save a computer document or file	88	8	3	2
Delete a computer document or file	88	8	3	2
Draw pictures using a mouse	85	10	3	1
Print a computer document or file	86	9	3	2
Scroll a document up and down a screen	87	8	3	3
Create/edit a document	80	13	4	2
Move files from one place to another on a computer	76	17	6	2
Copy a file from a floppy disk	75	16	7	3
Internet tasks				
Get onto the Internet	88	7	3	1
Write and send e-mails	79	12	6	3
Copy or download files from the Internet	70	19	8	3
Download music from the Internet	66	21	11	3
Attach a file to an e-mail message	58	24	13	5
High-level tasks				
Use a database to produce a list of addresses	52	30	11	7
Create a presentation (*e.g.* using Microsoft® PowerPoint®	47	27	15	10
Use a spreadsheet to plot a graph	44	31	17	9
Create a multi-media presentation (with sound, pictures, video)	35	35	23	7
Construct a Web page	28	39	27	6
Use software to find and remove computer viruses	37	29	26	7
Create a computer program (*e.g.* in Logo, Pascal, Basic)	21	35	31	14

Note: Each group of tasks is listed in descending order of the percentage of students responding "I can do this very well by myself" or "I can do this with help from someone", *i.e.* students on average are more confident performing tasks at the top of each list.
Source: OECD (2006a), Box 3.3, p. 46.

StatLink: http://dx.doi.org/10.1787/224100781677

In some countries there is a marked difference between school and home use. In Germany, for example, 23% of students regularly use a computer at school (the lowest percentage among OECD countries) but 82% are frequent users at home. The degree of computer access in schools also varies across countries, even when schools are equipped with computers. Thus, the number of students sharing a computer at school in Germany, for example, is three times higher than in Australia, Korea and the United States.

In most countries boys and girls tend to have equal access to computers at school. In Belgium, Ireland and Korea more girls than boys report having access to computers in schools. However, girls are less confident than boys about performing computer functions, especially high-level tasks such as programming or multimedia presentations. Overall, girls tend to use computers less frequently than boys and are less likely than boys to have computers at home in most OECD countries. Students tend to use computers at home for a wide range of functions, including frequent use of word processing software and of the Internet as a research tool.

Overall, these findings confirm that people more and more acquire basic ICT skills as part of their normal education, and at a relatively young age, as computers are increasingly present in schools, despite wide variations across countries and among different groups within countries.

Private-sector training: basic ICT skills

In Europe, the European Computing Driving License Foundation Ltd. (ECDL) and the Microsoft alliance (see below), among others, actively promote basic ICT skills for the populations as a whole. The Microsoft alliance focuses on ICT training for older workers and is part of the "Skills for Employability Alliance", which aims to advance digital literacy and support ICT skills training in order to alleviate challenges posed by an ageing population. The idea is that through ICT training and access to technology, older workers should find it easier to change jobs, move across sectors, participate longer in the workforce, and develop skills that will remain useful after retirement.[7] This approach emphasises partnerships between businesses, government, the education sector and local communities to provide skills and improve employability of workers and the competitiveness of the economy.

Private-sector training: ICT specialist skills

The formal education system is still an important supplier of entry-point ICT specialist skills. For example, for each of the six ICT-related occupations listed among the top 30 occupations expected to grow fastest in the United States over the period 2004-14, a bachelor's degree is listed as the most significant source of postsecondary education or training. However, the formal tertiary education system is increasingly considered not flexible enough to respond to the rapid changes in demand for specialist skills that follow rapid technological changes. Multi-stakeholder partnerships (involving players from the public and the private sector as well as local authorities) may be a more flexible way of producing skilled workers and better adapted to satisfying changing demand.

Private-sector training and vendor certificates are generally thought to constitute a relatively flexible means of supplying ICT specialist skills.[8] A large number of such certificates exist. For example, the Computing Technology Industry Association (CompTIA[9]) lists 96 skill categories in their Technical Certification Database. Each includes a number of specific skills and associated certifications. A wide variety of training methods is available, for example, asynchronous online, audio, blended learning, computer-based training, instructor-led, self-study materials, synchronous online, video, and Web-based training. Training providers include academic educational institutions, certification preparation materials providers, certification vendors, commercial learning centres, curriculum materials providers, non-profit associations, non-profit learning centres, onsite training providers, and vendor-sponsored IT academies (Box 6.5 gives the example of the Cisco Networking Academy).

Workplace training

With rapidly changing technologies, workplace training, in addition to formal education and private-sector training, is increasingly important for augmenting and adapting workers' ICT skills. This is true for many categories of workers, but is generally thought to be more important for older workers, for whom skills acquired through the educational system are likely to be substantially depreciated, and for the less skilled and less educated (Bassanini *et al*., 2005).

Box 6.3. Private-sector-initiated training and assessment of skills supply and demand

One reaction to perceived skills shortages and the sense that the formal (tertiary) education system is not flexible enough to produce graduates with the right skills has been the increase in vendor-based certificates and public-private partnerships, or multi-stakeholder partnerships. One example is the Cisco Networking Academy Programme (CNAP).

As of November 2005, the Cisco CNAP was present in some 155 countries worldwide with over 11 000 academies. The qualifications offered are open standard, *i.e.* they are not tied to Cisco technologies. The CNAP is an important example of a public-private partnership in the educational sector with some 98 partnerships at local, regional, national and even international (*e.g.* the UN Development Programme, the International Telecommunications Union) level. CNAP courses have also been integrated into the educational curricula of 41 countries. Cisco continuously works to update courses to keep up to date with the latest developments in technology; the curricula of formal education systems tend to take longer to adapt and cannot necessarily offer courses at the forefront of technological developments.

To better understand emerging trends a survey of demand and supply of networking skills in western and eastern Europe was undertaken by the International Data Corporation (IDC) at Cisco's request. The study (IDC, 2005) was based on over 950 interviews with Chief Information Officers (CIOs) in 31 countries and concluded that there would likely be an increasing shortage of people with networking skills. In particular, it found that skills gaps would be relatively high in Central and eastern Europe while western Europe would have relatively low skills gaps but would face growing demand for advanced skills in networking technologies.

Interviews with CIOs also showed that companies face the problem of finding people with the right combination of skills, especially business-related skills combined with knowledge of applications. In response, Cisco has introduced a new curriculum, i-executive, which aims to bridge this skills gap. Making work experience part of training courses constitutes another way of improving skills combinations and may also bring students closer to jobs. Furthermore, 72% of respondents claimed that certification is important at the time of recruitment, and the CCNA (Cisco Certified Network Associate) and CCNP (Cisco Certified Network Professional) were the qualifications most demanded. The main "future" advanced technology skills identified include those related to IP telephony, security and wireless technologies.

Workplace training is received while in employment and is usually, but not exclusively, provided by the employer. The average incidence of training is very heterogeneous. It is quite frequent in France, the United Kingdom and the Scandinavian countries as compared to Canada and the United States; it is relative rarer in eastern European and some southern European countries. There are concerns that employers may be reluctant to invest in training because the skills acquired (in the present case ICT skills) tend to be transferable to other employers.

Bassanini *et al.* (2005) show that most workplace training is done by employers. On average, the full cost of three-quarters of training courses is directly paid by employers, and there is little evidence that employees pay directly or indirectly through lower wages. They also report that in Europe large and innovative firms and R&D-intensive sectors[10] tend to train more than small and non-innovative firms, and that there are only small cross-country differences in training in large and innovative firms and in advanced sectors. Training also increases with educational attainment and the skill intensity of occupations; it decreases with age, and, on average, temporary workers are trained less often.

Data from Eurostat show that in 1999 in all European countries, continuing vocational training (CVT) among employees was higher in firms that had introduced technologically new and/or improved products or services and/or methods of producing products or services than in those that had not, except in Denmark where there was no difference. Furthermore, the percentage of employees receiving CVT tended to increase with firm size. However, in most countries, less than 20% of total CVT training hours were spent on computer training. In many countries, employees in smaller firms spent relatively more time on computer training.

The rise of Internet recruitment

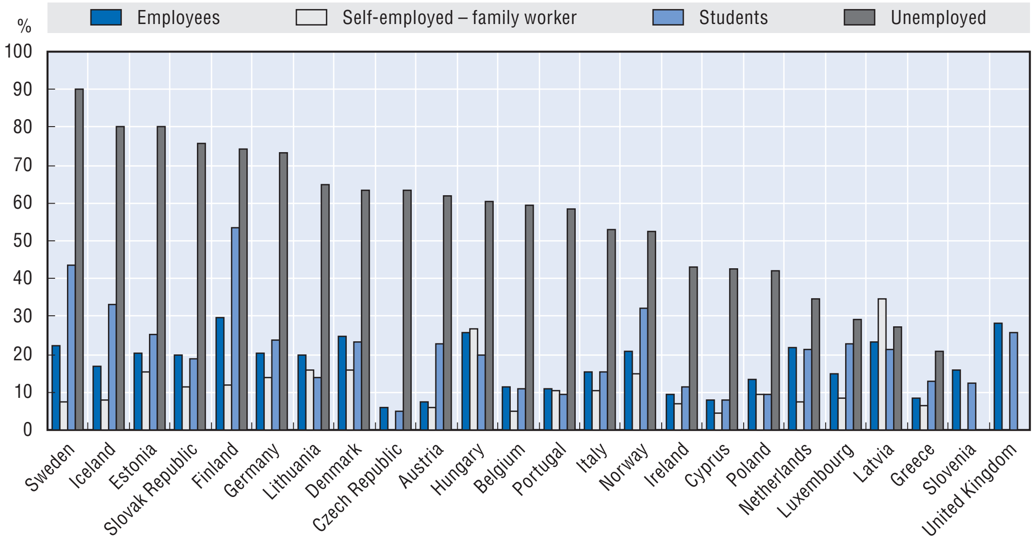
In a trend that has emerged as ICTs become an ever more common tool, the Internet has become a means of finding jobs, in the ICT sector but also in other sectors, not only for ICT specialists but for users with basic skills as well. While this means of job search is relatively new, it is likely to grow in importance. Recruitment is a very information-intensive activity, and online recruitment should clearly improve the efficiency of the labour market. Surveys show that online recruitment is quite important for ICT-related jobs and ICT-related sectors, but it is also fairly common in other sectors. Nevertheless, despite the rapid growth, the number of vacancies filled solely through online recruitment is still thought to be fairly small.

An indication of the current scope of online recruitment can be obtained by looking at the Monster Monthly Employment Indicators.[11] They show that there has been a significant increase in online demand, particularly for ICT specialist and ICT-using services workers (the "broad" category). For example in January 2006, US demand was very strong for white-collar workers in business and financial services, ICT, legal services, and office and administrative support. Online demand for workers increased across sectors and occupations. The Monster Employment Index for Canada also shows a sharp increase in online demand for workers in that month. Demand increased in all occupations, but especially for ICT, sales and healthcare workers, and management professionals. However, the European Index, which tracks online demand in five European countries,[12] showed a sharp decline in online demand in early 2006, except in Sweden, across eight out of the nine main occupational categories.

Data on Internet users in European countries show fairly widespread use of the Internet to look for a job or send a job application. As one would expect, the unemployed make greater use of this means (over 70% in six of the countries surveyed). In most countries, use by students and employees is fairly similar, except in Finland, Sweden, Iceland, Austria and Norway where students outweigh the employed by at least 10 percentage points (and by up to 23 percentage points in Finland) (Figure 6.4).

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Figure 6.4. **Proportion of Internet users looking for a job or sending a job application (past three months), by employment status, 2005**



Note: Estonia, Germany, Ireland, Slovenia and United Kingdom (students only) 2004 instead of 2005. In Sweden in 2004, "for private use" was not included in the questionnaire. Denmark "past month" instead of "past 3 months".
Source: Eurostat, Community Survey on ICT usage in households and by individuals.

StatLink: http://dx.doi.org/10.1787/063782612834

The online recruitment market is quite concentrated. In the United States, the top ten sites in February 2006 accounted for 48.5% of the total market, with two large international online recruitment firms heading the list (Table 6.4). In the United Kingdom, the top ten sites accounted for only 34.1% and only one large firm is among them (with a smaller market share than either of the top two firms in the United States). Sites from the Monster network appear both in the US and UK top 10.

A UK survey among people who have used online recruitment to find a job[13] shows that 75% have applied for a job found on the Internet (slightly up from 71% in the 2003 survey). This was mainly done by emailing a CV (curriculum vitae) to the employer or a recruitment consultant (43%) or by completing an online application form (23%). As many as 68% of those questioned reported having obtained an interview as a result of an application for a job found on the Internet, and 52% reported having found a job as a result of an interview (compared to only 29% in the 2003 survey).

While Internet recruitment appears to be gaining in importance, its impact may still be quite modest. A lot more needs to be learned about the phenomenon and about the extent to which online recruitment increases the efficiency of the labour market, in particular by matching demand and supply more quickly and at lower cost.

Table 6.4. **Markets shares of US and UK online recruitment sites, February 2006 (ranked by "visits")**

	United States			United Kingdom		
Rank	Name	Domain	Market share	Name	Domain	Market share
1	Monster.com	*www.monster.com*	14.2	Jobcentre Plus	*www.jobcenter.gov.uk*	10.9
2	CareerBuilder	*www.careerbuilder.com*	14.1	Total Jobs	*www.totaljobs.com*	4.5
3	Yahoo! Hotjobs	*hotjobs.yahoo.com*	5.5	Jobsite	*www.jobsite.co.uk*	3.6
4	Monster.com – My Monster	*my.monster.com*	5.3	Monster.co.uk	*www.monster.co.uk*	3.6
5	USAJOBS	*www.usajobs.opm.gov*	2.4	Reed.co.uk	*www.reed.co.uk*	3.4
6	America's Job Bank	*www.jobsearch.org*	1.9	National Health Service – Careers	*www.jobs.nhs.uk*	2.6
7	Job.com	*www.job.com*	1.7	TES Jobs	*Jobs.tes.co.uk*	1.7
8	MSN CareerBuilder Network	*msn.careerbuilder.com*	1.4	Friends Reunited Jobs	*www.friendsunitedjobs.co.uk*	1.3
9	Hewitt Associates	*www.hewit.com*	1.3	Guardian Unlimited Jobs	*jobs.guardian.co.uk*	1.3
10	RegionalHelpWanted.com	*www.regionalhelpwanted.com*	0.8	JobsGoPublic.com	*www.jobsgopublic.com*	1.2

Source: Data provided by Hitwise: *www.hitwise.co.uk* (last accessed 7 March 2006).

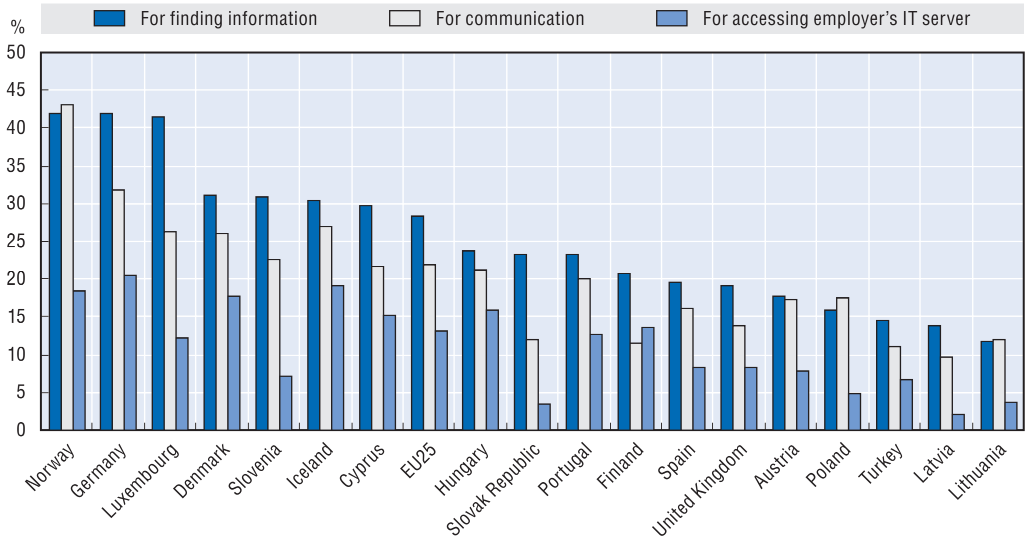
The trend towards distance work

The possibility of uncoupling work from a particular physical location points to another trend that has gained in importance with the ever broader diffusion of ICTs and more pervasive ICT skills, but may be tied to specific rules, especially in the public sector. Distance work or teleworking is work carried out from "remote" locations (from home, the train, clients, hotels, etc.), that is, anywhere other than the firm or "location" of employment itself. It is enabled by rapid technological advances in ICTs, and the diffusion of broadband Internet access has contributed to its development.[14] While work may only be carried out remotely some of the time and from locations that are not very distant geographically, it gives an idea of the scope for work that could be carried out from any remote location. It also has implications in terms of a potential increase in labour market participation, but also for a potential increase in offshoring.

Teleworkers obviously need at least basic ICT skills. They have to be being able to use a computer, connect to the Internet and download files. Enabling technologies include (laptop) computers, (mobile) phones, Internet, broadband, (remote) email, and access to the company's network. According to ATAC (2005), IP Virtual Private Network (VPN), which replicates the office environment at a remote location, is expected to become the "must have" technology for teleworkers. Data on Internet users in European countries in 2004 show that use of the Internet for (ICT-enabled) teleworking outside the employer's premises is most common in Norway, Germany and Luxembourg. In all countries except Norway, Poland and Lithuania, finding work-related information was the main reason for using the Internet, followed by communication purposes such as using email (except in Finland) and accessing employers' IT servers (Figure 6.5). While the last of these uses is still relatively rare, presumably because it tends to require a relatively more advanced IT infrastructure, its importance can be expected to increase in future.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Figure 6.5. **Proportion of Internet users (employees) performing selected work activities outside the premises of their employer (past 3 months), 2004**



Notes: For Austria "employees" includes "self-employed and family workers".
Source: Eurostat, Community Survey on ICT usage in households and by individuals.

StatLink: http://dx.doi.org/10.1787/648417824676

A survey in the United States,[15] conducted from 15 August to 1 September 2005, found that out of 135.4 million US workers, some 45.1 million (about one-third of the total) telework from an average of 3.4 locations (home, clients or customers, plane/car, outdoors, etc.). Of these, 26.1 million reported working from home at least once a month and 22.1 million at least once a week. The increase in the ability to work anywhere comes, in part, from the increased availability and lower cost of portable devices and high-speed communication technologies. The survey found that "the use of broadband in the home by teleworkers increased by over 60% during the past year resulting in 25.6 million home-based teleworkers with high-speed access."[16] The increasing importance of services, which can be traded with the help of ICTs, also plays a role.

According to the Canadian Telework Association (*www.ivc.ca/cta/*), studies for Canada show there is still a wide discrepancy between the desire to telework and the ability to do so.[17] Nevertheless, the Gartner Group[18] reported that 10% of employees in Canada engaged in telework in 2004 and that 6.4% did so at least eight hours a week (an increase from 5.9% and 3.6% respectively in 1998). Furthermore, the Gartner Group predicts a further increase to 13% and 8.4%, respectively, by 2008.

ATAC (2005) reports that around 11% of employed workers in Australia regularly worked from home in 2000. Teleworking is concentrated in service sectors, in larger firms, and in managerial or professional occupations (followed by associate professionals and advanced clerical and service workers). While there are still relatively few formal teleworking agreements, the uptake of technologies enabling teleworking has increased so that the incidence of teleworking is expected to increase as well. In 2004 some 80% of firms offering flexible work arrangements also provided the enabling technologies and 53% also offered access to the company network.

According to the Japan Telework Association,[19] Japan had 10.4 million (15.6% of total workforce) teleworkers (7.5 million employed and 2.9 million self-employed) in 2002, of which 4.1 million (6.1% of total workforce) teleworking more than eight hours a week. For employed teleworkers, most teleworking time was spent on data and information gathering, writing reports, treating statistics, and communicating with their manager and colleagues. For self-employed teleworkers, occupations were divided into three categories based on the degree of dependence on ICTs: *i)* jobs that depend on the diffusion and use of ICTs, such as Web design and programming, *ii)* jobs for which the diffusion of ICTs has changed how the job is done, such as design or finance jobs that were previously paper-based, and *iii)* jobs for which the diffusion of ICTs has had a minor impact on how the job is done, such as jobs which entail physically handling goods or those that require face-to-face contact with customers. Among the self-employed, the first category accounted for 5% of total, the second for 34% and the third for 61%. The Japan Telework Association provides a useful table comparing telework in Japan and in several EU countries (Table 6.5).

Table 6.5. **Importance of telework in selected EU countries and Japan, 2002**

% of total workforce

	Regular teleworker (at least 1 day/week)	Occasional teleworker (less than 1day/week)	Total
Finland	10.8	6.0	16.8
Sweden	8.0	7.2	15.2
Netherlands	8.3	6.3	14.6
Denmark	6.6	3.9	10.5
United Kingdom	4.8	2.8	7.6
Germany	4.4	1.6	6.0
Ireland	1.9	2.6	4.5
Italy	2.9	0.7	3.6
France	2.3	0.6	2.9
Spain	2.0	0.8	2.8
Average EU10	4.1	2.0	6.1
	Teleworker (8 or more hours a week)	Teleworker less than 8 hours a week	Total
Japan	5.8*	9.1*	14.9*
	(6.1)	(9.5)	(15.6)

* Adjusted to be comparable with EU figures.

Note: The EU defines a non-regular teleworker as an occasional teleworker. In the Japanese survey, a regular teleworker teleworks 8 hours or more a week, while an occasional teleworker teleworks less than 8 hours per week. The EU calculates the teleworker ratio relative to the total workforce (the sum of the employed and the unemployed). For comparison purposes, Japan's teleworker ratio is recalculated as the ratio of telework population relative to total workforce. The teleworker ratio is shown in parentheses.

Source: Japan Telework Association, *www.japan-telework.or.jp/english/pdf/english_010.pdf* (last accessed 13 February 2006).

StatLink: http://dx.doi.org/10.1787/230450280665

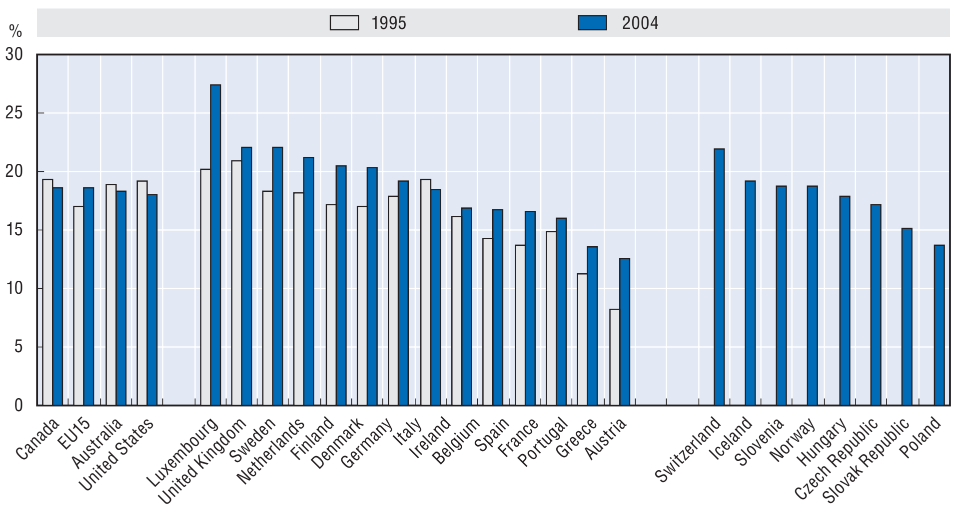
These data show that distance work, or telework, is a significant and growing phenomenon. With rapid technological developments (which make many services tasks storable and transportable and therefore candidates for distance work) and the increase in broadband roll-out, it can be expected to grow further. Distance work can help increase labour market participation of people in remote locations, women and the handicapped. However, combined with other characteristics (*e.g.* no face-to-face contact requirements) some of these tasks or jobs carried out through distance work could also be offshored.

ICT-enabled offshoring of services[20]

Outsourcing or offshoring of ICT-intensive activities is another way of supplying ICT or ICT-related skills.[21] Analysis of selected occupations on the basis of their "offshorability attributes"– *i)* intensive use of ICTs; *ii)* output that can be traded/transmitted via ICTs; *iii)* highly codifiable knowledge content; and *iv)* no need for face-to-face contact – shows that up to 20% of total employment could potentially be affected by ICT-enabled offshoring (Figure 6.6).[22] This does not mean that 20% of jobs will be offshored but it means that around 20% of all people employed (in selected OECD countries) carry out the kinds of tasks and functions that could potentially be carried out from any geographic location owing to technological advances in ICTs and the increased tradability of services. Countries and regions also gain jobs in these functional areas owing to the ICT-enabled globalisation of services as well as expanding markets for these services. Cross-country estimates of this share for 1995 and 2004 are shown in Figure 6.6; Figure 6.A1.1 shows the evolution of the share over time for Australia, Canada, EU15 and the United States.

These estimates should be interpreted as an outer limit as no assumptions are made as to how many jobs will actually move. They merely show how many are intensive in the types of tasks potentially affected by ICT-enabled offshoring. Comparing 1995 and 2004, there is a small decline in share for Australia, Canada and the United States. In the EU15 aggregate there is a small increase. Data for the underlying EU15 countries show that the share increased in all countries except Italy. While these changes should be interpreted with caution, it is possible that one reason for the decline is that some potential offshoring has become actual offshoring. In Europe the increase is consistent with an increase in employment in the services sector. Surveys have found that many European firms offshore within Europe and that countries such as Ireland also receive offshored activities from outside Europe.

Figure 6.6. **Share of employment potentially affected by ICT-enabled offshoring of services,[1] 1995 and 2004[2]**



1. See van Welsum and Vickery (2005a) and van Welsum and Reif (2006a) for further details. One methodological difference between this measure and the measure of broad ICT-skilled employment (in addition to the use of the four criteria mentioned above) is that in the latter case some detailed information was ignored to ensure maximum comparability between countries, whereas this offshoring measure exploits all available levels of detail.
2. Except Belgium, the United Kingdom, the United States, 1997 instead of 1995; Ireland, 1998 instead of 1995, and Finland, 1999 instead of 1995. Australia and France, 2003 instead of 2004.

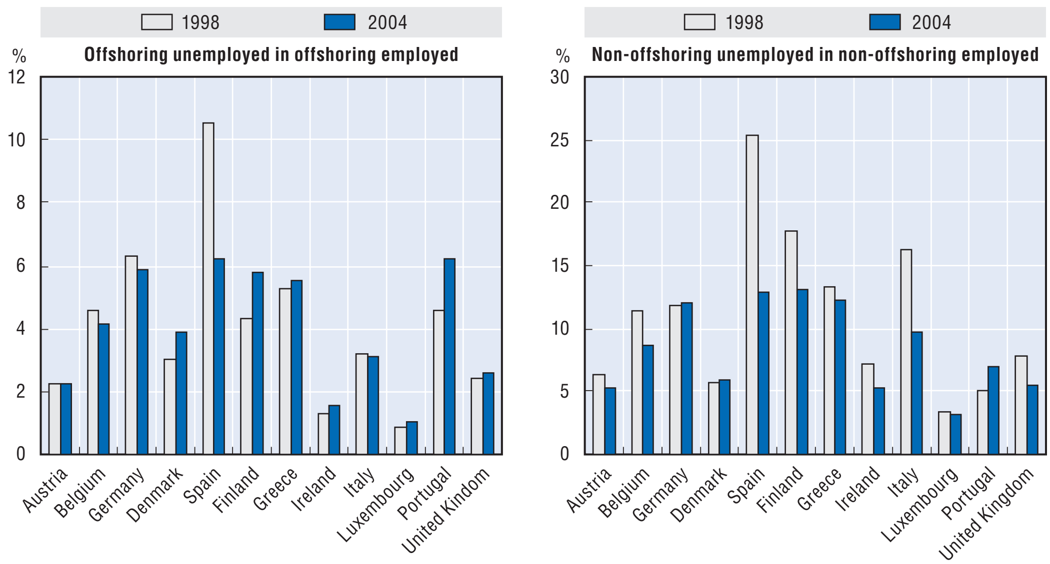
Source: Based on EULFS, US Current Population Survey, Statistics Canada, Australian Bureau of Statistics.

StatLink: http://dx.doi.org/10.1787/264114671647

The same unemployment indicator calculated above for the narrow and broad measure of ICT-skilled employment (Figure 6.3) is calculated here for employment potentially affected by offshoring (Figure 6.7). The left-hand figure shows, for the same category, the ratio of unemployed to employed among those identified as potentially affected by offshoring. The right-hand figure shows the same ratio for all those not identified as potentially affected by offshoring.

The ratio of unemployed to employed potentially affected by offshoring decreases in Belgium, Germany and Spain, corresponding to a relative improvement in their situation (the improvement also occurs for those not identified as potentially affected by offshoring). For the other countries, the ratio increases, *i.e.* relatively more people who are potentially affected by offshoring are unemployed. For those not in occupations potentially affected by offshoring the ratio of unemployed to employed goes down in all countries except Germany, Denmark and Portugal.

Figure 6.7. **The relative importance of the unemployed in occupations potentially affected by offshoring, selected countries, 1998 and 2004**



Note: The reference populations for unemployed and employed are not strictly the same and thus not directly comparable. Instead their relative shares are calculated as an indication of the relative importance of certain occupations for the two groups. Ireland 1999 instead of 1998. Austria and Germany 2003 instead of 2004, Luxembourg 2002 instead of 2004.
Source: OECD, based on EULFS.

StatLink: http://dx.doi.org/10.1787/683401052770

Clerical versus *professional occupations potentially affected by ICT-enabled offshoring*

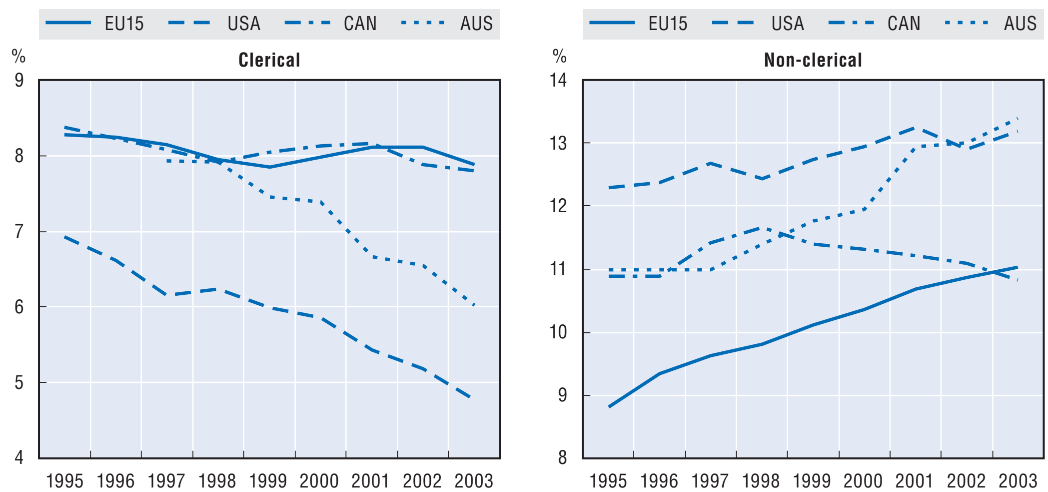
ICT-using employment potentially affected by ICT-enabled offshoring of services is analysed in more detail by distinguishing between clerical occupations and non-clerical-type mainly professional occupations (*e.g.* engineers, scientists, accountants, economists, statisticians). This is important since clerical-type occupations may be more likely to be substituted for by technology through digitisation and automation of tasks. The share of clerical workers and professional workers (potentially affected by ICT-enabled offshoring) in total employment is shown in the left- and right-hand panels of Figure 6.8, respectively.

Even though the levels of shares are not directly comparable as the classifications have not been harmonised, it is interesting to look at trends over time. In Australia and the United States, the clerical share decreases while that of professional occupations potentially affected by offshoring increases. For Canada and the EU, the share of clerical occupations is more or less stable, but the EU share of professional (non-clerical) occupations increases, whereas Canada has a small decline.

A decline in share does not necessarily imply an absolute decline in employment in the categories in question. In most cases, relatively slower employment growth in the categories in question than in total employment explains the decline. These observations therefore tend to support the idea that offshoring may lead to slower growth of employment in occupations potentially affected by offshoring but not necessarily to actual declines in employment. Indeed, the offshoring phenomenon does not inevitably result in a decline in services employment. Many existing services sectors have expanded, new services have emerged, and owing to ongoing technological developments and services trade liberalisation yet more are likely to be created. Furthermore, with the elasticity of demand for internationally traded services greater than one (*e.g.* Pain and van Welsum, 2004; van Welsum, 2004; Mann, 2004), rapid growth in countries such as India and China should also lead to greater exports from OECD countries. The offshoring phenomenon will itself create new jobs in the domestic economy.

Figure 6.8. **The share of employment potentially affected by ICT-enabled offshoring of services: EU15,[1] United States, Canada and Australia 1995-2003,[2] broken down by clerical- and non-clerical-type occupations**

Percentages



1. 1995 and 1996 exclude Finland and Sweden; 1998 excludes Ireland, and 2003 excludes Denmark, Luxembourg and the Netherlands.
2. Because of classification changes, the number for the United States for 2003 is an estimate. Due to differences in classifications, levels are not directly comparable.

Source: Calculations and van Welsum and Reif (2006b), based on EULFS, US Current Population Survey, Statistics Canada and Australian Bureau of Statistics (2004/5).

StatLink: http://dx.doi.org/10.1787/565833547200

While it is difficult to draw inferences from these trends without further analysis, since the trends are affected by many factors, they are consistent with anecdotal evidence on the ICT-enabled offshoring that is taking place. For example, the decline in the share of clerical occupations may be consistent with the offshoring of ICT-related and back-office activities (with some "potential offshoring" having become "actual offshoring"), even though this is unlikely to account for all of the decline. Another possible explanation may be a differential pace of technological change owing to more rapid adoption and integration of new technologies, so that relatively more jobs are disappearing sooner as they become automated and/or digitised.[23]

Europe's increasing share is compatible with an overall rise in services employment as well as the survey finding that European firms tend to offshore within Europe. At least one EU country, Ireland, is also a major destination for offshoring activities from the United States (ICT-related activities in particular). Other factors may also be important, *e.g.* cyclical developments and changes in labour supply and labour quality, varying importance of the size of the public sector and the services sector in the economy, and the differential pace of technology adoption and integration. However, while there are many reports of clerical-type occupations being offshored, in some countries at least still more are being created at home. In the United Kingdom, for example, employment growth in ICT and call-centre occupations potentially affected by offshoring over the period 2001-05 was 8.8% compared to 3.2% for total employment, in spite of many media reports of such jobs being offshored. Nevertheless, *Computer Weekly* (February 2006) reports that the effects of offshoring are being felt in the UK ICT job market, with more and more ICT employers offshoring and outsourcing basic development and programming work.

Even though technology (digitisation, automation) may account for at least some of the relative decline in occupations potentially affected by offshoring, the possibility that some of these jobs have effectively been offshored cannot be ruled out. For example, Baily and Lawrence (2005) argue that at least some of the declines in US low-wage ICT-enabled occupations – a concept close but not equivalent to the group of clerical workers identified above – took place as a result of activities being shifted overseas. Looking at ICT specialist occupations, they also find that the net loss of computer programmers in the United States was most likely the result of offshoring. Nevertheless, even the largest projections of jobs to be offshored, as reported in the media, are in fact relatively small compared to annual job churning in OECD labour markets (OECD, 2004b).

ICT skills supply in offshore locations

The need to cut costs and fill skills shortages is a driver of ICT-enabled offshoring of services. Competition has created a self-reinforcing dynamic since once one or two firms shift to lower-cost locations and move the cost/quality frontier, others must follow. How long the dynamic will be maintained will depend on the availability of skills and relative wage and other costs. As activities are moved offshore, relative wages will adjust and slow the offshoring process. The extent to which activities can be moved offshore will also depend on the supply of skilled labour overseas and the potential for undertaking service activities at a distance.

The supply of skilled workers is often mentioned as an important factor in choosing the location of ICT-enabled offshoring of services, sometimes driven by skills shortages in the country of origin, but possibly now also in some potential host countries. While countries such as India and China have a large supply of workers, all may not have the right skills; in fact, a large proportion are unskilled, thus limiting the current scope of ICT-enabled offshoring. Nevertheless, the potential for growth is important, especially in these two countries. Box 6.4 shows that in India competition for talent in the ICT services industry is increasing but that Indian companies are adopting new strategies to get around the labour scarcity issue. The same holds for countries such as the Philippines,[24] where company interviews suggest that booming demand for English-speaking call centre workers increases attrition rates and salary inflation (OECD, 2006b).

Given that the focus is on the ICT skills aspect of ICT-enabled offshoring, the ICT-related infrastructure, often mentioned in the offshoring debate, may give a first broad indication of what ICT skills may be available in locations that receive offshored services. The absolute number of PCs and Internet and broadband subscribers give an indication of the hardware available in those countries (see Chapter 3). However, to gain insight not only into the current availability of ICT-skilled labour but also the potential for growth in the supply of skilled workers in countries receiving offshored activities, it is more interesting to look at numbers per 100 inhabitants. For example, even though there may be a large absolute number of PCs in China, there are only four PCs per 100 inhabitants, suggesting that only a small proportion of the population is likely to use computers and computer applications at present and that there is a huge potential for increasing the skilled labour force. Language skills (English-speaking workforce in most cases, or French-speaking in Morocco[25] or Tunisia, for example) are also often mentioned as an important factor in choosing locations where people have the right skills mix. TOEFL (Test of English as a Foreign Language) test scores are included as a further indicator of skills in some of these countries. These indicators are compared to a sample of OECD countries in Table 6.6 below.

The indicators point to a relatively limited supply of ICT-skilled workers in some of these countries, particularly in India and China. However, while the indicators show that these skills are not widespread in these countries, the stock of ICT-skilled workers may still be relatively large because of the size of the population (see also Table 3.3 in Chapter 3 which gives absolute numbers of PCs and Internet and broadband subscribers). Brazil, China and Estonia perform relatively poorly on the indicator of managers' views of labour skills as a major constraint. Furthermore, most countries emerging as offshoring locations still tend to have relatively fewer researchers and technicians than OECD countries.

Another indicator of the broad availability of skilled labour is given by the stock of highly skilled workers. Figure 6.9 shows the total stock of people with completed tertiary education (ISCED5+ISCED6), as well as the share of the population aged 25-64. While the share may be relatively small as a percentage of total population, the absolute stock is relatively large, especially in China.

Returning students can also be important because of skills acquired abroad and networks of contacts established there. However, the importance or relevance of this indicator may change over time. Indeed, as some "home country" locations grow, it becomes increasingly attractive for students to study in the home country rather than abroad. Over a third of US doctorates in science and technology awarded to foreign citizens in 2003 went to students from China and India (Figure 6.A1.2; although the graph does not show if and when these students returned home, "stay rates" for Chinese and Indian students tend to be quite high).

Table 6.6. **Indicators of the presence of skills required for ICT-enabled offshoring, such as ICT and language skills, selected countries**

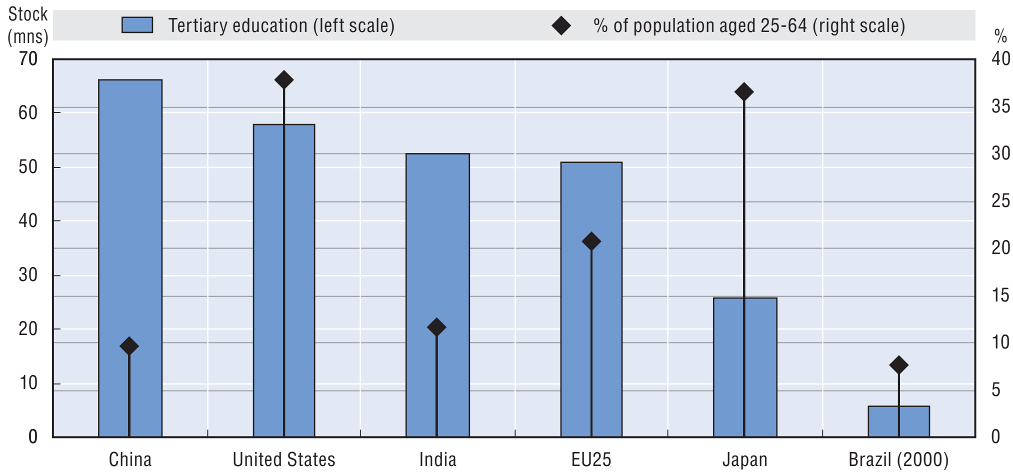
	PCs per 100 inhabitants[1]	Internet subscribers per 100 inhabitants[1]	BB subscribers per 100 inhabitants[1]	TOEFL Total Score Mean[2] Computer based test	TOEFL Total Score Mean[2] Paper based test	Labour skills (% of managers surveyed ranking this as a major constraint)[3]	Researchers in R&D (per million people)[4]	Technicians in R&D (per million people)[5]
Australia	68.9	28.8	7.8	227	X	n.a.	3 445.86	n.a.
Brazil	10.7	*4.4*	*1.2*	230	549	39.6	n.a.	128.8
Canada	70.5	25.6	17.7	236	588	n.a.	3 487.16	1 104.97
China	4.0	5.5	*2.0*	215	559	30.7	n.a.	n.a.
Czech Rep.	24.0	*22.3*	*0.7*	238	573	9.1	n.a.	792.4
Estonia	95.0	13.1	*8.5*	244	602	23.8	n.a.	385.9
France	48.7	19.8	11.2	237	569	n.a.	3133.9	n.a.
Germany	56.1	27.9	8.4	253	597	n.a.	3 222.16	1 434.95
Hungary	15.0	7.6	*3.8*	236	X	12.5	1 473.1	485.9
India	1.2	0.5	*0.0*	244	578	12.5	n.a.	n.a.
Italy	31.3	34.7	8.2	205	571	n.a.	1 155.91	1 346.49
Japan	54.2	*26.5*	14.9	191	495	n.a.	5 084.92	n.a.
Latvia	21.9	3.9	*2.1*	238	563	15.5	1 476.1	282.3
Lithuania	15.5	15.0	*2.4*	230	X	7.5	1 823.6	429.5
Morocco	2.1	0.3	*0.2*	217	512	n.a.	n.a.	n.a.
Philippines	4.5	1.5	*0.1*	234	555	11.9	n.a.	n.a.
Poland	19.1	6.5	*2.1*	203	568	12.2	1 468.6	296.0
Romania	11.0	4.4	*0.4*	249	590	10.8	909.7	288.6
Russia	13.2	*1.3*	*0.5*	231	544	9.9	3 414.6	2 315.2
South Africa	8.3	*2.2*	*0.1*	256	X	n.a.	192.0	74.4
Sri Lanka	2.8	0.5	*0.0*	225	546	n.a.	n.a.	n.a.
Thailand	5.9	*3.8*	*0.1*	202	497	n.a.	289.5	116.2
Tunisia	4.8	1.2	*0.0*	219	530	n.a.	1 013.2	33.6
United Kingdom	60.4	26.6	10.5	240	X	n.a.	2 690.66	n.a.
United States	74.1	*21.5*	12.8	226	570	n.a.	4 525.82	n.a.
Vietnam	1.3	2.3	*0.0*	204	534	n.a.	n.a.	n.a.

1. ITU (2005). Numbers for 2004; numbers in italics are estimates or refer to years other than 2004.
2. ETS (2005). Based on non-native English-speaking examinees by native country, based on 554 942 examinees who took the test between July 2004 and June 2005. Results are suppressed when the sample size is less than 30 examinees (indicated by "x").
3. World Development Indicators (World Bank, *http://devdata.worldbank.org/dataonline/*, last accessed 15 February 2006). Brazil, China, India, Philippines, Poland 2003; Czech Republic, Estonia, Hungary, Latvia, Lithuania, Romania, Russia 2002.
4. World Development Indicators (World Bank, *http://devdata.worldbank.org/dataonline/*, last accessed 15 February 2006). 2002, except Italy, Thailand 2001, Australia, Canada 2000, United States 1999, United Kingdom 1998.
5. World Development Indicators (World Bank, *http://devdata.worldbank.org/dataonline/*, last accessed 15 February 2006). 2002, except Thailand 2001, Brazil, Canada 2000, Italy 1999.

StatLink: http://dx.doi.org/10.1787/013876568023

In conclusion, while the supply of ICT and other skills may limit the extent of offshoring in the short run, the potential for growth of a skilled labour pool in India, China and other countries in the region, combined with greater diffusion of ICTs and broadband roll-out, leaves room for strong growth of offshoring to these countries in the future. The domestic market for these services is also likely to grow; this should increase demand for services from OECD countries to complement domestic supply. This will enable these countries to move up the value chain, but will ultimately also mean that their relative labour costs will rise and they will become less competitive in the long run.

Figure 6.9. **Tertiary education attainment, 2003**



Source: Schaaper (2005) based on OECD education database, Eurostat NewCronos Database, China: MOST (China S&T Indicators 2004), India: NCAER, India Science Report, Brazil: Census data.

StatLink: http://dx.doi.org/10.1787/832315161137

Box 6.4. **How does the Indian ICT industry tackle limited labour supply?**

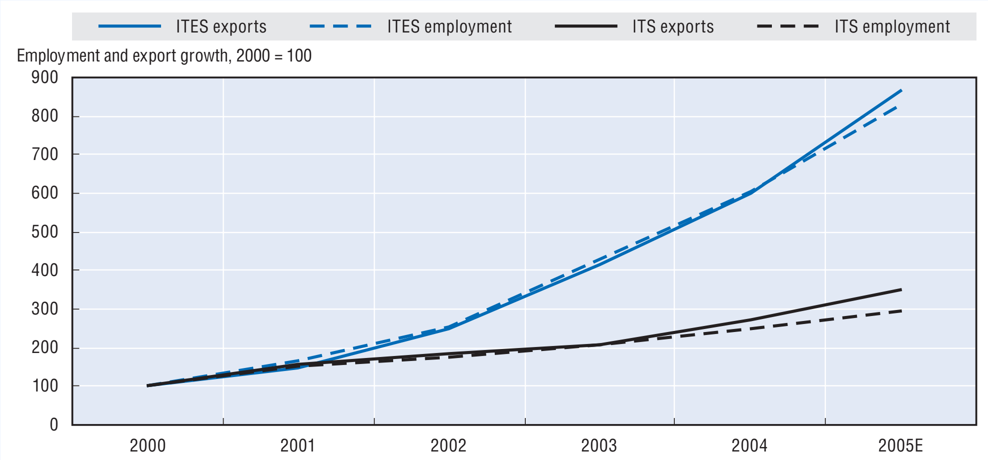
Over the past year, a growing number of analysts and ICT industry representatives have voiced concern over a looming labour shortage in the Indian ICT market. The labour shortage is said to potentially affect quality of service, further increase salary inflation and staff attrition rates, and ultimately create difficulties for the industry to service the booming export markets in ICT and ICT-enabled services (Deutsche Bank Research, 2005; Engardio, 2005; MGI, 2005). The Indian government estimates that the need for qualified employees in call centres will reach 1 million by 2009. According to Gartner (2005), this would leave an expected shortfall of more than 260 000 workers. The following describes the Indian labour market for ICT professionals and shows how the ICT industry addresses some of the labour supply concerns.

Early in 2005, the Indian export industry of IT services (ITS) employed approximately 670 000 professionals. An additional 350 000 professionals were providing IT-enabled services (ITES) (NASSCOM, 2005a). Over the past five years, India's export growth has been highly correlated with the industry's employment and therefore its ability to employ and retain skilled workers (Figure 6.10) and average billing rates have remained fairly constant over time (OECD, 2006b). Recently the industry has seen an increase in average employee turnover, but Figure 6.10 suggests that the industry's future growth potential may well be constrained by the country's capacity to produce ICT professionals.

India needs to both increase the number of computer and software graduates it produces and improve the average quality of its higher education system (MGI, 2005; NASSCOM, 2005a). It takes time for the education initiatives that are being implemented to produce results. Therefore, the Indian ICT industry will need to factor in potential future supply constraints. It has already started to address some of the issues. In 2004, 99 000 "IT professionals" graduated from India's higher education system and 158 000 students were admitted to ICT-related programmes (NASSCOM, 2005b). While demand for computer science and software developers is high, graduates are increasingly being recruited from non ICT-specialist engineering fields which have much higher numbers of graduates.

Box 6.4. **How does the Indian ICT industry tackle limited labour supply?** *(cont.)*

Figure 6.10. **Employment and export growth, 2000-2005**



Source: NASSCOM (2005a).

StatLink: http://dx.doi.org/10.1787/812108450782

Indian software companies estimate that around 30% of local engineering graduates have the appropriate training for recruitment (OECD, 2006b). Indian subsidiaries of foreign multinationals provide a lower estimate of 10-25%, with the upper estimate relevant for engineering graduates and the lower estimate for general degree holders (MGI, 2005). In the year ending March 2005, the Indian ITS sector recruited 107 000 professionals (it had an annual growth rate of 18% over the last four years) and 95 000 professionals were recruited in the ITES sector. If recent growth levels are sustained, the Indian ICT industry may indeed need to adopt new recruitment strategies and expand hiring in other emerging market countries.

The pressure on the labour market is aggravated by the varying quality of India's higher training institutes. For example, one leading Indian software company argues that only the top 20% of India's graduates meet its recruitment profile. Another 30-40% might fit the job profile by completing a rigorous training programme supervised by the company. The numbers may vary but complementary training is widely regarded by Indian executives as an important way to increase the number of hireable graduates. The industry is thus increasingly investing in in-house training capabilities. For example, Infosys Technologies is building a training campus in Mysore which will be able to host 4 000 employees at any given time. The industry is investing 8% of its turnover in training and this is expected to increase in future (OECD, 2006b). External training is also gaining ground: institutes like the privately owned National Institute of Information Technology trains 500 000 students at its 3 155 training centres.

There is also a relative scarcity of experienced middle managers owing to the rapid expansion of and demand for increasingly sophisticated services. Part of the solution to this problem is lateral recruitment from other industries. However, Indian markets have been relatively protected from international competition and thus missed out on foreign investment and transfers of technology and market expertise. Market protectionism has also led to a scarcity of professionals with leading domain expertise. According to India's ICT industry association, software companies are recruiting foreign professionals both in India and at their foreign subsidiaries (Thibodeau, 2006). Meanwhile, the Indian ICT industry is expanding abroad to achieve its business objectives and overcome these kinds of hurdles (Indian ICT companies are investing in eastern Europe, for example).

Conclusion

ICT skills have increasingly become a requirement in the workplace. Today, up to 5% of total employment is in ICT specialist occupations and around 20% in ICT-using occupations in a wide variety of sectors. Moreover, for ICT specialists, job definitions appear to be evolving, requiring some combination of ICT specialist skills with other skills, *e.g.* business or marketing.

Today, various means of supplying ICT skills are available for different populations. Basic skills needs are increasingly likely to be filled "naturally" through generalised diffusion of ICTs and their use in schools. Efforts are being made to improve the access of older workers to ICT skills through training programmes of different sorts. Because ICT specialist skills needs are likely to change rapidly with changes in technology, it is thought that the formal education system may not offer the flexibility for adapting curricula that private-sector schemes, usually set up as multi-stakeholder partnerships, can offer.

Internet recruitment and distance work are two interesting trends that are closely linked to the broad diffusion of ICTs throughout society. Internet recruitment appears to be gaining in importance but seems to have a fairly limited impact at present. However, not enough is known about it, especially on a time-series cross-country basis, to evaluate the impact it may have on the functioning and clearing of the labour market. Teleworking work is also gaining in importance, and more and more workers now work at least some of the time away from their firm. In addition, rapid technological developments in ICTs combined with ongoing liberalisation of trade and investment in services, have made production of services more footloose, so that many can now be provided from remote locations.

Analysis suggests that up to 20% of employment is potentially affected by ICT-enabled offshoring. This does not mean that these jobs will necessarily be offshored but that around 20% of all people employed carry out the kinds of tasks and functions that could potentially be carried out from any geographic location owing to technological advances in ICTs and the increased tradability of services. And of course countries also gain jobs in these functional areas due to the ICT-enabled globalisation of services. A further distinction needs to be made between clerical and other mainly professional types of potentially offshorable occupations, as clerical occupations are more likely to be affected by digitisation and automation, and the share of these occupations in total employment is tending to decline. A question arises about whether a potential shortage of ICT and other skills in supplying countries might constitute a barrier to ICT-enabled offshoring of services. While this may sometimes occur in the short term, it is unlikely to be a problem in the long run.

The policy implications of this chapter appear to be in line with what countries report as having in place under their ICT policies. This includes promoting basic ICT skills through the use of ICT in schools, but also for the population as a whole, and initiatives for industry-based training for more specialised skills undertaken in conjunction with professional bodies and industry associations, and improving labour market information. Chapter 8 outlines the policy initiatives for ICT skills in more detail.

Notes

1. This builds, in part, on Chapter 6 of the 2004 Edition of the *Information Technology Outlook* (OECD, 2004a), as well as other work carried out for the OECD Working Party on the Information Economy: *www.oecd.org/information-economy*.
2. These measures were developed in OECD (2004a) and extended and updated a first time in van Welsum and Vickery (2005b).
3. Forrester Research, "IT Skills Shortages on the Horizon – The IT Skills That Will Be in Demand in 2005 and Beyond", by Craig Symons, 25 January 2005, Abstract at *www.forrester.com/Research/Document/Excerpt/0,7211,36304,00.html*.
4. *http://stats.bls.gov/news.release/ooh.t01.htm* (last accessed 12.04.2006).
5. Autor *et al.* (2003), using a "tasks framework", find that computer technologies substitute for workers performing routine tasks that can readily be described with programmed rules, *i.e.* those that can easily be digitised and/or codified. Thus, technology is also making redundant some occupations that were considered potentially affected by offshoring (see above, and van Welsum and Vickery, 2005a) and may lead to a decline in the share of these types of occupations in total employment. On the other hand, computer technologies were found to act as a complement to workers that perform non-routine tasks "demanding flexibility, creativity, generalised problem-solving capabilities and complex communications". Thus, occupations intensive in these kinds of skills are not likely to disappear as a result of increased diffusion of computer technology, although they may be affected by offshoring if they satisfy the "offshorability attributes". Autor *et al.* (2003) also found that changes in tasks within occupations (a move away from standardised tasks to relatively more non-routine tasks) took place throughout the economy, but especially in industries that adopted computer technologies most rapidly.
6. OECD (2006a) provides the first internationally comparative data on the use of computers by 15-year olds. It is based on the OECD's PISA 2003 assessment of educational performance by 15-year olds and it complements previous OECD analysis about the importance of computers in schools.
7. The alliance was founded by Microsoft in partnership with the European e-Skills Certification Consortium (eSCC) including among its members Cisco Systems Inc., CompTIA, The European Computing Driving License Foundation Ltd. (ECDL-F) and the Examination Institute for Information Science (EXIN), and with the support of State Street Corporation and Randstad Corporation. It is aiming to provide access to technology and ICT training to 20 million people in Europe over the next five years. Microsoft Corporation, "Delivering 21st century skills for employability in Europe".
8. IT certification can have a wider importance too. According to independent research commissioned by Microsoft, human resource managers in Europe consider IT certificates to be important both for IT and non-IT roles, would choose candidates with IT certification over those without, and would be willing to pay an average of 6.9% additional salary for these certified skills (Microsoft Corporation, "Delivering 21st century skills for employability in Europe").
9. CompTIA is the leading global IT trade association with more than 20 000 members in 102 countries: *www.comptia.org*.
10. Innovative firms are defined as those that have introduced at least a new product or process during the reference period.
11. The Monster employment indices are based on a real-time review of millions of employer job opportunities culled from more than 1 500 Web sites, including a variety of corporate career sites, job boards and Monster. They present a snapshot of employer online recruitment activity *www.monsterworldwide.com/Press_Room/MEI.html* (last accessed 7 March 2006).
12. Namely, France, Germany, the Netherlands, Sweden and the United Kingdom.
13. The National Online Recruitment Audience Survey 2006, available from *www.noras.co.uk/* (last accessed 30 March 2006).
14. While a wide range of economic and social issues are related to (ICT-enabled) teleworking (*e.g.* working conditions, union representation, access to training), this section focuses on the relative importance of the phenomenon, especially with a view to drawing a parallel with the potential for ICT-enabled offshoring of services.
15. The Dieringer's 2005 American Interactive Consumer Survey, which is used by the Dieringer Research Group in its research conducted for the International Telework Association and Council (ITAC)

(*www.workingfromanywhere.org/* last accessed 8 February 2006). This survey is the longest-running primary research survey of US Internet user and multi-channel consumer behaviours and trends.

16. *www.workingfromanywhere.org/news/pr100405.htm* (last accessed 8 February 2006).
17. *www.ivc.ca/studies/canadianstudies.htm* (last accessed 15 February 2006).
18. Gartner Group Paper: "Teleworking: The Quiet Revolution" (2005 Update), as reported on *www.ivc.ca/studies/canadianstudies.htm* (last accessed 15 February 2006).
19. *www.japan-telework.or.jp/english/pdf/english_010.pdf* (last accessed 13 February 2006).
20. Offshoring includes both international outsourcing (where activities are contracted out to independent third parties abroad) and international insourcing (to foreign affiliates). The cross-border or geographical aspect is the distinguishing feature of offshoring, *i.e.* whether services are sourced within the domestic economy or abroad – not whether they are sourced from within the same company or from external suppliers (outsourcing). FDI and offshoring overlap only partially. There tends to be a time aspect to this definition, with offshoring referring to the movement of activities previously carried out in the domestic economy. Offshoring includes trade, the movement of production not financed by domestic sources (*i.e.* borrowing abroad) and FDI, but FDI can also include activities that were never previously undertaken in the home country.
21. In spite of the recent interest in ICT-enabled offshoring, the impact of ICT on the relocation of white-collar workers was already discussed in the late 1970s and early 1980s, for example by Huws (1985).
22. See van Welsum and Vickery (2005a) and van Welsum and Reif (2006a) for details on the occupational selections. As classifications are not harmonised internationally, the levels of the estimates are not directly comparable across countries.
23. A parallel can be drawn with some of the work undertaken by Autor *et al.* (2003) and Levy and Murnane (2004). These authors argue that the tasks most vulnerable to being substituted by technology are those for which information processing can be described in rules. If a significant part of a task can be described by rules, this increases the likelihood of the task being offshored, since the task can then be assigned to offshore producers with less risk and greater ease of supervision.
24. Other factors matter of course. For example, the McKinsey Quarterly (2005, No. 4) also reports that the Philippines are emerging as a market for offshored services with its main advantages being a large pool of workers suitable for work in multinational companies and low costs (in particular low hourly wages). However, the Philippines score relatively low in other domains. It has a relatively poor risk profile (which is based on factors such as natural disasters, security threats and data theft), high levels of corruption and bureaucracy, relatively strict labour laws, high electricity and telecommunications prices, a relative scarcity of management skills, and a relatively small domestic market for services.
25. According to the *McKinsey Quarterly* (2005, No. 4), Morocco is positioning itself to become a major player in the market for offshored services for French-language companies. Its advantages include relatively low wages, relatively low cost but good quality telecommunications infrastructure (with further improvements planned), many French-speaking (and in the northern part of the country often also Spanish-speaking) university graduates. Furthermore, the government actively seeks to attract companies through tax breaks, infrastructure and services, reduced administrative burden and more flexible labour laws.

References

Australian Telework Advisory Committee (ATAC) (2005), "Telework in Australia", ATAC Paper II, March 2005, *www.dcita.gov.au/data/assets/pdffile/25248/ATACPaper2-Autralia.pdf* (last accessed 09 February 2006).

Autor, D.H., F. Levy and R.J. Murnane (2003), "The Skills Content of Recent Technological Change: An Empirical Exploration", *Quarterly Journal of Economics*, Vol. 118, No. 4 (November 2003), pp. 1279-1333.

Baily, M.N. and R.Z. Lawrence (2005), "What Happened to the Great US Job Machine? The Role of Trade and Electronic Offshoring", mimeo, forthcoming in Brookings Papers of Economic Activity.

Bardhan, A.D. and c. Kroll (2003), "The New Wave of Outsourcing", University of California Berkeley, Fisher Centre for Real Estate and Urban Economics, Fisher Centre Research Report No. 1103.

Bassanini, A., A. Booth, G. Brunello, M. De Paola and E. Leuven (2005), "Workplace Training in Europe", IZA Discussion Paper No 1640, June 2005, Institute for the Study of Labor (IZA), Bonn.

Computer Weekly, 15 November 2005.

Computer Weekly, 14 February 2006.

Deutsche Bank Research (2005), "Outsourcing to India: Crouching Tiger Set to Pounce", India Special, Current Issues, 25 October.

Educational Testing Service (ETS) (2005), TOEFL Test and Score Data Summary – 2004-05 Test Year Data, available at *www.ets.org* (last accessed 24 November 2005).

Engardio, P. (2005), "India's Looming IT Labor Shortage", 16 December.

European e-Skills Forum (2004), *E-Skills for Europe: Towards 2010 and Beyond*, Synthesis Report, European Commission, Enterprise and Industry Directorate-General, September 2004.

Gartner (2005), "Staff Attrition May Stall the Offshore Call Centre Boom".

Huws, U. (1985), "The Global Office: Information Technology and the relocation of white-collar work", *Third World Trade and Technology Conference Papers*, Third World Information Network.

International Data Corporation (IDC) (2005), "Networking Skills in Europe: Will an Increasing Shortage Hamper Competitiveness in the Global Market?", IDC White Paper commissioned by Cisco Systems, September.

International Telecommunication Union (ITU) (2005), *The Internet of Things*, ITU, Geneva.

Kirkegaard, J.F. (2004), "Outsourcing – Stains on the White Collar?", Institute for International Economics, Washington, DC.

Levy, F. and R.J. Murnane (2004), *The New Division of Labor*, Princeton University Press and the Russell Sage Foundation, New York.

Mann, C.L. (2004), "The US Current Account, New Economy Services and Implications for Sustainability", *Review of International Economics*, Vol. 12, No. 2, pp. 262-276.

McKinsey Global Institute (MGI) (2005), "The Emerging Global Labor Market", June.

NASSCOM (2005a), *Strategic Review 2005 – The IT Industry in India*, NASSCOM, New Delhi.

NASSCOM (2005b), "Knowledge Professionals", www.nasscom.org.

OECD (2004a), *Information Technology Outlook 2004*, OECD, Paris.

OECD (2004b), *OECD Economic Outlook*, Vol. 2004/1, No. 75, June, OECD, Paris.

OECD (2006a), *Are Students Ready for a Technology-Rich World? What PISA Studies Tells Us*, OECD, Paris.

OECD (2006b, forthcoming), "Facilitating Adjustment: International Sourcing of ITS and BPS", TD/TC/WP(2005)29.

Pain, N. and D. van Welsum (2004), "International Production Relocation and Exports of Services", *OECD Economic Studies*, No. 38, Vol. 2004/1.

Schaaper, M. (2005), "Emerging Knowledge Economies", presentation at the Second Workshop on Indicators in the Knowledge Economy (KEI), October 6-7 2005, Maastricht.

Thibodeau, P. (2006), "Q&A: Nasscom's Kiran Karnik on India Wage Hikes, Talent-Pool Shortage", *Computer World*, 31 January 2006.

van Welsum, D. (2004), "In Search of 'Offshoring': Evidence from US Imports of Services", Birkbeck Economics Working Paper 2004 No. 2, Birkbeck College, London.

van Welsum, D. and G. Vickery (2005a), "Potential Offshoring of ICT-intensive Occupations", DSTI Information Economy report, DSTI/ICCP/IE(2004)19/FINAL, OECD, Paris; available at: *www.oecd.org/sti/offshoring*.

van Welsum, D. and G. Vickery (2005b), "New Perspectives on ICT Skills and Employment", DSTI Information Economy report, DSTI/ICCP/IE(2004)10/FINAL, OECD, Paris; available at: *www.oecd.org/sti/ICT-employment*.

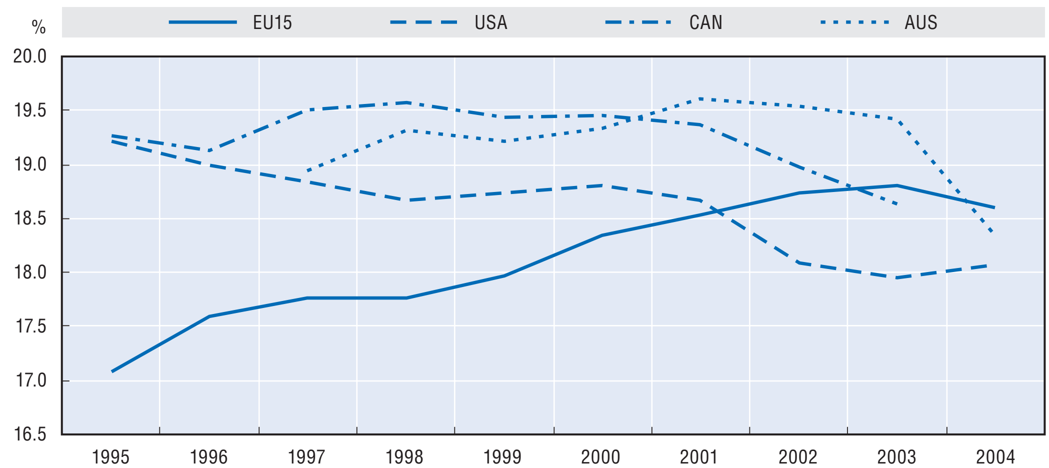
van Welsum, D. and X. Reif (2006a), "The Share of Employment Potentially Affected by Offshoring: An Empirical Investigation", DSTI Information Economy report, DSTI/ICCP/IE(2005)8/FINAL, OECD, Paris; available at *www.oecd.org/sti/offshoring*.

van Welsum, D. and X. Reif (2006b), Impacts of International Sourcing on Different Occupations", DSTI Information Economy report DSTI/ICCP/IE(2006)1/FINAL, OECD, Paris; forthcoming at *www.oecd.org/sti/offshoring*.

ANNEX 6.A1

Figures

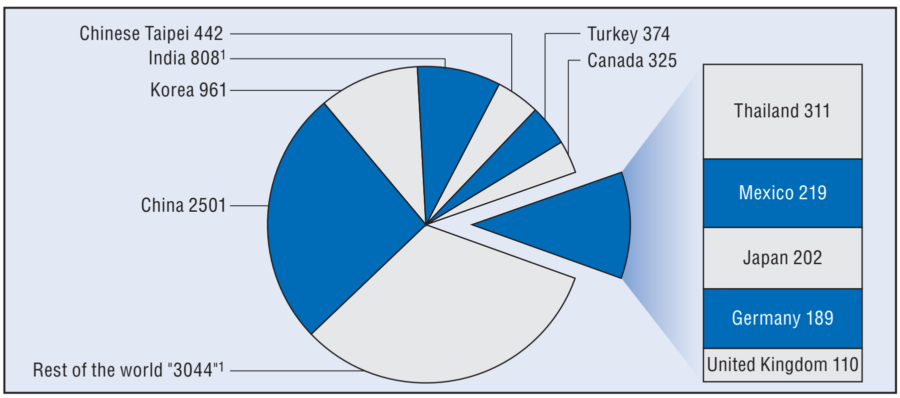
Figure 6.A1.1. **The share of employment potentially affected by ICT-enabled offshoring of services, selected countries, 1995-2004**



Source: Based on EULFS, US Current Population Survey, Statistics Canada, Australian Bureau of Statistics.

StatLink: http://dx.doi.org/10.1787/607287827150

Figure 6.A1.2. **Number of doctorates in science and engineering awarded to foreign citizens in the US by citizenship, 2003**[1]



1. The number for India is for 2001. The total number for 2003 is 9 486. (* indicates that the rest of the world number for 2003 is distorted by the amount of the difference between India 2001 and India 2003, which is unknown, as the number for India is for 2001).

Source: OECD calculations based on US National Science Foundation, 2004.

StatLink: http://dx.doi.org/10.1787/564515658725

ISBN 92-64-02643-6
OECD Information Technology Outlook 2006

Chapter 7

Emerging Technology Applications

Many emerging ICT applications have major economic and social potential. Applications of ubiquitous networks (including RFID), location-based services, natural disaster prevention and warning technologies, the participative Web and the convergence of nano-, bio- and information technology are all growing and developing. Commercial applications and social acceptance and use will determine their long-term impacts.

Introduction

This chapter deals with selected emerging information technology (IT) applications and discusses their historical background, economic opportunities, social acceptance and benefits. The interaction between technological opportunities, commercial development and social acceptance and use determines which technologies become widespread and have positive economic impacts. The chapter illustrates some of the many developments and opportunities in information and communications technology (ICT):

- **Ubiquitous networks** connect persons and objects anywhere at any time to provide real-time tracking, storing and processing of information. Applications of enabling technologies such as RFID (radio frequency identification) and sensor technologies are increasingly affordable, investment is rising and specific applications are being deployed as applications move into commercial use.
- **Location-based services (LBS)** use a variety of position-determining technologies to follow the location of objects and users. Besides the two most common applications – navigation and asset tracking – other uses include emergency and rescue, nearby information services and people tracking, the last of which raises privacy and security concerns.
- **Natural disaster prevention and warning technologies** are becoming more important at different phases of disaster management. While technologies are often specific to one type of disaster, satellite remote sensing technology is used to detect nearly all types, often combined with a geographical information system (GIS) for analysing and processing the data which are then transmitted via different ICTs.
- **Participative Web** is the active participation of Internet users in creating content, customising the Internet and developing applications for a broad variety of fields. Blogs are one of the most popular examples of the participative Web. Their impacts include development of new business models, enhanced efficiency and new communication possibilities and ways to influence traditional media.
- The **convergence of nano-, bio- and information technology** provides major opportunities and challenges, driven by ongoing innovations in all three enabling technologies. Convergence in applications such as healthcare and robotics is leading OECD countries increasingly to assess its potential and impacts.

These technology applications are very different but they have common points and are interlinked. On the *technological side*, the convergence of nano-, bio- and information technology paves the way for further development of ubiquitous networks, for example via ambient sensor devices. Applications of ubiquitous networks, location-based services and natural disaster prevention and warning technologies are based on tracking and can, for example, rely on global positioning systems (GPS). The participative Web encourages Internet users to develop open source applications that can be used in other emerging technology applications (*e.g.* GIS systems for disaster prevention). On *the economic side*, data on market estimates vary; the market is often not clearly defined, but overall, estimates are positive and promising, and practical commercial development is the necessary link between technological potential and economic and social impacts. On the *social side* almost all applications face the challenge of social acceptance. Only if their utility is clearly understood can new and promising applications be introduced, commercialised and contribute to economic and social development.

Ubiquitous networks

The "ubiquitous network" is a network environment in which persons and objects are always connected. It is characterised by an all-inclusive use of networks and networked devices (ITU, 2005; OECD, 2002a). The term "ubiquitous" in the IT context was coined in 1988 to describe a new era in which computers are (invisibly) embedded into the everyday world and in which scale and location are of crucial importance (Weiser, 1991). Both Japan and Korea have policies to develop ubiquitous networks (Box 7.1).

Box 7.1. **U-Korea and u-Japan: Korea's and Japan's policies towards a ubiquitous network**

In order to promote the development and propagation of ubiquitous networks, Korea and Japan have put in place the "IT839 strategy" and the "u-Japan" strategy respectively. Both aim at the realisation of a "ubiquitous network society" (see also Box 8.1).

Korea's "IT839 strategy" defines specific measures and links eight IT services to three infrastructures and nine products. Short-, medium and long-term goals have been set for each service, infrastructure and product. Services include for example WiBro, RFID and Internet telephony services. Long-term goals include 9 million WiBro and 4 million Internet telephony users as well as a 5% share in the world RFID market. The eight services are supposed to encourage investment in the three infrastructures: broadband convergence network, ubiquitous sensor network and next-generation Internet protocol (IPv6). Among the nine products are mobile handsets and equipment, telematics and intelligent service products. To promote the "839" measures, government initiatives include model projects, provision of funds and support for technological development.

The u-Japan strategy applies ICT to resolve diverse social and economic problems and to address negative aspects of ICT. These targets will be promoted by: *i)* the development of infrastructure (*e.g.* consistency among wired, wireless networks, broadcasting systems and transport networks); *ii)* advanced usage of ICT, to achieve a society in which 80% of the population can appreciate the role of ICT in resolving issues; and *iii)* the development of the usage environment, which deals with the challenge of anticipating negative effects and devising solutions. Clear goals are defined and a schedule was prepared for measures to achieve these goals up to 2010.

Source: Korea, Ministry of Information and Communication; Japan, Ministry of Internal Affairs and Communications; Murakami (2005).

As ubiquitous networks are available anywhere and anytime, they can provide real-time tracking, storing and processing of information, and as devices get smaller these networks becomes almost invisible. One application is the use of contactless tags in supply chain management to track goods and their condition at any stage of the chain (usually known as RFID for Radio Frequency IDentification).

The structure of the ubiquitous network ICT industry has four layers (MIC, 2004): the network, the terminal, the platform and the solution. The network layer includes infrastructure and technologies such as DSL, cable Internet and the transport network. The terminal layer comprises mobile phones, PCs, sensors, electronic tags, etc. The platform layer deals with such issues as billing/payment, authentication and copyright. The solution layer comprises applications such as tracking, disaster monitoring, electronic data exchange and telemedicine.

Examples of enabling technologies that will drive the development of ubiquitous networks include radio frequency identification (RFID), sensor technologies, smart technologies and nanotechnology (ITU, 2005). RFID is an increasingly common example of the deployment of ubiquitous networks, and its economic and social impacts provide insight into some of the challenges confronting these technologies.

RFID

RFID technology is being deployed to monitor manufacturing assembly, track goods of all kinds, enable financial transactions, pay tolls and fuel, and allow secure building access and other applications (see OECD, 2004a, for an earlier overview). RFID uses radio frequency-based communications for contact or contactless identification of entities (products, animals or humans), places, times or transactions. RFID can be combined with sensors and actuators, with localisation functions enabled by Global Positioning System (GPS) technology or mobile telephony, and is increasingly (inter)connected through radio technology to produce innovative applications. RFID offers promise as the first iteration of intelligent sensor networks, and the interlinking of RFID and various increasingly capable, smaller and cheaper devices constitutes the technological basis for an environment in which everyday objects can communicate. By extension, RFID is considered a building block for networks of distributed sensors.

Overview

RFID consists of the following key elements: RFID tags (transponders, typically miniaturised semiconductors); RFID readers (transceivers), which transmit data via electromagnetic radio waves using air interface and data protocols; and a data collection, distribution, and management system that is able to identify or scan information with speed and accuracy.

RFID tags consist of tiny electronic circuits with limited on-board memory attached to small antennas that can transmit a unique serial number to "reader" devices. The tags are attached to physical objects, people or animals, which can then be tracked. Readers located within limited distances communicate with the tags, receive data from the tags, and send the data for processing to an IT system consisting of databases, middleware and application software. When a tag comes into proximity with a specified RFID reader, data on the tag can be read. The data may be used to identify the tagged object or to provide information about it. According to the needs of the application, readers transmit data such as information on identification and location or product price, colour, date of purchase and expiration date.

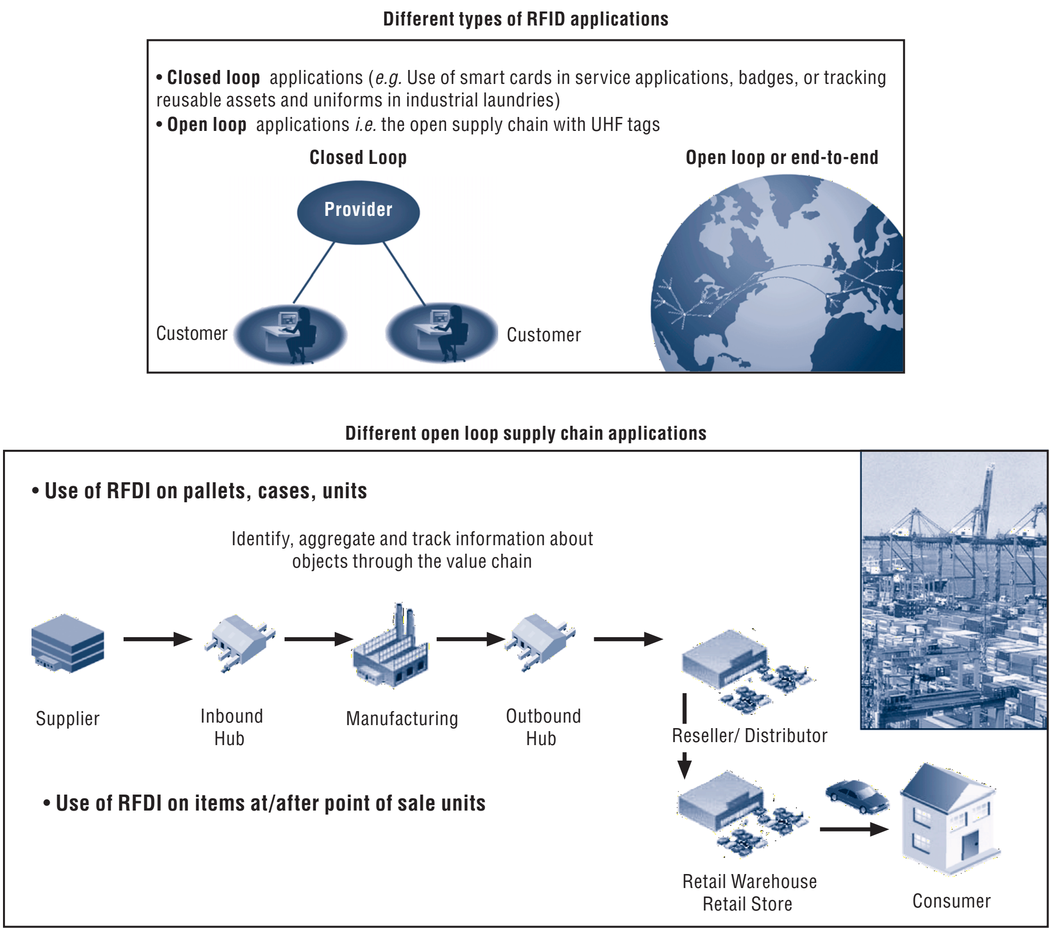
There are many different types of RFID systems and they vary in their mode of operation and performance. For example, a completely "passive" RFID tag has no internal power supply. Instead, it harvests power for its operation from the electromagnetic field of the reader. This makes the tag much cheaper, but the reader has to drive the communication. With "active" RFID systems, instead, the tag contains a small battery which enables it to communicate with

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

the reader. "Active" tags have a longer range, depending on the size of their antenna, strength of battery and the portion of radio spectrum used. Active tags also typically have more memory than passive tags.

There are significant differences between open loop applications, *e.g.* the open supply chain with ultra-high frequency (UHF) Electronic Product Code™ (EPC) tags, and closed loop applications, such as contactless payment cards used in a closed payment system or inventory applications such as tracking reusable assets (Figure 7.1). In the open supply chain, a distinction needs to be made between use of RFID at pallet level and use of RFID at item level for retail goods. In the supply chain, pallet-level tagging offers clear economic benefits. RFID can make the whole supply chain more productive, and it is predicted to shift the dynamics of competition from the enterprise level to the supply chain level. However, pilots for item-level tagging of individual goods in retail environments suggests that economic benefits are likely only in specific cases and only with time, widespread adoption, and a virtuous circle of innovation in supporting technologies.

Figure 7.1. **Overview of different RFID applications**



Source: OECD.

Contactless smart cards, such as payment cards, identity cards, passports, transport cards and loyalty cards, are essentially a sophisticated form of RFID technology, with embedded processing power[1] and ancillary security features.

Economic potential and applications

RFID is increasingly used by firms involved in manufacturing and production, logistics, retail and health care and by some government agencies. The technology enables users to efficiently collect, store, analyse and distribute information on tracked objects. Benefits include fewer human and machine resources dedicated to simple data entry, better inventory control, more efficient just-in-time production, and increased transparency and accountability in supply chains.

The development of standards, technological advances and end-user mandates has spurred the use of RFID in retail and consumer goods applications. RFID is poised for growth worldwide, as businesses and governments implement RFID applications to facilitate global commerce and spur innovation and competitiveness. RFID promises greater reliability and efficiency than the bar code system in areas such as supply chain management, transport, defence, health care and security and access control. It is increasingly used in commercial supply chains through aggregate level tagging (*e.g.* tagging of cases and pallets) and is projected to produce long-term measurable productivity gains in supply chains and economies as a whole.

High costs in the early stages of adoption will give way to cost reductions and growing adoption, leading to benefits and further adoption. Based on current assessments, demand will grow from tens of billions of tags in 2006 to hundreds of billions by 2009. Analysts have identified three distinct phases of RFID deployment: initial pilot tests and experimentation (2003-05); a supply chain infrastructure phase mainly using aggregate-level tagging (2005-09); and widespread item-level tagging (2009-13). An improving cost structure and smaller component size have recently made RFID accessible and practical for wide-ranging tracking and tracing applications across the economy, especially in the industrial, transport, security, consumer goods and services sectors. However, owing to cost barriers, performance issues and lack of accepted standards, the impact on supply chain management is just beginning to be felt.

Drivers of RFID applications

RFID tags are expected to generate productivity benefits in "open loop" supply chain management and asset allocation, through automation of receiving, expediting, replenishment, handling, quality control, tracking of lots for recall or expiration, and other supply chain tasks. They can also enable better asset allocation with increased fill rates, lower inventory, reduced theft and better management of products. They are also increasingly considered for specialised "closed loop" applications. These include in-process inventory tracking, goods location or tracking, warehousing, repair and maintenance, mobile payments, theft detection, luggage tracking and location or identification of people. RFID will also affect other facets of business processes, including sales and marketing. General benefits include:

- ***Speed and accuracy:*** RFID has greater potential for speed and accuracy than barcodes because applications may require less human intervention.
- ***Visibility:*** Supply chain participants can benefit from the ability of RFID tags to hold more information about an item than existing barcode technology.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

- ***Information enrichment:*** Some RFID tags are writeable, and as they go through various stages of the product life cycle, information can be added to the tag.

Studies have found that RFID can lower supply-chain costs by 3-5% and increase revenue by 2-7%. The EPC™ provides for the delivery of a unique serial number at the individual item, pallet or box level. A unique ID number offers the potential for reducing counterfeiting, and could, for some applications, significantly reduce infringement of intellectual property rights by tracking and identifying genuine articles (pharmaceuticals, fashion goods) and comparing them with counterfeit products. It could also enable animal pedigree tracking.

Mandates by large retailers and governmental agencies, such as Wal-Mart and the US Department of Defense, requiring their top suppliers to use RFID tags, have spurred the adoption of this technology. Mandates of key customers were cited by many manufacturers as their primary reason for deployment of RFID in 2005.[2]

Legislation and procurement, particularly relative to product traceability, person tracking and national security, catalyse RFID adoption in certain industries and for certain application areas. These include recycling obligations, requirements to provide country-of-origin labelling, pharmaceuticals tracking, food ingredient traceability, and techniques to prevent counterfeiting and cross-border controls.

Emerging issues

Realising the potential of RFID requires addressing interrelated economic, technological, standards, interoperability, privacy and security issues which have potentially wide-ranging social, economic, as well as national security implications. RFID touches on several regulatory and/or policy issues, including international trade, intellectual property rights, standards, spectrum, security and privacy.

Business and technological challenges

At this early stage, cost is a significant impediment to adoption of RFID. There is also the related issue of who bears the cost and who reaps the benefits. Suppliers claim they are forced to pay for an investment that saves retailers money. Successful implementation of RFID also requires process changes and companies' ability to redirect personnel from tasks such as scanning, searching and verifying products to higher-value tasks. Another main stumbling block is the edge-of-network or RFID middleware, which links RFID hardware to an enterprise's various IT systems. Tracking many RFID-enabled objects will require efficient data management, very rapid access and high-capacity storage, methods of dealing with inaccurate data, and ensuring data integrity and data transfer across different systems.

Technological issues must also be managed. Although radio waves can pass through most articles, the combination of materials, operating frequencies, associated power and the environment can be problematic. Interference from other RFID or wireless devices (mobiles, personal digital assistants [PDAs], etc.) is a main issue. In addition, RFID hardware must be tuned to specific radio wave frequencies, but these are not consistent worldwide or even in Europe. Yet another challenge is security through encryption, since the inclusion of cryptographic features increases cost and may reduce speed.

Standards and interoperability

Standards work is under way in both standards developing organisations and industry consortia, such as the International Organization for Standards (ISO) and EPCGlobal. Challenges include harmonising frequency allocation for RFID operations and adopting worldwide interoperable communication protocols. ISO has set standards for "closed loop" RFID, including standards for animal identification and for the air-interface (contactless) protocol for RFID tags used in payment systems, smart cards and in-vicinity cards. It also has established standards for testing the conformance of RFID tags and readers to a standard and for testing performance.

Fewer standards have been finalised for "open loop" supply chains, with tags designed for use throughout the whole supply chain. ISO is developing standards for tracking 40-foot shipping containers, pallets, transport units, cases and unique items. The EPCGlobal consortium has produced a taxonomy of tag classes, standard radio frequency signalling protocols between tags and readers, and formats for the storage of identity and data in tags. EPCGlobal has ratified a UHF Class 1 Generation 2 RFID standard for the air-interface protocol of second-generation EPC technologies, which has yet to be ratified by ISO. In addition, common standards have to be worked out with China, which has stated that it will adopt standards that are compatible with EPCGlobal and ISO standards but will use its own intellectual property to build a royalty-free standard.

Security and privacy

As RFID migrates to item-level tagging and as governments adopt it for various personal identification schemes, it is crucial to address privacy and security issues related to certain types of RFID systems and applications: a solution might combine self-regulatory mechanisms, policy guidelines and technological solutions with education and awareness programmes.

Privacy is an important issue for RFID implementation, as an individual's personal details could be compromised if the application is not sufficiently secured.

Trade unions in some countries have complained that RFID tracking technology may violate employee privacy. There is also opposition from consumer groups who worry about the "big brother" aspect of the technology.[3] If privacy-related issues are not carefully addressed, including through education, consumer and citizen backlash could limit the long-term benefits and development of RFID.

Location-based services

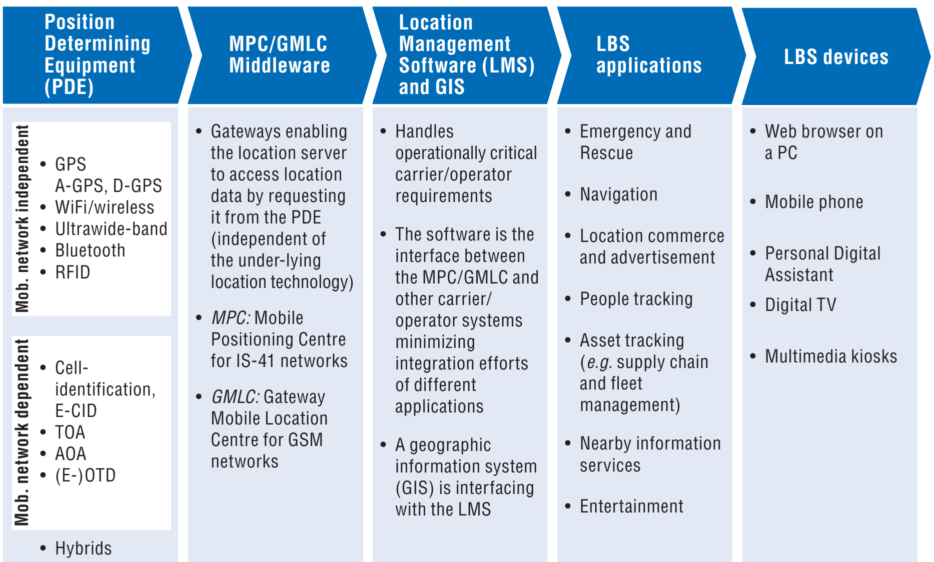
Location-based services (LBS) follow the geographic location of objects or users to provide enhanced, specific and usually personalised services. These relatively new services facilitate safety and rescue in emergency situations, they represent new business opportunities for various participants at different positions of the value chain (such as geographical data providers, application developers and content providers) and for a wide field of applications, but they also present privacy and security challenges. Following a short history, this section presents the value chain of the LBS sector and its wide range of applications. It then discusses market size and market drivers in order to estimate the economic impacts of LBS. Before dealing with emerging issues, social impacts are analysed.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

LBS were first used in 1978 when the US Department of Defense launched the GPS, a satellite infrastructure for military purposes comprising 24 satellites (Pfeiffer, 2003). In the 1980s, the United States made the positioning data generated by the system freely available worldwide (Schiller and Voisard, 2004). This was the starting point for the development of commercial applications. Fleet management and car tracking applications began to be developed in the early 1980s, but widespread interest in LBS only emerged in the late 1990s when there was a new market interest in data services. In 2001, the US Federal Communications Commission (FCC) required tracking subscribers' location for emergency service response to E911 calls (Dao *et al.*, 2002). In Europe since mid-2003, operators must be able to make caller information available for all calls to the emergency number E112 where it is implemented (Commission of the European Communities, 2003). Overall, whereas LBS were first only used by companies that could afford to invest in special software and devices, they are now widely accessible via devices connected to the Internet and cellular wireless devices. Companies such as Google, Yahoo! and MSN have reduced their prices significantly or offer LBS at no cost. They also provide developers with access to interfaces for Internet-based maps and therefore the possibility to develop LBS further (Malykhina and Lecca, 2005). Consumer applications are at the end of the LBS value chain.

Figure 7.2 represents LBS technologies and services. At the beginning of the value chain, position-determining equipment (PDE) identifies the location of devices. The equipment used to locate devices can be grouped into equipment that is dependent on or that is independent of the cellular wireless network. Table 7.1 provides an overview of the main PDEs with their advantages and drawbacks. Besides cost and investment issues, LBS applications have three fundamental characteristics: *i)* accuracy of measurement; *ii)* the application environment (*i.e.* if the technology can be used both indoors and outdoors), and *iii)* range of coverage.

Figure 7.2. **The value chain of location-based services**



Note: For acronyms see Table 7.1. IS-41 is a standard for identifying and authenticating users, and routing calls on mobile phone networks.
Source: OECD based on D'Roza and Bilchev (2003), ESBI Computing (2006), Giaglis *et al.* (2003), Spinney (2003), TruePosition (2006).

Table 7.1. **Overview of the main position-determining equipment**

Technology and methodology	Accuracy	Application environment (AE) Coverage range (CR)	Advantages	Problems
GPS, A-GPS, D-GPS Network of 24 satellites A-GPS and D-GPS: Enhanced measurement using information from terrestrial infrastructure A-GPS: increases the sensitivity of GPS receivers. D-GPS: increases the accuracy of the measurement	GPS: ca. 3-15m A-GPS: up to 1-10 m	AE: GPS and D-GPS: outdoor A-GPS: outdoor/indoor CR: long (cross-national)	High outdoor precision Long coverage range (nearly global)	Line of sight required Problems in big cities ("urban canyons") Cost of the integration of components in mobile devices New or upgraded handsets needed
Wi-Fi WLAN infrastructure similar to cellular systems where the terminal communicates with the base station over an air interface at a certain frequency band	1-20 m	AE: indoor/outdoor CR: rather short (more than 100m but depending on the network quality)	High accuracy Low implementation costs Development of free public wireless networks Advantage compared to Blue-tooth: higher band-width capability	Possibility of signal interference Limited geographical range
Ultrawideband (UWB) Technology using short energy bursts at extremely low power over a large frequency spectrum	Up to several cm	AE: indoor/out-door CR: short (about up to 70m)	Very high accuracy	Until now not as developed as other position determining equipments (such as Wi-FI) Two competing standards. The IEEE UWB task group failed to develop a common standard in January 2006
Bluetooth Radio frequency specification for short-range, point-to-multipoint data transfer	Very high, up to milli-meters	AE: indoor CR: Short range (10cm to 1m; can be extended up to 100m)	Low-power requirements and low costs compared to Wi-Fi	Very short range Not possible to maintain multiple Bluetooth connections simultaneously for mobile phones
Radio frequency Identification (RFID) Wireless systems for non-contact reading of RF-enabled tags. Effective in environments where other identification mechanisms (such as barcode labels) may not be sufficient	High (few cm to one metre)	AE: indoor/outdoor CR: Short	Works in environment where other identification technologies are not effective (*e.g.* barcodes) Accuracy can be very high	Costs for tags currently too high for the mass market but falling rapidly
Cell identification (Cell-ID) Detects the approximate position of a device by identification of the cell the device is using. Most basic form of cellular detection	Rather low, but depends on the cell size	AE: indoor/outdoor CR: long	Already in use Relatively widespread infrastructure	Low accuracy Differences in cell size affect the accuracy
Time of arrival (TOA) TOA measures the time it takes a signal from a mobile device to reach three different cell sites which are equipped with location measurement units (LMUs) (triangulation)	10-100 m	AE: indoor/outdoor CR: long	Fairly accurate method	Significant investments for network operators due to the equipment of all cells with location measurement units which must be synchronized (maybe included with 3G)
(Enhanced) observed time difference ((E)-OTD) Similar to TOA. Method also based on triangulation but the measurement is realised by the mobile device	50-125 m	AE: indoor/outdoor CR: long	Only a limited number of cells have to be equipped with LMUs. No handheld modifications necessary	Significant investment for the end user as mobile devices must be suited for calculations
Angle of Arrival (AOA) AOA identifies the location of a mobile device using antenna arrays based on the angle at which signals transmitted from the device arrive at one or more base stations (BS)	Can get < 100 m	AE: indoor/outdoor CR: long	No modifications of mobile phones necessary	Requires special receivers at the base stations

Source: OECD based on Dao *et al.* (2002), D'Roza and Bilchev (2003), Djuknic and Richton (2000), Giaglis *et al.* (2003), Madhava and Tse (2005), Pfeiffer (2003), Rao and Minakakis (2003).

The raw location data obtained by the PDE is insufficient for most uses. It is only useful when combined with information that includes personal profiles, geographical data (*e.g.* in map form), directions to a location and nearby information (*e.g.* restaurants, hotels). To combine these data, a middleware depending on the network system (see Figure 7.2) enables the location server to access location data by requesting it from the PDE. The location server has two main functions: it acts as the interface between the middleware and other carrier or operator systems to minimise the effort to integrate different LBS applications and it interfaces with the GIS. The GIS server provides geographic and location information, including maps, street networks or information on consumers and locations. It then provides location-based information tailored to specific needs. The value chain described above is for networked services. The value chain may be less complex for some applications, *e.g.* car or boat navigation systems which receive positioning data from a satellite and then consult stored information such as driving directions.

LBS applications can be classified in seven main fields (Figure 7.2).

- *Emergency and rescue* LBS contribute to early warning systems by providing location-based weather and geological information. For example, for rescue services they provide information on the location of people by tracking calls from their mobile devices, especially to E911 in the United States or E112 in Europe.
- *Navigation services* are one of the most popular location-based applications and include navigation itself, information about traffic conditions, driving directions as well as safety driving. Car navigation systems are increasingly popular and often come as standard equipment in cars.
- *Location commerce and advertising* has promising commercial applications and good measurability but is potentially intrusive. It includes location-sensitive billing, transaction services (*e.g.* ticket reservation) and location advertisement services. Location-based advertisements to cellular wireless users have a significant advantage over other forms of advertisements as they can be personalised because of knowledge of customers' location and history of use. Mobile banners, SMS alerts and proximity-triggered advertisements are examples of location advertisement services (Giaglis *et al.*, 2003). As these advertisement services can raise privacy concerns it is generally acknowledged that consumers should opt for the service (see below on privacy concerns).
- *People tracking* monitors the location of specific groups such as children, elderly people, employees or friends and raises even more sensitive privacy and trust issues but also has an important security aspect.
- Besides people, location-based services also *track goods and assets*. Two important sub-application areas are supply chain management (SCM) and fleet tracking. The ability to locate assets at certain stages of the supply chain generates important gains in efficiency and thus cost reductions. The same applies for fleet tracking, which is mainly used by logistics companies. Tracking of stolen cars is also an application of asset tracking.
- *Nearby information services* group all LBS that provide mobile yellow pages, travel and tourist services such as accommodation information and information on landmarks, etc.
- Finally, LBS are also used for *entertainment* purposes, such as location-based games or dating services. All the above-mentioned applications are displayed on a LBS device such as a mobile phone or a PDA.

Economic impacts

It is very difficult to estimate market size and projected growth, and data may vary as there is no widely accepted or official definition. According to some industry analysts, the LBS market amounted to about USD 1 billion in 2005 (Juniper Research, 2005; ABI Research, 2005). ABI Research predicts a market size of USD 4 billion in 2009 and USD 8 billion in 2010, while Juniper Research estimates that the market will be over USD 8.5 billion by 2010. Market growth is slower than expected some years ago. According to Red Herring (2005), in 1998 analysts' estimates for the LBS market in Europe in 2005 ranged from USD 13 billion to USD 30 billion. Current estimates set the European LBS market at around USD 333 million in 2005. Taking all estimates into account and focusing on more recent ones (after the initial enthusiasm that accompanies most promising technologies), all sources suggest a significant increase in LBS, albeit from low levels.

A closer look at drivers and inhibitors of LBS can help project future development. As mentioned, the US FCC requirement for emergency services was an early driver. In 2006, broadband, through 3G wireless and Wi-Fi networks, delivers a diversified range of mobile or nomadic services. Public Wi-Fi networks are proliferating and starting to provide LBS. Furthermore, mobile phones are converging with PDAs. Network operators are still considering how to develop profitable business models. However, there are some inhibitors to the growth of LBS. Lack of LBS standards and low dependability – low content and communications quality as well as software reliability – mean that users cannot fully rely on the service. Security and privacy concerns, discussed below, are also factors in the rate of uptake. When such issues are resolved, as they have been for some LBS services, LBS will increase significantly.

A further factor influencing the success of LBS is the choice of business model, which depends on the application and the targeted customers. According to Rao and Minakakis (2003), subscription-based services and pay-per-view business models can be used for the consumer (mass) market mainly for nearby information and navigation application. For nearby information, a possible business model is free access to a service that is fully financed by advertisement. For niche consumer markets, another business model, revenue sharing (the user is charged for the service and the mobile operator gets part of the revenue) can be used. This is well-suited to people tracking, navigation and nearby information services. Finally, several business models for corporate customers concern asset tracking. They include consulting services and full-service solutions (*e.g.* infrastructure, network and application services).

Social impacts

As mentioned, security and particularly privacy concerns are important challenges for the further development of LBS. For people-tracking applications, for instance, security concerns include unauthorised access to the data of the person tracked. There is also the question of the possibility of circumventing privacy and security measures and tracking people without their knowledge. As to the issue of privacy, there is a fundamental question for people tracking (friend finder, child tracking): do users want other people to know where they are at any time? The same applies to users receiving location-based advertisements when using free LBS applications. Do they want companies to know where they are and be able to reconstruct their route during the day? To protect privacy, it is crucial to have the explicit consent of users and give them the possibility of turning off location finding (Giaglis *et al.*, 2003; Pfeiffer, 2003).

Customers' trust with respect to providing location information to third parties (*e.g.* advertisers) is crucial for service providers. Broad and flexible framework guidelines have been established by the OECD in the areas of privacy and information security which provide guidance and foundations for meeting privacy and security concerns associated with LBS (OECD, 1980, 2002b). One regulatory example is the EU Directive on Privacy and Electronic Communications (2002) which states that the "use of mobile phone location (for purposes other than routing calls) must have the consent of the user or be anonymised" (Soppera and Burbridge, 2005). Voluntary rules and codes of conduct can also be useful, but they do not provide legal redress if the code of conduct is not incorporated in legal regulations.

Once a user has decided to opt in or the service is put in place, privacy and security concerns during service provision can be significantly mitigated by effective technological security that protects the identification process. A hardware token can be used to identify people or assets and a software token can be used to identify applications or processes. Identifier systems consist of three parts, each of which requires specific design solutions: the physical device storing the identifier, the communication channel and the back-end system. On the device level, a trusted platform, which contains a module that is separate from the CPU, stores the secret information. Its drawback is that it can be used in PDAs, for example, but not in most embedded systems. For such systems the solution might be to change the identifier continuously, although this requires high management capability or encryption.

For security of the communication channel, three approaches can help: *blocking* which prevents "surreptitious scanning"; *access control* by simple passwords, encrypted identifiers to authorised readers, or a mutual authentication mechanism; and *encryption*. For the back-end system, two approaches have been suggested: In one, a trusted intermediary can be employed and act as anonymiser for communication between the end user and the application, and privacy can be enhanced if the intermediary blurs the location information. Encryption-based models can also be used. Pseudonym schemes, the second approach, allow the linkage between different pseudonyms and other data. Pseudonyms can be generated by the devices which are then communicated to the reader. Through the pseudonyms, limited secret information can be delegated to a reader for "a limited number of read operations". The advantage is that if an application is compromised, the user loses only the delegated parts. Furthermore, the pseudonym scheme makes it possible to link different pseudonyms (*e.g.* a pseudonym used in interaction with a doctor with a pseudonym used in a pharmacy (Soppera and Burbridge, 2005).

Emerging issues

Standardisation is another crucial factor for widespread adoption of LBS. Paradoxically, LBS depend on current localisation but users generally need them when they are in another environment (*e.g.* for asset tracking) which raises in particular the interoperability issue (Giaglis *et al.*, 2003). This issue has to be addressed across the whole value chain (see Figure 7.2). Several international bodies are dealing with standards and interoperability: the Location Working Group (formerly the Location Interoperability Forum) of the industry forum Open Mobile Alliance (OMA) is working on the development of specifications to ensure interoperability (OMA, 2006). Another example is the Open Geospatial Consortium (OGC, the former Open GIS Consortium), an international industry consortium of companies, government agencies and universities developing OpenGIS specifications that support interoperable solutions. OpenGIS specifications define a set of core interfaces for implementing interoperable LBS applications (OGC, 2004). Despite these interoperability standards, major companies (currently Google and

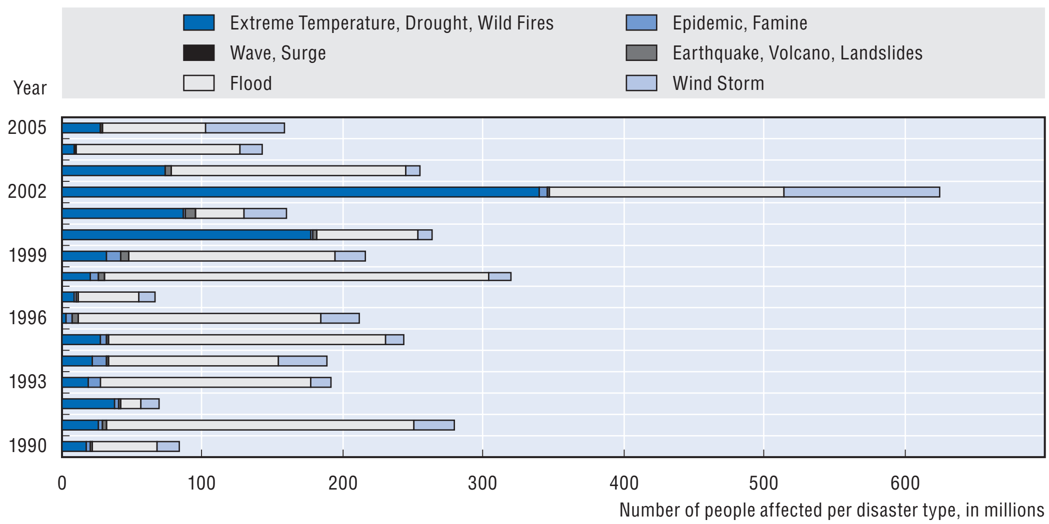
Microsoft) are also developing standards, making further developments difficult to predict (Bell, 2006). Service portability and roaming issues also have to be addressed to guarantee that LBS are affordable for users (Giaglis *et al.*, 2003).

Natural disaster prevention and warning technologies

The impact of disasters

The term "disaster" refers to a "sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, economic or environmental losses that exceed the community's or society's ability to cope using its own resources".[4] Natural disasters involve climatic disasters (such as windstorms, flood, drought, wildfires and extreme temperature), lithosphere disasters (such as volcanic eruptions, earthquakes and landslides) and other disasters (famine and epidemics) that are due to the complex interaction of many factors. The number of disasters[5] worldwide has exceeded 300 a year since 1998. In 2000 and 2002 there were over 500. Floods play a dominant role in both the number of disasters and the number of people affected (Figure 7.3). The number of occurrences of a type of disaster is not necessarily correlated with the number of people affected. For example, there are large numbers of earthquakes a year, but relatively few people are affected.

Figure 7.3. **Number of people affected[1] per disaster type per year**



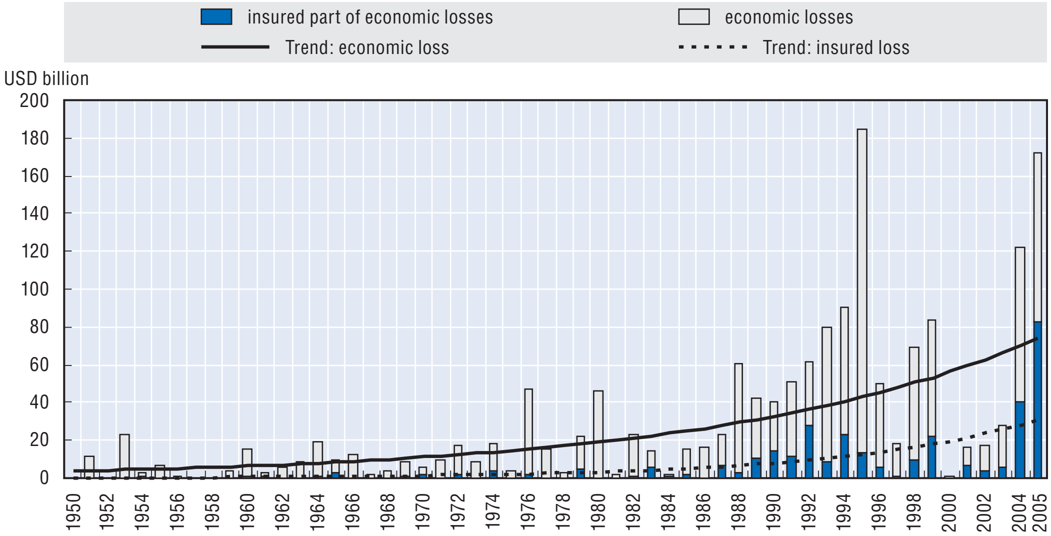
1. The category "total affected" covers people "that have been injured, affected and left homeless after a disaster". The term "affected" refers to "people requiring immediate assistance during a period of emergency, *i.e.* requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance".

Source: EM-DAT: The OFDA/CRED International Disaster Database, *www.em-dat.net*; Université Catholique de Louvain, Brussels.

StatLink: http://dx.doi.org/10.1787/574518225844

As Figure 7.4 shows, disasters entail important economic losses. The data, adjusted to present values, are collected by an insurance company and are mainly based on official reports and claims paid. Consequently, the numbers are conservative and may underestimate effective economic losses in particular cases. Nonetheless, the figure illustrates the importance of economic losses. In 2005, catastrophe economic losses amounted to more than USD 170 billion. There is a clear upward trend for both economic and insured losses.

Figure 7.4. **Economic and insured losses due to disasters: absolute values and long-term trends (2005 values)**



Source: OECD based on Munich Re (2006), "Topics Geo: Annual Review: Natural Catastrophes 2005".

StatLink: *http://dx.doi.org/10.1787/472346304415*

Technologies for disaster prevention and warning

Natural disasters cannot be avoided, but efficient disaster management can reduce the number of people affected and the economic losses. Disaster management has three main phases: prevention, warning and preparedness, and relief management. The following paragraphs concentrate on information technologies used in the first two phases.

Satellite remote sensing technology is used for nearly all types of natural disaster but different types of satellites are used for different types of disaster. *Earth observation satellites* provide extensive, real-time coverage of wide areas of the world in order to observe the state of the Earth and its processes. They provide synoptic views of large-scale phenomena and dispose of rapid measurement capabilities. Applications include forecasting hurricane and cyclone tracks. *Geo-stationary satellites* remain in place over a defined point, *i.e.* the satellite rotates around the Earth at the same speed as the Earth rotates around its axis. They are positioned at about 36 000 km and can provide continuous, frequent observations over large areas. They are particularly suitable for meteorological applications (see Box 7.2). *Polar orbiting satellites* have a much lower orbit and can provide images at much higher resolution. They have an inclination of 90° and pass over or nearly over the North Pole and the South Pole. Owing to their high resolution imagery, they are suitable for disaster monitoring even if the temporal frequency is rather low. *Communication satellites* play a crucial role in the diffusion of disaster warnings and the co-ordination of preparations for disaster mitigation. They are especially essential for data collection and for distress alert (CEOS, 2005; NOAA, 2005; Rao, 2000; Sylves and Wood, 2003).

Despite recent developments in satellite remote sensing technology, challenges and obstacles remain. Satellite systems and the linked computer systems are complex and expensive; this may impede the use of their data for disaster management (OECD, 2003). Furthermore, there are institutional and technical challenges. On the institutional side,

Box 7.2. **Tsunami early warning systems**

Geostationary satellites are used in the data transmission and communication phase of tsunami early warning systems. These systems have two important phases: the prediction and detection phase and the data transmission and communication phase.

For the first of these phases, tsunami early warning systems use different kinds of data, including seismographic and oceanographic data and data generated by the Deep Ocean Assessment and Reporting (DART) programme. Whereas regional early warning systems rely mainly on seismographic data, the international Tsunami Warning System (TSWS) in the Pacific also uses tide gauges and the DART system, which currently consists of six buoys. Both tide gauges and the DART system measure changes in the ocean's depth. Among the advantages of the DART system are its ability to measure deep ocean tsunami energy directly and the fact that it is less vulnerable to earthquake damage. It relies on an anchored pressure recorder on the seafloor that measures changes in water depth. The recorder uses an acoustic modem to transmit data to a surface buoy (González *et al*., 1998).

Transmission of data from the buoy to tsunami early warning centres takes place via the Geostationary Operational Environmental Satellite (GOES). In the early warning centres, the data are combined with the seismographic and oceanographic data. Once the data are processed and show the need to issue a tsunami warning, it is crucial to have a reliable and effective communication system to warn the population. This system should include a clear communication framework and a reliable communication infrastructure. In Aceh, Indonesia, for example, the warning could be transmitted via loudspeakers of mosques (Alverson, 2005).

In addition to the TSWS a tsunami warning system for the Indian Ocean is currently being deployed which, like the TSWS, will rely on buoys, regional seismographs and satellite communication. In addition, technologies currently under development might be integrated. They include satellite-based radar interferometry which maps the deformation of the ground as well as new computer models and two-way communicating ocean buoys (BMF, 2005; Coren, 2005).

better and more extensive co-operation among space agencies and between these agencies and the private sector is needed to ensure adequate and fast response (CEOS, 2005). Additionally, satellite-generated data has to be embedded in appropriate and user-friendly tools to ensure that the data are used effectively for disaster management. Speed of delivery and spatial resolution could be improved (OECD, 2005). For the future, CEOS (Committee on Earth Observation Satellites) expects new capabilities such as greater compatibility of satellite-derived data with the GIS and better precipitation measurements for flood warnings.

Once satellite data are generated, they must be processed and combined with other spatial data and relevant information to be useful for disaster management. A GIS, which is a computer system, assumes the role of interrelating, analysing, processing and displaying geographically referenced data. Its advantage is that it can convert digital information that may not be in map form into a recognisable and useful form (USGS, 2005). For example, digital satellite imagery can be analysed and converted to a user-friendly map form. In addition to commercial GIS software applications, open source GIS software applications are increasing available, especially for Web services. Owing to the active GIS market and lower costs, GIS software, hardware and data have been improving continuously and may lead to broader use of GIS software by the public and private sector (USGS, 2005).

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Transmission of disaster warning

After the data is processed, fast and effective communication is crucial. Different technologies are currently used to alert the population, ranging from loudspeakers, radio communication, sirens, beepers and television to mobile phones, the Internet and a combination of technologies. Currently, radio, TV and mobile communication are mainly used. The Dutch government, for example, is testing a mobile phone SMS danger alert system relying on the GSM (Global System for Mobile Communications) standard for mobile phones to identify users of mobile phones in a particular area (Clothier, 2005). When a disaster occurs, a message is sent out to all mobile phone users in the area. In another example of the use of mobile phones for hazard alerts, the Japanese city of Yokosuka delivers information, including map and location information, to mobile phones via the Internet. New projects include the use of broadband for disaster warning. Korea is developing a means of disaster warning via Terrestrial Digital Multimedia Broadcasting (T-DMB) (see Box 7.3).

Box 7.3. **Korea Disaster Warning System with Terrestrial Digital Multimedia Broadcasting**

T-DMB is a technology for broadcasting digital content to mobile devices such as mobile phones, PDAs and moving vehicles. The digital content includes video and audio services as well as data services such as weather forecasts or news. Mobile TV in cars and buses was successfully tested in the metropolitan area of Seoul and commercial services were launched in the second half of 2005.

When disasters occur, T-DMB broadcasting stations convert disaster warning information into DMB format data which are transmitted to automatically activated T-DMB receiver devices. The receiver devices display information on the screen and check disaster warning information periodically. The advantages of T-DMB include spectrum efficiency (national coverage with single frequency network), easy installation and wide coverage.

Source: ETRI (2005), Korean Ministry of Information and Communication.

When different public agencies and emergency services want to combine disaster warning systems, they often face the problem of incompatible communication systems owing to the use of different networks, frequency bands or radio technologies. This can seriously impede the transmission of disaster warning, with severe consequences. To solve the problem there are four main approaches: use of the same systems, of gateway devices, of software-defined radio (SDR) or of an interoperability system[6] that relies on IP networks.

SDR developments allow multi-mode terminals to support a wide range of radio standards seamlessly (ITU, 2005). A single device can thus provide different services which were previously only available through different products. The interoperability system relying on IP networks ideally integrates different push-to-talk radio systems with other communication systems like voice, data (used in GIS for example) as well as images and video devices (Cisco, 2005a). The integration is done by converting voice communication on radio and other devices into data traffic over networks (Markhoff, 2005). Each radio channel is mapped to an IP address, for example. This approach is independent from the underlying technologies and can be used on a geographically broad area (Cisco, 2005b).

All of these approaches make communication between different public agencies and emergency services easier and faster. Technology can contribute to better communication between agencies but it cannot replace a framework that determines the co-ordination of different agencies and services in case of natural hazards. The effectiveness of new technology applications will increase if clear, preferably global, policies for disaster preparedness and warning are implemented to determine which agencies are responsible for which task and at which time. Learning from recent disaster management experience (hurricanes, tsunami) will also help improve future management.

Emerging issues

On the technological side, disaster prevention and warning technologies will improve with advances in information, bio- and nanotechnology and their convergence. As computing processing power increases, costs will decline and larger amounts of data generated by different disaster prevention and warning technologies can be processed, visualised and included in the decision-making process. Moreover, new devices will be developed, and nanotechnology applications will likely make these devices lighter and more powerful.

Effective future disaster warning systems have to cope with two important characteristics of disasters: their increasingly international dimension and the multitude of types of disaster. International co-operation needs to be strengthened to maximise knowledge transfer and take full advantage of observation and monitoring instruments. In addition, disaster warning systems should be able to detect different disaster types. The Indian Ocean tsunami warning system, for example, is currently only conceived for tsunami warnings. This entails large investments for a single type of disaster, yet it may be many years until the next tsunami. The development of a tsunami system for the Indian Ocean should be part of a global ocean disaster warning system that also detects other disaster types, storm surges for example, by upgrading the Global Sea Level Observation System (GLOSS) which observes long-term sea level and ocean circulation (Alversen, 2005). Creating global systems, however, entails challenges. Besides the cost of a system that is always available, there are issues such as co-ordination of the activities of different countries and security considerations. Scientists from different fields would have to work together and commit to a common project. Furthermore, national warning centres need to be integrated and the system adapted to their needs and conditions, as disaster warnings are transmitted at a regional and local level.

It is also essential to train local emergency agencies to communicate disaster warnings and to educate the public on how to use information on natural hazards and how to respond to disaster warnings through the media, schools, hospitals and local public authorities (OECD, 2003). Only if the whole process of disaster prevention and warning, from the detection of natural hazards to communication of warnings and appropriate behaviour by the public, is effective can disasters be mitigated or avoided. Disaster prevention and warning is only as strong as the weakest link in the warning chain.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Participative Web

The Internet is entering an era of increased participation and greater interaction among Internet users. Various developments confirm this evolution, notably Web 2.0 and virtual communities, with Internet users becoming more active in developing and distributing Internet content.[7] Web 2.0 is increasingly seen as a comprehensive platform for Web service applications. Software is no longer delivered as a product but as a service, such as knowledge networks (*e.g.* Wikipedia) or content-sharing sites which use the Internet as a delivery platform. The underlying technology, which consists of lightweight programming models, is an important driver. Another important characteristic is the increasing number of contributions from individuals (O'Reilly, 2005). The term "virtual community" refers to a group of individuals sharing a common interest via online services. These include email, podcasts, blogs, forums and chat rooms. As Internet access has increased, the concept has become more and more popular. These practices reflect the changing attitude of Internet users. Instead of passive consumption, users participate actively in developing open source software, creating content and customising the Internet. This new behaviour pattern, which applies both to individuals and to companies, is known as participative Web.

Participative Web comprises various services and applications (see Table 7.2 for illustrative examples). Among these services, blogs are the most cited textual applications and are very popular among users who create digital content (see Table 7.3 for a ranking of the most visited UK sites in February 2006). However, Hoem (2004) highlights that textual applications were only the starting point of a cascade of activities: participation via textual

Table 7.2. **Examples of participative Web services and applications with varying levels of user involvement**

Application	Definition	Examples
Online forum	Web service that enables post- and reply-based discussions	Online discussion forums and bulletin boards such as the UNDP Vietnam Discussion Forum
Chat/Instant messaging	Service that provides Internet users a venue for real-time communication	Chat platforms such as IRC and instant messaging services such as MSN and AIM
Feed reader or aggregator	An application that collects and aggregates syndicated content (usually via RSS, Atom) into a consolidated view	Feedreader, NewzCrawler or Web-based aggregator such as BlogLines
File-sharing service	Platform allowing content sharing between users	Video-sharing sites such as YouTube and various P2P applications
Tagging service	Service that tags information on the Web	Bookmarking services, photo management services such as Flickr
Social networking site	Web service that enables users to create profiles, connect with friends and join and interact with various communities	MySpace, Facebook, Friendster
Blog	Type of Web page usually displaying date-stamped entries in reverse chronological order	Daily Kos, BoingBoing
Podcast	Audio segment on Web sites for downloadingindividually or via subscription	Podcasts made by individuals and by corporations, PodcastAlley
Knowledge network	Network of Internet users where users add value to the network by exchanging knowledge	Open source software collaboration, Wikis (Web sites that allow users to add content such as Wikipedia), professional knowledge networks such as InnoCentive
Bundling service	Services that provide a set of some of the applications listed above	Cyworld, TagWorld, LunarStorm

applications, then images, recently also podcasts and finally moving images. OhmyNews, a Korean Internet news service with more than 30 000 citizen journalists, and Wikipedia, a free online encyclopaedia, are examples of textual applications that depend significantly on the participation of Internet users. Image-sharing sites such as Flickr or Fotolog also rely on active participation by users. As an audio application, user-created podcasts are increasingly popular. A further step will be moving images as a combination of visual and audio applications. Footage from individuals at the scene of a natural disaster is already used.

Table 7.3. **Blogs and personal websites, net communities and chat monthly, UK rankings, February 2006**

Rank by number of "visits"

Rank	Blogs and personal Web sites	Market share %	Net communities and chat	Market share %
1	MSN Spaces	36.0	MSN Spaces	8.6
2	BlogLines	31.6	MySpace	8.5
3	MySpace - Blog	4.7	Bebo	6.7
4	LiveJournal.com	3.9	Piczo	5.5
5	LiveJournal Community Center	1.8	Faceparty	5.0
6	Blogger	1.8	Friends Reunited UK	3.7
7	Xanga	1.4	MSN Messenger	2.2
8	CarrieLynne's World	1.4	MSN Groups	2.2
9	Yahoo! 360	1.2	hi5	2.1
10	LiveJournal's Photo Hosting Service	0.7	Yahoo! Groups	1.9

Source: OECD based on Hitwise. Ranks by "Visits", 2006.

Several factors have contributed to greater use of these applications and greater involvement of Internet users. First, the number of broadband subscriptions throughout the OECD area increased in the first half of 2005 from 119 million to 137 million (see OECD Key ICT Indicators and Chapter 5), as prices have declined. The availability of (partly free) easy-to-use software allows users to create content inexpensively (Herring *et al.*, 2004). Participative Web is also supported by Web development techniques like Ajax and XML (Extensible Markup Language) file formats, mainly RSS. Both Ajax and RSS play an important role.

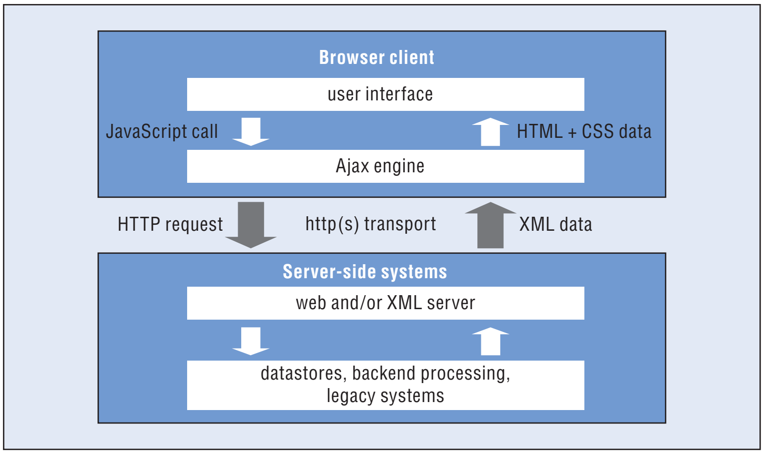
Ajax (Asynchronous JavaScript and XML) is a Web development technique for interactive Web applications which encompasses different technologies. Ajax incorporates XHTML (eXtensible HyperText Markup Language) and CSS (Cascading Style Sheets) for standards-based presentation, the Document Object Model for interaction, XML and XSLT (Extensible Stylesheet Language Transformations) for data interchange and manipulation, XMLHttpRequest (Extensible Markup Language Http [HyperText Transfer Protocol] Request) to retrieve data asynchronously from the Web server as well as JavaScript (Garrett, 2005). The main advantage of this technique is that "Web pages are dynamically updated without a full page refresh interrupting the information flow" and allows creating "richer, more dynamic Web application user interfaces" (McCarthy, 2005). This can be achieved by an Ajax engine which is interposed between the user and the server (Figure 7.5). New Web applications like Google Groups, Google Maps and Flickr (a photo-sharing Web site) are based on Ajax.

The abbreviation RSS can refer to three different terms: Rich Site Summary, Really Simple Syndication or RDF (Resource Description Framework) Site Summary. RSS is an XML (Extensible Markup Language) file format for content syndication. RSS files, also called feeds, transmit structured data which typically include headlines, dates, authors,

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

content summaries and links to the full versions (Bowman, 2003; Gill, 2005). Users can subscribe to a feed and transform the transmitted data into information via a RSS reader. The latter usually aggregates data of a number of feeds and displays a list of new entries with short descriptions and a link to the full text version.

Figure 7.5. **Ajax Web application model**



Source: OECD, based on Garrett (2005).

The first RSS versions (RSS 0.9 and RSS 0.91) were developed by Netscape in 1999 with a view to publishing news headlines or content summaries on Web site portals (Gill, 2005). As Netscape lost interest, UserLand created another RSS 0.91 version for blogging software in June 2000 which was incompatible with Netscape's versions. Finally in 2002, RSS 1.0 was created and again was not compatible with prior versions. In 2002, RSS 2.0 was developed. This version has so far remained unchanged, which significantly facilitates the work of feed reader developers.

RSS files are important both for content creators and readers. On the one hand, content creators are able to easily syndicate content for RSS readers. Often, RSS tools are already integrated in publishing software. On the other hand, readers are able to personalise Web services: they do not have to check Web pages regularly for new entries but are kept informed by their RSS readers. While use of RSS is widespread among content creators, RSS readers, especially for news, are currently only used by early adopters (Business Week Online, 2005a).

A Web page that supports RSS usually has a small RSS or XML icon on the site. News Web pages, blog Web sites, and podcasts that make use of RSS to enable subscriptions have made these icons popular. RSS will increase in popularity when RSS readers are included in Internet browsers.

Blogs

Blogs are currently the most cited application in the present early phase of the development of the participative Web. In the following paragraphs, blogs are defined and classified, and the underlying software and economic and social impacts are discussed.

Although blogs are very popular, there is no consensus on a precise definition of what constitutes a blog. Some definitions only cover online journals (*e.g.* Bowman and Willis, 2003), while others state that the Web page must be updated frequently without specifying the exact meaning of "frequently". The PEW Internet and American Life Project Study on Teen Content Creators and Consumers (Lenhart, 2005) and Gill (2004) define a blog as a type of Web page usually displaying date-stamped entries in reverse chronological order.

The types, purposes and contents of blogs vary widely. Blood (2002) distinguishes three types: filters, journals and notebooks. In filters, the blogger (author of a blog post) comments on external content (Herring *et al.*, 2004) such as world news. Journals, in contrast, reflect the reader's daily life: posts are relatively short and the content is internal to the blogger. Notebooks differ from journals in that posts are longer. They sometimes deal with external content and sometimes with internal content like a longer personal story.

Blogs have four main purposes: one is delivering and/or sharing information. Examples are news blogs, "alternative sources of news and public opinion", and knowledge blogs (k-logs) in organisations and for educational purposes (Herring *et al.*, 2004). Another is reader attraction, a purpose common to nearly all blogs but particularly to news blogs and some personal blogs. Self-expression and self-empowerment is a third purpose and is mainly reflected in personal journals where bloggers note their thoughts and views. The fourth is social network building and social interaction. Many blogs link to other blogs and create social interaction with other bloggers. Compared to emails, blogs facilitate more dynamic interaction and easily include a large group of readers and bloggers. Moreover, compared to chat rooms, any number of individuals can be included. Stating an opinion is also probably easier than in short chat messages.

On the technological level, several tools support the creation and maintenance of blogs. Content management systems (CMS) allow bloggers to create their own weblogs. One important characteristic of CMS is the separation of content from presentation (Machrone, 2005). Content is archived on a database and formatting is only done once the page is built (in contrast to ordinary Web pages). CMS, in the context of blogs often called blogging software, are partly free of charge. Movable Type, WordPress and Nucleus CMS are popular software. Blog-hosting services make it even easier to create a blog by providing online editing and easy-to-use setting up features. The most popular are Blogger, LiveJournal, TypePad and Xanga (InformationWeek, 2005). Technological developments like TrackBack also improve communication among blogs. For example, TrackBack allows automatic notification of references by other blogs.

There are several ways to measure the importance and influence of blogs. Country surveys analyse the blogging behaviour of individuals. Blog search engines and related companies are trying to estimate the total number of blogs worldwide. For example, a survey on US content creators and consumers by the Pew Internet and American Life Project provides demographical data on the popularity of blogs among different age groups. Whereas 27% of adult users declared they had read blogs, 38% of those aged 12 to 17 had done so. While 7% of adult users said they had created their own blogs, 19% of those aged 12 to 17 had done so (Lenhart, 2005). The survey also revealed that teens who blog are generally technically more knowledgeable than their non-blogging counterparts.

According to Herring *et al.* (2004), the first blog with the current format was created in 1996. Jorn Barger, an early American blogger, first used the term weblog in 1997. The

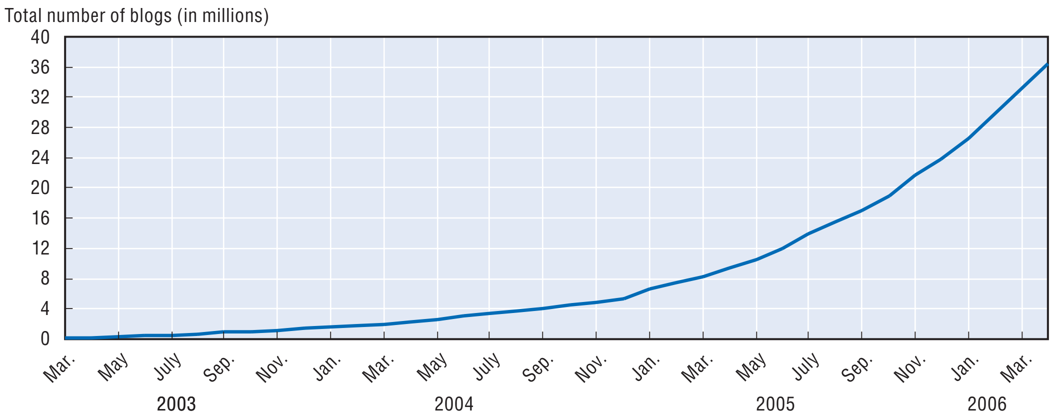
 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

earliest blogging software was issued in 1999. Since then, blogging has increased steadily. By 2002, there were an estimated 500 000 blogs (Gill, 2004). Recent estimates vary between 18 million and 37 million worldwide. The wide variance is due to differences in measurement methods. Blog search engines, for example, track the number of links to blogs and their perceived relevance (*i.e.* they count the number of blogs they effectively identify). Other companies conduct surveys and use blog samples.

Figures 7.6 and 7.7 are based on data generated by a blog search engine. The strength of the data is the fact that blogs are indexed and therefore effectively exist. This means, however, that blogs not indexed by the search engine are not covered; this is especially true for Korea.[8] Figure 7.6 plots the number of blogs from March 2003 to April 2006. During this period, the number of tracked blogs nearly doubled every five months. This rapid development is driven by easy-to-use software and a social network effect, which incites more and more Internet users to create their own blog in order to participate and to express themselves.

Figure 7.6. **The total number of blogs March 2003-April 2006**

Millions



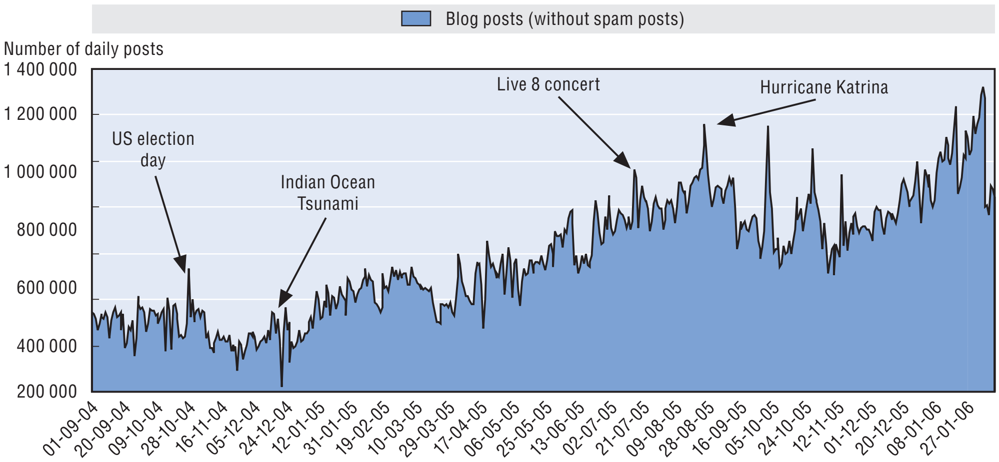
Source: OECD based on Sifry (2005).

StatLink: http://dx.doi.org/10.1787/008771056318

Another way to represent increased participation in blogs is the daily posting volume, *i.e.* the number of individual entries a day. Figure 7.7 plots these for the period September 2004 to January 2006. Its advantage over Figure 7.6 is that it measures bloggers' actual daily activity. The figure illustrates two important points: first, daily posts increased significantly over the last year to over 1 million posts per day; and second, post peaks depend on incidents.

A breakdown reveals that the blogging phenomenon varies significantly between languages. Figure 7.8 plots the language distribution of blogs tracked by a search engine machine and Figure 7.9 represents the use of the Internet per language. Nearly 75% of all blogs are written in English, Japanese or Korean. As mentioned, the data underestimate the number of Korean blogs so that the effective percentage should be higher than 75%. While it is not surprising that English blogs represent 34% given that 32% of Internet users are English-speaking, the number of Japanese and Korean blogs is disproportional to the general use of the Internet (see Chapter 4 for Chinese blogs). There may be several reasons why blogs are so popular among those who speak Japanese or Korean. On the technological side, high diffusion of broadband and hand-held portable Internet access devices such as mobile phones ensure high connectivity to the Internet and enable users to post comments anytime and anywhere. In addition, Japan and Korea are usually early adopters for new information technologies and new services. Furthermore, Korean blog-hosting services often offer a bundle of connected services. Cyworld, for example, with 15 million Korean members (one-third of the country's population) in September 2005, provides a free blog service coupled with other services such as picture sharing and tagging (Business Week Online, 2005b).

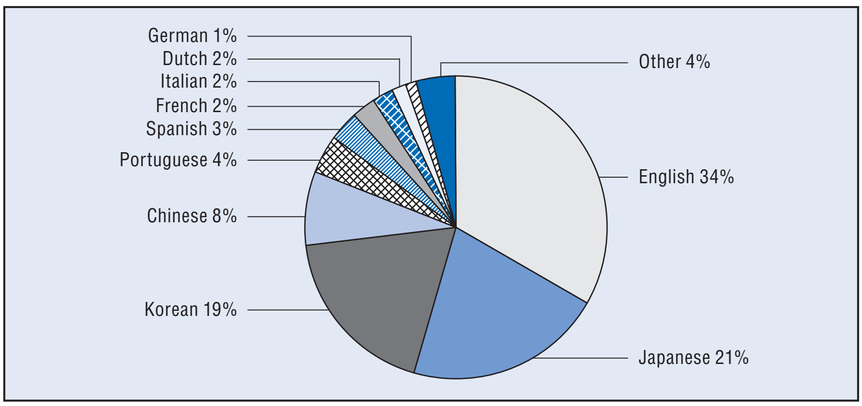
Figure 7.7. **Posts per day September 2004-January 2006**



Source: OECD based on Technorati.

StatLink: http://dx.doi.org/10.1787/303300744306

Figure 7.8. **Language distribution of blogs indexed by Technorati**



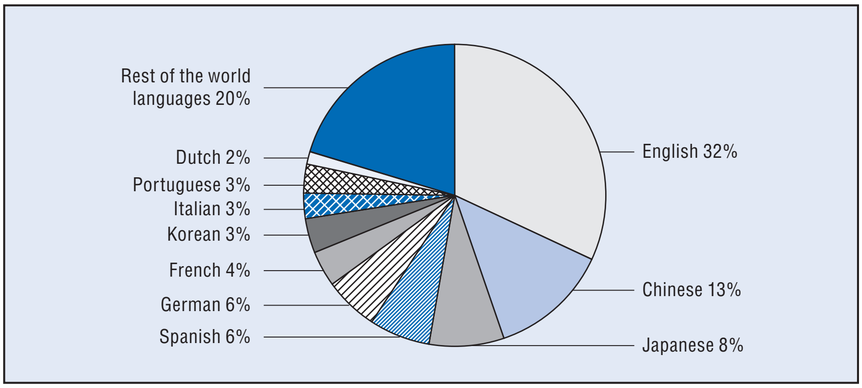
Source: OECD based on Technorati.

StatLink: http://dx.doi.org/10.1787/408783364828

Economic impacts

The development of the blogosphere has economic dimensions: new business models allow bloggers or networks of blogs to make blogging profitable. Companies use blogs in various ways to place classic advertisements for single products or the company's name and are beginning to use new models for advertising purposes. Bloggers currently have two

Figure 7.9. **Internet users per language, November 2005**



Source: Internet World Stats.

StatLink: http://dx.doi.org/10.1787/887201187674

main ways to earn money when blogging: selling their content to a blog or blog network or generating revenue by advertisements on their blog. Content can be sold to news blogs like Korean OhmyNews or to professional blog publishing services like Gawker Media or Weblogs Inc. Weblogs Inc. is a professional network of blogs; bloggers are paid on a freelance basis depending, among other things, on the frequency of updating, and lose their copyright when they sell content. Weblogs Inc. generates revenue by selling advertising space in the form of network advertisements (Google ads, Tribal Fusion) and direct advertisements (Madden, 2005). Although revenues are not formally disclosed, a posting by the founder of Weblog Inc. noted that advertisement revenue amounted to USD 1 000 a day from Google AdSense alone. AOL bought the company in October 2005 for USD 25 million (Reuters UK, 2005). It is more difficult for individual blogs to finance their blogging activity in this way given that the money paid by advertisers generally depends on the size of the readership. Several business services like FM Publishing or BlackIncMedia are offering to provide outsourced business and technical support services.

For companies, blogs offer a variety of advertisement possibilities. As mentioned above, advertisements can be placed on individual blogs with a large readership or on blog networks either directly or via online advertisement services. Furthermore, companies can include blogs on their Web pages to promote a dialogue on the company or a product. However, this marketing tool is questionable, as it is difficult to avoid credibility problems. Blogs dealing with a general topic but sponsored by a company are probably more credible as the content does not deal with a single product or service and as the blogger responsible usually has a private blog and a good reputation. A blog sponsored by the French fashion brand Celio (*http://vousleshommes.blogs.com*) deals with general advice for men. Sponsoring is clearly visible on the site. Employees' blogs are another way for companies to avoid the credibility problem. This is particularly true for blogs that criticise the company, although there have been reports of dismissals for critical blogs. Robert Scoble's Scobleizer blog criticises Microsoft, his employer, and he has a credible image in the blogosphere (Allison, 2005).

Companies also use blogs as an internal communication tool. Compared to other communication tools, blogs have several advantages: they allow rapid communication, do not depend on schedules and largely organise knowledge exchange horizontally. Different R&D teams can for example communicate more easily through blogs than through the traditional hierarchical structure. IBM employees have set up an internal blogging service as well as corporate blogging guidelines. The service is used by more than 9 000 registered users and hosts over 3 000 blogs (Snell, 2005). Beside adequate guidelines, the provision of high-quality information is another challenge. According to Neus (2001), incentives should be provided for high-quality information such as accountability for contributions, personal profile pages, a thematic focus as well as membership criteria.

Social impacts

Blogs are often equated with platforms for exchange of cooking recipes or online journals with very limited readership. However, blogs have important social impacts. One is a contribution to the democratisation of the media through participatory journalism (Bowman and Willis, 2003). Through blogs, individuals and groups can participate in the creation, annotation and selection of news and commentary. Unlike traditional journalists, bloggers are not bound by editorial policy, delays or page constraints and are free to publish what they wish (Hourihan, 2002). Compared to traditional homepages, for which the arguments mentioned above apply as well, blogs make publishing much easier. Thanks to weblogging software, Internet users can create their own Web page with little technological knowledge at nearly no cost. Furthermore, information probably passes faster through the Internet given that many blogs are linked together and that many blogs have subscribers via RSS.

The content distributed by blogs usually differs from the content of traditional mainstream media. Whereas traditional media are organised hierarchically and are generally profit-oriented, the blogosphere is more like an interactive network. Workflow is not dictated and content is not filtered before it is published. This could pose a threat as inaccurate or unethical content can be diffused easily. Blogs use a bottom-up approach whereas traditional journalism follows a top-down approach (Bowman and Willis, 2003). Accordingly, values are different: integrity and profitability are typical values of traditional media whereas collaboration and egalitarianism are values of participative journalism.

Blogs have increasingly shown their influence as a new form of journalism. According to Gill (2005), bloggers have undertaken the role of grassroots reporters and fact-checkers and created a kind of collective databank that influences content in traditional media. Furthermore, some blog sites have a large number of readers and writers and therefore have influence. BoingBoing, one of the most popular blogs , has 1.7 million readers a day, 80% of which read the blog via RSS. Korea's OhmyNews has an estimated half a million readers daily (Lu Stout, 2005). More than 30 000 citizen reporters write articles for OhmyNews.

So far, however, only a few blogging Web pages have a wide readership. Many blogs of the journal type have few readers and are unlikely to influence traditional media significantly. Moreover, the survey of the Pew Internet and American Life Project 2005 shows that 62% of US teens between 12 and 17 years stayed in their personal teen network when reading blogs. Thus, blogs may find it difficult to take a leading media role even though some blogs have the power to affect the news agenda and reach a wide readership. Recent Pew data (December 2005) show that for high US Internet users, who are typically in younger age groups, online news is their major news source and that 20% of under-35 active broadband users have contributed to blog content (Horrigan, 2006). Furthermore, blogs can provide news very fast and are able to give attention to topics that are not treated by the traditional media. For this purpose, blogs do not necessarily need a big readership. It is sufficient to be well linked to other Web sites.

Blogs also have an important social role as a way for political parties to provide information on the party and candidates but also to raise money. During the 2004 US presidential elections, both John Kerry and George W. Bush had blogs on their Web sites. Kerry created his blog in 2003 and encountered some problems as registration was not required for posting comments (Gill, 2004). Political parties need to use blogs with care to avoid the presence of negative images on their Web pages. Besides special blogs for elections, US parties' Web sites have some eye-catching blogs. The Republican National Committee runs a blog with 25 thematic RSS files for RSS readers. The Democratic Party runs a blog with RSS files for different RSS versions as well as an RSS file for podcasts. According to Gill (2004), blogs on parties' Web sites will probably not have enough influence to motivate people to become politically active. However, they are a rapid and inexpensive way to keep the public informed and to appeal for its engagement.

Emerging issues

As the number of blogs rises, the spam phenomenon, which was originally associated only with email, is entering the blogosphere. "Splogs", a combination of blog and spam, are *weblogsites* with faked articles which the author uses only for promoting affiliated Web sites. Content is randomly composed using catchwords that appear on a search engine. For an Internet user searching for example for a lock and key service, a splog would try to maximise the number of words related to this service and thus get the reader to click on links to advertisements. In October 2005, the blog-hosting service "Blogger" received an avalanche of 13 000 spam blogs created on a single weekend (Noguchi, 2005). In order to increase their popularity on search engines, splogs link to many other Web sites. Google and Yahoo! are trying to improve their search mechanisms. Technorati sorts out identified splogs when counting the total number of blogs. Spam in blogs is a form of spam, that is usually random comments having nothing to do with the blog's topic and tries to advertise or to get the reader to click on a link (Noguchi, 2005).

Blog spam functions differently from spam email. Users do not automatically receive it on their computer; they must click on the splog or blog with comment spam. Furthermore, such spam does not currently represent a security problem as it does not transmit viruses. It provokes confusion on search engines and loss of time, but costs should be lower than costs of e-mail spam. However, serious problems may arise from faked or manipulated information aimed at influencing bloggers, as shown by a UK survey which indicated that 77% of UK consumers would use information from blogs for their purchase decision (New Media Age, 2005).

The convergence of nano-, bio-, and information technology

The end of the 20th century was marked by crucial innovations in information technology, biotechnology and nanotechnology. Information technology "prepared the ground for the computer, cell phones and the Internet" and has developed to handle very large databases, computations and data transmission at very high speeds (Nordmann, 2005; Roco and Bainbridge, 2003). Some of these developments are the source of many of the advances discussed in preceding sections. Biotechnological developments have paved the way for targeted and personalised drugs and diagnostic testing as well as innovations in agriculture and food. For its part, nanotechnology is becoming part of other technologies and contributing to the development of new materials, electronics, pharmaceuticals, chemicals, aerospace and tools. It is expected to represent a market of USD 1 trillion by 2015 (OECD, 2004a).

All of these technologies enable R&D, innovation and economic growth, and exploiting the huge potential of their convergence is a major challenge. Nanotechnology involves the creation of tiny structures and contributes to the miniaturisation of many other structures and processes. It can therefore be of value to every technology that can gain from miniaturisation and molecular-level applications. Information technology provides the modelling and computing power for complex processes and problems. Biotechnology detects structures as well as the chemical-physical processes in living systems (Nordmann, 2005). Convergence of these technologies is already having significant impacts and they are likely to increase. Large-scale computing played an important role in mapping the human genome and led to rapid completion of this project. The application of bioinformatics in drug discovery and development is expected to reduce some R&D costs by approximately 30%, so that more resources can be allocated to promising fields (BCC Research, 2005).

The discussion of the convergence of nano-, bio-, and information technology begins with an overview of studies and reports. It then presents some applications and describes in more detail two applications, microarrays and neuroprosthetics, before dealing with social impacts.

Overview of converging technologies

Most reports dealing with converging technologies study an individual technology. The term converging technologies (CT) was first used in this context during two workshops held by the US Department of Commerce and the US National Science Foundation, and in the follow-up report, *Converging Technologies for Improving Human Performance* (Roco and Bainbridge, 2003). CT was defined as "the synergistic combination of nanotechnology, biotechnology, information technology and cognitive sciences (NBIC)".[9] The report states that significant convergence could lead to "a tremendous improvement in human abilities, societal outcomes, the nation's productivity, and the quality of life". Benefits include new organisational structures and management principles thanks to efficiency gains in communication, advances in robotics, machines that adapt to changing situations and wearable sensors that enhance awareness of potential hazards and the individual's state of health. More futuristic ones include the ability to control the human genome or establish broadband interfaces between human brains and machines. That report was criticised as being highly positivistic, futuristic and blurring the frontier of reality and science fiction (NSF/DoC, 2002; Royal Society, Royal Academy of Engineering 2004), and as largely avoiding "discussions of ethical, legal or social issues related to NBIC" (Coenen *et al.*, 2004). However, it initiated a range of activities and reports regarded as the starting point of CT research.

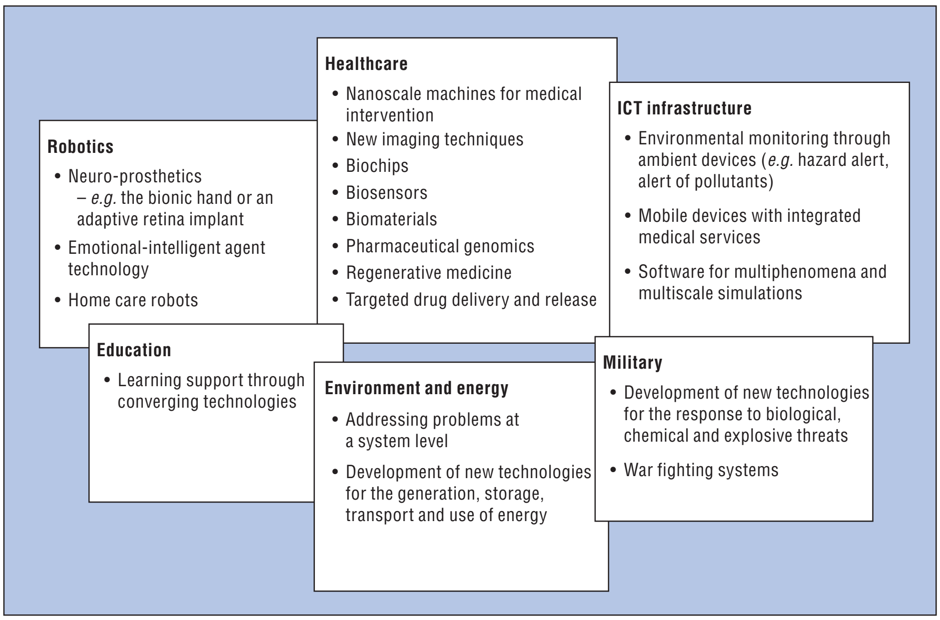
In 2003 the EU set up a high level expert group on "Foresighting the New Technology Wave" to deal with questions raised in that report and contribute to implementation of the Lisbon Agenda.[10] In 2004, this group published "Converging Technologies – Shaping the Future of European Societies" (Nordmann, 2005), the starting point in the EU for debating challenges relating to CT (Coenen, 2004). The European approach is called CTEKS (Converging Technologies for the European Knowledge Society) and besides nano-, bio- and information technologies, it includes social sciences and humanities as well as other enabling technologies and knowledge systems. The European report speaks to the importance of societal needs, which must be considered in order to enhance the European economy and to preserve cultural diversity. It is critical towards brain implants or interfaces between brains and machines (Coenen, 2004).

Economic impacts were seen to depend on technological potential, international markets and social attitudes. Scenario analysis to 2020 identified overall positive impacts in health, education and ICT infrastructure; CTEKS is also expected to have a powerful impact on environment and energy. Whereas CT research in general was "likely to be perceived as beneficial" except for applications that could invade privacy, it was expected to be more strongly contested in environment and energy areas. It was thought that checks and balances should "shape a process of convergence which is malleable and adaptable by its very nature" to ensure that CTEKS applications are targeted and avoid after-the-fact regulation. The report makes 16 recommendations for European policy including inclusion of CTEKS in the Sixth and Seventh Framework Programmes (FP6 and FP7). The first CT project under the nanotechnology priority was expected to start in 2006. Furthermore, CT has been included as a pilot activity in the NEST (new and emerging science and technology) section of FP6, and will probably be taken up in FP7 (Commission of the European Communities, 2005).

Applications

Figure 7.10 shows the main fields of application of converging technologies, and other fields are being continually added. In health for example, CT can increase healthcare efficiency by replacing labour-intensive diagnostics by "biochip" technologies. One application, microarrays, is presented in more detail below, as is the sub-field of neuroprosthetics in the field of robotics, which has seen significant technological progress.

Figure 7.10. **Fields of applications of converging technologies**



Source: OECD based on Nordmann (2005), Roco and Bainbridge (2003).

Microarrays

Microarrays, also called "biochips" or "labs on a chip", are usually composed of a solid support which can be glass, plastic or a silicon component and biological material. As the name "labs on a chip" suggests, they function as tiny laboratories that are able to store biological material (even the entire human genome (Harbert, 2005) and conduct tens of thousands of biochemical reactions simultaneously. There are different types of microarrays. According to Dill and McShea (2005), the most common are DNA microarrays on which snippets of DNA are stored or synthesised. There are also peptide or protein microarrays, as well as other types such as glycobiology and organic chemistry-based combinatorial microarrays. Table 7.4 gives an overview and brief descriptions of the most frequent applications. Gene expression analyses, for example, are used to gain insight into genetic causes of diseases. They are mainly used in cancer research but also for research on cardiovascular disease, immune and inflammatory diseases and central nervous system disorders (Agilent, 2004). Variants of diseases can be detected by confirmation of gene sequences that are present in the sample. Genotyping can, for instance, be used in pharmacogenomics to analyse which variations in the genotype correlate with which response variations to drugs. Another application consists in using aptamers as potential drug candidates owing to their ability to bind to a specific molecule. An application reported to have major potential is the use of DNA chips for diagnostics and personalised medicine (Dill and McShea, 2005).

Table 7.4. **Overview of microarray applications**

Application	Brief description
Diagnostic and personalised medicine	Diagnostic of infectious agents Diagnostic of, for example, drug metabolisation of individuals to aid physicians in drug dosage and treatment selection
Gene expression analysis	Differential gene expression information (*i.e.* which genes are turned on or off in a given tissue or disease state) obtained from pairs of RNA samples
Confirmation of gene sequences	Confirmation of which base pairs (molecular building blocks) are present in the sample, *e.g.* for identifying variants of infectious diseases
Genotyping Single-nucleotide polymorphism (*i.e.* a special DNA sequence variation) analysis and mismatch detection	Determination of which specific gene variations are present Specific genotyping application able to detect a single-nucleotide substitution on a microarray platform
De novo synthesis of DNA	Multiplex synthesis of DNA
Peptide synthesis	Creation of peptide via microarrays
Strain differentiation	Discrimination of specific strains of bacteria, fungi and viruses
Aptamers	Aptamers (small molecules with an affinity for another molecule) for drug development as well as for screening and capturing of proteins

Source: OECD based on Dill and McShea (2005), and Roche Diagnostics (2006).

In January 2005, a DNA microarray, analysing how different individuals metabolise drugs, received the first US Food and Drug Administration (FDA) approval for *in vitro* diagnostics. Then, in March 2005, the FDA published new guidelines that make it easier to get FDA approval for new DNA microarray content. This increased interest in the development of DNA-based tests (Dill and McShea, 2005).

The microarrays market began as a niche market characterised by upscale, high-end products for basic research and drug development, with most firms selling to this market (Harbert, 2005). Estimations on market growth are difficult to compare because of differing definitions of the technology, but they usually include the major instruments and services in the different steps of microarray-based analyses (*i.e.* instruments, reagents and consumables as well as software). The microarray market was about USD 2 billion in 2004 and was projected to grow to about USD 5.1 billion by 2009 (Fuji-Keizai USA, 2005). The point-of-care and clinical diagnostics markets in particular are expected to grow (Harbert, 2005). For point-of-care, companies are also developing simpler and less expensive products and for clinical diagnostics growth is driven by efficiency gains and faster response times. A third "point-of-need" market is emerging for microarrays that are able to detect diseases and toxins; for example, a microarray able to detect strains of avian flu is under development (STMicroelectronics, 2006). An increasing number of semiconductor companies are entering the market as revenue growth is seen as higher than in traditional component and mobile phone markets.

Neuroprosthetics

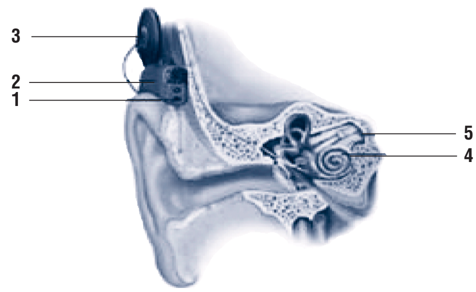
Neuroprosthetics is emerging as a promising example of the convergence of nano-bio- and information technology, which are increasingly integrated in recent research. Neuroprosthetics is a sub-area of the neurotechnology market. Neurotechnology is the application of electronics and engineering to the human nervous system. The total neurotechnology market was estimated to reach around USD 3.1 billion in 2006 and projected to reach USD 7.6 billion in 2010 (Neurotech Reports, 2005).

Neuroprosthetics aims to create interaction between physical devices and neural tissue or the brain in order to augment, restore or otherwise change function (Hall, 2003). Devices range from auditory and visual prostheses to bionic members such as hand prostheses. Nanoscale materials, sensors and microsystems are increasingly incorporated into research projects on neuroprosthetics. For example, the Healthy Aims EU FP6 project aims to develop nanoscale applications for medical implants. Among these implants, auditory devices are currently the most successful. Cochlear implants were the first devices to get FDA approval in 1984 and are widely commercially available. Different forms of visual prostheses are currently under clinical trial and many research teams are working on hand prostheses. Owing to the commercial availability and the advanced development stage of cochlear implants, these devices are discussed in more detail, followed by an outlook on visual implants.

Cochlear implants treat sensori-neural hearing loss which occurs when the cochlear does not function properly and is unable to transfer sounds to create neural impulses (Med-El, 2006). This hearing loss takes different forms, ranging from mild to profound, and is generally permanent. Hearing aids can help in the case of mild to severe sensori-neural hearing loss. Severe or profound hearing loss is usually treated with auditory implants as hearing aids are not an ideal solution. Hearing aids amplify sound which means that only the sounds a person can already hear are turned up. A person with severe or profound hearing loss will not benefit from hearing aids as the sound is still delivered through a damaged part of the ear. The cochlear implant bridges the damaged tissue and sends the sound to the auditory nerve. The implants are composed of several devices: an internal implant that usually comprises an electrode array and the electronics housing and external devices which include a speech processor containing the microphone, the cable and transmitting coil (Med-El, 2006).

The cochlear implant converts sound into electrical pulses that stimulate the auditory nerve. The key technology is a nanoscale biomaterial interface (a silicone elastomer) situated between the metal electrode implant and the stimulated nerve endings (Australian Government, 2005). Loudness is a function of the intensity of the stimulus (Hall, 2003). Figure 7.11 illustrates how cochlear implants operate. The market for cochlear implants was estimated to reach USD 528 million in 2006 and USD 1.07 billion in 2010 (Neurotech Reports, 2005). The upward trend is driven by the rapid growth of implants in children and market expansion beyond the profoundly deaf to the severely hearing impaired. New devices are also being developed which combine a cochlear implant with a hearing aid for persons with little residual hearing who previously had to wait until their hearing loss was more severe (*Business Week*, 2005a, 2005b). Besides the limited target group and the fact that cochlear implants can only be used for sensori-neural hearing loss and not for other forms, current medical reimbursement policies are a challenge: implants may cost USD 25 000 plus equivalent costs for surgery. Current reimbursement levels may be an obstacle both for individuals and surgeons and hospitals (Hall, 2003). Nonetheless, cochlear implants are currently the most successful neuroprostheses.

Figure 7.11. **Mode of operation of cochlear implants**



1. Sound is picked up by the microphone of the speech processor.
2. The speech processor analyses and converts sounds into a special code.
3. This code is sent to the coil and transmitted across the skin to the implant.
4. The implant interprets the code and sends electrical pulses to electrodes in the cochlea.
5. The auditory nerve picks up this signal and sends it to the auditory centre in the brain. The brain recognises these signals as sound.

Source: Med-El (2006).

The field of visual implants is at an earlier stage of development, owing for example to the extreme complexity of encoding three-dimensional objects. Retinal implants aim to restore (partial) vision to persons with retinal diseases (European Commission, 2004). As about 50% of all blindness is due to damage in the retina, there is major potential for epiretinal and subretinal implants (Zrenner, 2002). Epiretinal implants consist of several devices: a tiny external video camera, a processing unit and a component implanted on the innermost layer of the retina which consists of silicon photocells coupled to electrodes (Hall, 2003). The processor translates the visual information from the camera, which could be installed in a pair of glasses, into radio signals which are sent to the implanted component (Termen, 2006). This generates electrical impulses that reach the brain through the optical nerve.

Subretinal implants do not require external cameras or external image processing (Zrenner, 2002). The microphotodiodes of subretinal implants directly replace damaged photoreceptor cells; these may be described as the "light-sensing" cells of the eye which convert light into electrical signals within the retina (Medical News Today, 2005). These electric signals are then "injected" into remaining neurons of the retina network. Both methods are currently in clinical trial. So far, patients have reported improved visual functions, including the ability to detect light and recognise shapes, expansion of the visual field and improved colour vision. Developments in nanotechnology will make it possible to improve these implants further (European Commission, 2004). Retinal implants could be on the market in as soon as three to five years (Medical News Today, 2005).

Economic and social impacts

Social benefits in the field of health care include the development of new diagnostic possibilities and new ways to treat diseases. New robotic applications make daily life easier. Neuroprosthetics in particular can contribute to better integration of patients in society. Developments in ICT infrastructure allow for better monitoring of the environment through ambient devices. In the area of environment and energy, CT enable the development of new technologies to secure energy supply.

CT also entail challenges. Besides the inherent risks of the technologies involved (see OECD, 2004a, for a discussion of issues related to nanotechnology health hazards and fears of "grey goo"), these include: *i)* cross-disciplinary and cross-sectoral research has to be organised across widely differing companies and research institutions; *ii)* new applications need to be cost-effective and have commercial or quasi-commercial promise; *iii)* social acceptance and ethical concerns for human integrity and dignity have to be addressed in some application fields (*e.g.* blurring man-machine boundaries). These and similar challenges will determine to what extent new and promising applications are developed, the extent to which they are commercialised and used, and their final acceptance and uptake.

Conclusion

This chapter examines ubiquitous networks, location-based services, natural disaster prevention and warning technologies, the participative Web and the convergence of nano-, bio- and information technology within the framework of emerging technology applications.

All these technology applications are increasingly interlinked and converging, and ICT plays a fundamental role in the interaction of the different technologies. There is very large potential for the development of new applications but their increasing complexity and uncertainty about their development paths makes the impact on the economy and society difficult to assess. There is for example a tendency towards greater interconnectedness and tracking of persons and objects. While this allows fast reactions (*e.g.* in the field of disaster prevention and management) it can transform social structures significantly and challenges privacy.

At the same time, the Internet paves the way for more interaction, participation and exchange of information and opinion. This may transform the way content is perceived and used in daily life. The participative Web automatically provides more visibility to content to which users attribute high importance (*e.g.* Google, Technorati). While traditional media rely on centralised human decision making (*e.g.* editorial committees, TV programme directors) for prioritising content, the participative Web makes it possible to reflect users' interests more directly. Online content produced by Internet users, including discussions, opinions and debates, has reached critical mass. This enormous conversation addresses all possible topics and, as such, affects all aspects of society, business, education and politics. Search for information on a given subject retrieves a vast amount of data and opinions and potentially sensitises users to complexity.

Developments in the areas analysed are only at their beginning but as they mature they will have an impact on how converging technologies are perceived and be addressed.

Notes

1. However, a distinction is often made between RFID and contactless smart cards, see for example *www.smartcardalliance.org/pdf/alliance_activities/rfidvscontactless_final_121704.pdf*.
2. Reports by AMR Research and ABI Research.
3. For instance Katherine Albrecht, a vocal opponent of RFID, in Albrecht, K. and L. McIntyre (2005), "Spychips: How Major Corporations and Government Plan to Track Your Every Move with RFID", Nelson Current, Nashville, Tennessee.
4. Integrated Regional Information Networks, part of the UN Office for the Coordination of Humanitarian Affairs.
5. A disaster is plotted in Figure 7.4 when at least one of the following criteria is fulfilled: ten or more people are reported killed; 100 people are reported affected; there is a declaration of a state of emergency; international assistance is officially requested (EM-DAT: The OFDA/CRED International Disaster Database, *www.em-dat.net*).
6. This new system, called Internet protocol interoperability and collaboration systems (IPICS), was developed by Cisco and has been available since December 2005.
7. See papers from the conference, "The Future Digital Economy: Digital Content Creation, Distribution and Access", where this new development was a major theme: *www.oecd.org/sti/digitalcontent/conference*.
8. The Korean market is dominated by a few service providers, which are reluctant to provide data on their business, making it very difficult to get information on the number of blogs.
9. Although some reports use an expanded definition of converging technologies, this section uses the term with a focus on nano-, bio- and information technology.
10. European strategy for a European knowledge society and a knowledge-based economy.

References

ABI Research (2005), *Location-Based Services*, ABI Research, Oyster Bay.

Agilent (2004), "Agilent in Gene Expression", *www.agilent.com/about/newsroom/lsca/background/2004/gene_expression.pdf*.

Allison, K. (2005), "Who's afraid of the big, bad blog", *The Financial Times*, 3 November.

Alverson, K. (2005), "Watching over the world's oceans: A Quick Technological Fix is Not the Best Response to the December Tsunami", *Nature*, Vol. 434, Issue 7029, Nature Publishing Group, London, pp. 19-20.

Australian Government – Invest Australia (2005), "Australian Nanotechnology: Nano-biotechnology: creating medical miracles", Australian Government – Invest Australia, Canberra.

BCC Research (2005), "*RB-206 Bioinformatics Business: Technical Status and Market Prospects*", BCC Research, Norwalk.

Bell, S. (2006), "GIS specialists should complement Google, Microsoft", *Computerworld*, 15 March.

Blood, R. (2002), "What is a Weblog", *The Weblog Handbook: Practical Advice on Creating and Maintaining your blog*, Perseus Publishing, Cambridge, Massachusetts, pp. 1-9.

BMF (2005),"Konzeption der Bundesrepublik Deutschland zur Einrichtung eines Tsunami-Frühwarnsystems in der Katastrophenregion des Indischen Ozeans", *www.bmbf.de/pub/konzept_tsunami_fruehwarn0305.pdf*.

Bowman, S. and Ch. Willis (2003), *We Media – How Audiences are Shaping the Future of News and Information*, Commissioned by the Media Center at The American Press Institute, *www.hypergene.net/wemedia*.

Business Week Online (2005a), "Online Extra: Jakob Nielsen on the Unwieldy Web", *Business Week Online*, 26 September.

Business Week Online (2005b), "E-Society: My world is Cyworld", *Business Week Online*, 26 September.

Business Week (2005a), "Cochlear's Roberts: "We Have a Unique Opportunity", 7 December.

Business Week (2005b), "Listen: The Sound of Hope", 14 November.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Cisco Systems (2005a), "Solution Overview – Cisco IPICS", *www.cisco.com/application/pdf/ en/us/guest/products/ps6718/c1031/cdccont_0900aecd80352c7e.pdf*.

Cisco Systems (2005b), "White Paper – Solutions for Communications Interoperability", *www.cisco.com/application/pdf/en/us/guest/products/ps6718/c1244/ cdccont_0900aecd80350fee.pdf*.

Clothier, J. (2005), "Dutch Trial SMS Disaster Alert System", CNN, 11 November, *http://edition.cnn.com/2005/TECH/11/09/dutch.disaster.warning*.

Coenen, Ch., M. Rader and T. Fleischer (2004), "Of Visions, Dreams and Nightmares: The Debate on Converging Technologies", *Technikfolgenabschätzung – Theorie und Praxis,* Vol. 13, No. 3, Institute for Technology Assessment and Systems Analysis (ITAS), Karlsruhe.

Commission of the European Communities (2003), "Commission Staff Working Document - Extended impact assessment on Information and Communications Technologies for Safe and Intelligent Vehicles", *http://europa.eu.int/comm/secretariat_general/impact/docs/ SEC_2003_0963_1_EN.pdf*.

Commission of the European Communities (2005), "Proposal for a Decision of the European Parliament and of the Council Concerning the Seventh Framework Programme of the European Community for Research, Technological Development and Demonstration Activities (2007 to 2013)" *http://ica.cordis.lu/documents/documentlibrary/2461EN.pdf*.

Committee on Earth Observation Satellites (CEOS, 2005), *Earth Observation Handbook*: 2005, www.eohandbook.com/.

Coren, M. (2005), "Getting Word Out: A Challenge in Tsunami Warnings", CNN, 4 February, *http://edition.cnn.com/2005/TECH/science/01/06/tsunami.science/*.

D'Roza, T. and G. Bilchev (2003), "An Overview of Location-Based Services", *BT Technology Journal,* Vol. 21, No. 1, Springer Netherlands, GX Dordrecht.

Dao, D., Ch. Rizos and J. Wang (2002), "Location-based Services: Technical and Business Issues", GPS Solutions, Vol. 6, No. 3, Springer, Heidelberg, pp. 169-178.

Dill, K. and A. McShea (2005), "Recent Advances in Microarrays", *Drug Discovery Today*, Vol. 2, No. 3, Elsevier Science, London, pp. 261-266.

Djuknic, G. and R. Richton (2000), Geolocation and Assisted-GPS, Bell Laboratories, Lucent Technologies, *www.lucent.com/livelink/090094038000e51f_White_paper.pdf*.

EM-DAT (2005), *The OFDA/CRED International Disaster Database*, *www.em-dat.net/ index.htm,* accessed 10 December.

ESBI Computing (2006), "Components of Mobile GIS solutions", *www.esbic.ie/geobusiness/ mobile_gis/Main_Components.htm*.

ETRI (2005), "Disaster Warning System with Terrestrial Digital Multimedia Broadcasting (T-DMB)".

European Commission (2004), "Nanotechnology – Innovation for Tomorrow's World", *ftp://ftp.cordis.lu/pub/nanotechnology/docs/nano_brochure_en.pdf*.

Fuji-Keizai USA, Inc. (2005), "2005 The Worldwide Biochips and Equipments Market", Dublin, Ireland.

Garrett, J. (2005), "Ajax: A New Approach to Web Applications", *www.adaptivepath.com/publications/essays/archives/000385.php*.

Giaglis, G., P. Kourouthanassis and A. Tsamakos (2003), "Towards a Classification Framework for Mobile Location Services", *Mobile commerce: technology, theory, and application*, Idea Group Publishing, Hershey Pennsylvania, pp. 64-81.

Gill, K. (2004), "How Can We Measure the Influence of the Blogosphere", *faculty.washington.edu/kegill/pub/www2004_blogosphere_gill.pdf*.

Gill, K. (2005), "Blogging, RSS and the Information Landscape: A Look At Online News", *www-idl.hpl.hp.com/blogworkshop2005/gill.pdf*.

Gonzalez, F., H. Milburn, E. Bernard and J. Newman (1998), "Deep-ocean Assessment and Reporting of Tsunamis (DART): Brief Overview and Status Report", *Proceedings of the International Workshop on Tsunami Disaster Mitigation*, 19-22 January, Tokyo, *www.pmel.noaa.gov/ tsunami/dart report1998.html*.

Hall, S. (2003), "Commercialising Neuroprostheses: The Business of Putting the Brain Back in Business", Thesis, Princeton University.

Harbert, T. (2005), "The Evolution of the Biochip", *Electronic Business*, Vol. 31, No. 5, Reed Business Information, New York, pp. 55-59.

Herring, S., L. Scheidt, S. Bonus and E. Wright (2004), “Bridging the Gap: A Genre Analysis of Weblogs”, paper presented at the 37th Hawaii International Conference on System Sciences.

Hoem, J. (2004), “Vidoeblogs as ‘Collective Documentary’”, *BlogTalks 2.0*, Burg, Vienna, pp. 237-270.

Horrigan, J. (2006), “Broadband Internet Use in the United States: Patterns and Implications”, at *www.oecd.org/sti/digitalcontent*.

Hourihan, M. (2002), “Blogging for Dollars: Giving Rise to the Professional Blogger”, *www.oreillynet.com/lpt/a/2629*.

InformationWeek (2005), “Top 10 Blog Hosts”, *Information Week*, Issue 1052, CMP Media LLC, New York, p. 20.

ITU (International Telecommunication Union) (2005), *The Internet of Things*, ITU, Geneva.

Juniper Research (2005), *Mobile Location Based Services (MLBS): Information; Tracking; Navigation; Community and Entertainment*, Juniper Research, Basingstoke, Hampshire.

Lenhart, A. (2005), *Teen Content Creators and Consumers*, The PEW Internet and American Life Science Project, November, *www.pewInternet.org/pdfs/ PIP_Teens_Content_Creation.pdf*.

Lu Stout, K. (2005), “Korean Bloggers Making a Difference”, *CNN.com*, *http://edition.cnn.com/2005/TECH/03/31/spark.ohmynews*.

Machrone, B. (2005), “I Blog/I Do Not Blog”, *PC Magazine*, Vol. 24, Issue 13, Ziff Davis Media Inc., New York, p. 73.

Madden, A. (2005), “The Business of Blogging”, *Technology Review*, Vol. 108, No. 8, Massachusetts Institute of Technology, Cambridge Massachusetts, pp. 36-38.

Madhava, A. and A. Tse (2005), “A Study of Bluetooth Propagation Using Accurate Indoor Location Mapping”, UbiComp 2005, Lecture Notes in Computer Science, Vol. 3660, Springer, Berlin Heidelberg, pp. 105-122.

Malykhina, E. and S. Lecca (2005), “Maps on the Move”, *Information Week*, Issue 1055, CMP Media LLC, New York.

Markoff, J. (2005), “A Method to Link Up in a Crisis”, *The International Herald Tribune*, 25 October.

McCarthy, Ph. (2005), “Ajax for Java Developers: Building Dynamic Java”, *www-128.ibm.com/developerworks/library/j-ajax1*.

Med-El (2006), “Understanding Cochlear Implants”, Med-EL, Durham, *www.medel.com/ Shared/pdf/en/MEDEL_uci.pdf*, accessed 20 April.

Medical News Today (2005), “Solar Cell Implant May Restore Some Sight for the Blind”, 29 April, *www.medicalnewstoday.com/medicalnews.php?newsid=23572*.

MIC (Ministry of Internal Affairs and Communications (2004), *u-Japan Policy – Working Toward Realising the Ubiquitous Network Society by 2010*, Tokyo.

Munich Re (2006), *Topics Geo. Annual Review: Natural Catastrophes 2005*, Munich Re, Munich.

Murakami, T. (2005), “Japan’s National IT Strategy and the Ubiquitous Network”, *NRI Papers*, No. 97, Nomura Research Institute.

National Science Foundation (NSF)/Department of Commerce (DoC) (2002), Summary and Quick Review of the US Report on “Converging Technologies for Improving Human Performance”, authored by WTEC.

Neurotech Reports (2005), *The Market for Neurotechnology 2006-2010*, Neurotech Reports, San Francisco, California.

Neus, A. (2001), “Managing Information Quality in Virtual Communities of Practice”, IQ 2001: The 6th International Conference on Information Quality at MIT, Cambridge, Massachusetts.

New Media Age (2005), “UK Consumers Trust Blogger’ Opinion”, *New Media Age*, No. 09/ 29/2005, Centaur Communications, London, p. 9.

Noguchi, Y. (2005), “A New Place for Spam's Same Old Pitches”, *The Washington Post*, 4. November.

Nordmann, A., Rapporteur (2005), “Converging Technologies – Shaping the Future of European Societies”, *http://europa.eu.int/comm/research/conferences/2004/ntw/pdf/ final_report_en.pdf*.

O'Reilly, T. (2005), “What Is Web 2.0?”, *www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html*.

OGC (Open Geospatial Consortium, 2004), "OGC Members Adopt Implementation Specification for Location-Based Services", *portal.opengeospatial.org/public/pdf/pr_pdf.php?prid=163*.

OECD (1980), *Guidelines on the Protection of Privacy and Transborder Flows of Data*, OECD, Paris.

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

OECD (2002b), *Guidelines for the Security of Information Systems and Networks*, OECD, Paris.

OECD (2003), *Emerging Risks in the 21st Century – An Agenda for Action*, OECD, Paris.

OECD (2004a), *OECD Information Technology Outlook*, OECD, Paris.

OECD (2004b), *Space 2030 – Exploring the Future of Space Applications*, OECD, Paris.

OECD (2005), *Space 2030: Tackling Society's Challenges*, OECD, Paris.

OMA (Open Mobile Alliance, 2006), "Location Charter", *www.openmobilealliance.com/tech/wg_committees/loc.html*.

Pfeiffer, E. (2003), "WhereWare", *Technology Review*, Vol. 106, Issue 7, Massachusetts Institute of Technology,, Cambridge Massachusetts, pp. 46-52.

Rao, B. and L. Minakakis (2003), "Evolution of Mobile Location-Based Services", *Communications of the ACM*, Vol. 46, No. 12, Association for Computing Machinery, New York, pp. 61-65.

Rao, D. (2000), "Disaster Management", *www.gisdevelopment.net/application/ natural_hazards/overview/nho0004.htm*.

Red Herring (2005), "The Promise of LBS – After Years of Delays in the United States, Could Location-based Services on Cell Phones Finally Deliver on the Hype?, *www.redherring.com/Article.aspx?a=14192&hed=The+Promise+of+LBS+*.

Report of the High Level Expert Group (2004), "Foresighting the New Technology Wave", European Commission, Brussels, *http://europa.eu.int/comm/research/conferences/2004/ntw/pdf/ final_report_en.pdf*.

Research and Markets (2005), *RFID Industry – A Market Update*, *www.researchandmarkets.com/reports/c20329*.

Reuters UK (2005), "AOL to Buy Weblogs Inc., Courts Bloggers", *http://today.reuters.com/ business/newsArticle.aspx?type=media&storyID=nN06182182*.

Roche Diagnostics (2006), "Background Information – The Technology behind Amplichip Microarrays", *www.rochediagnostics.com/media/pdf/presskit/ final_technology_behind_cyp450.pdf, accessed* 13 April.

Roco, M. and W. Bainbridge (2003), *Converging Technologies for Improving Human Performance*, Kluwer Academic Publishers, Dordrecht. Version of 2002 also available at *www.wtec.org/ConvergingTechnologies/Report/NBIC_report.pdf*.

Royal Society, Royal Academy of Engineering (2004), "Nanoscience and Nanotechnologies: Opportunities and Uncertainties", RS Policy Document 19/04, London.

Schiller, J. and A. Voisard (2004), *Location-Based Services (The Morgan Kaufmann Series in Data Management Systems)*, Morgan Kaufman Publishers, San Francisco.

Sifry, D. (2005), "The State of the Blogosphere", *www.technorati.com/weblog/2005/10/53.html and updates 2006*.

Snell, J. (2005), "Blogging@IBM", *www-128.ibm.com/developerworks/blogs/dw_blog_comments.jspa?-blog=351&entry=81328*.

Soppera, A. and T. Burbridge (2005), "Wireless Identification – Privacy and Security", *BT Technology Journal*, Vol. 23, No. 4, Springer Netherlands, Dordrecht, pp. 54-64.

Spinney, J. (2003), "A Brief History of LBS and How OpenLS Fits Into the New Value Chain", *www.directionsmag.com/article.php?article_id=394&trv=1*.

STMicroelectronics (2006), "STMicroelectronics and Veredus Laboratories Team to Diagnose Avian Flu Using Rapid-Detection Point-of-Need Lab-on-Chip", 18 January, *www.st.com/stonline/stappl/press/news/year2006/t1753.htm*.

Sylves, R. and H. Wood (2003), "Hazards Watch – Reducing the Impacts of Disasters Through Improved Earth Observations", *Summary of A Workshop*, 22 October, Washington, DC.

Termen, A. (2006), "Retinal Implants May Soon Restore Lost Vision", CNET News.com, 4 April, *http://news.com.com/2102-11390_3-6057581.html?tag=st.util.print*.

TruePosition (2006), “PDE (Position Determining Equipment)”, *www.trueposition.com/TrueNorth-pde.php*.

USGS (US Geological Survey) (2005), “Geographic Information Systems”, *http://erg.usgs.gov/ isb/pubs/ gis_poster*.

Weiser, M. (1991), “The Computer of the 21st Century”, *Scientific American*, Vol. 265, No. 3, pp. 66 75, Scientific American Inc., New York.

Zrenner, E. (2002), “Will Retinal Implants Restore Vision?”, *Science*, Vol. 295, No. 5557, Science/AAAS, Washington, pp. 1022-1025.

ISBN 92-64-02643-6
OECD Information Technology Outlook 2006

Chapter 8

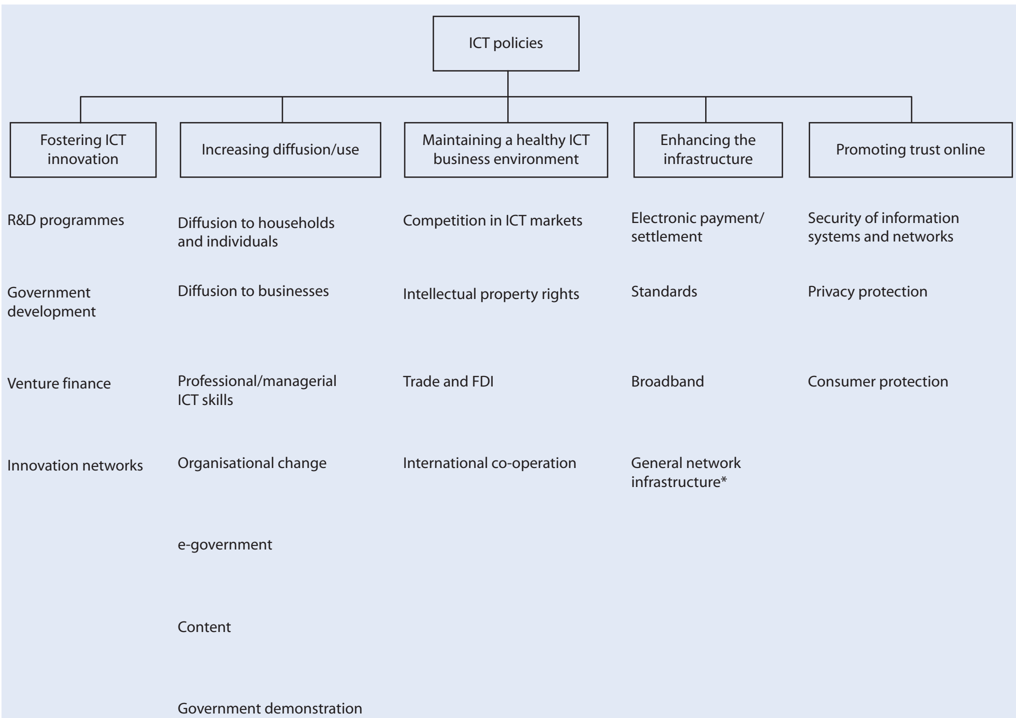
ICT Policy Developments

OECD countries increasingly recognise ICT as a source of innovation and economic growth, and ICT policies are increasingly integrated into economic strategies and co-ordinated across government to improve productivity and strengthen competitiveness. This chapter outlines policy priorities and changes in countries' policies. These focus on co-ordination and policy setting, using R&D for innovation and government applications, spreading broadband, increasing diffusion and use of ICT, raising ICT skills and employment, digital content and intellectual property rights. Policy assessment and evaluation remains an important weakness.

Introduction

This chapter analyses recent information and communication technology (ICT) policies and programmes. It covers developments and trends since 2003, the ICT policy environment, specific ICT policies and programmes, and tools for assessment and evaluation. Figure 8.1 provides the framework for the examination of ICT policy which draws on the detailed information on ICT policies and programmes provided by 27* countries and the European Commission. Individual country responses will be posted on the OECD Information Economy Web site, *www.oecd.org/sti/information-economy*.

Figure 8.1. **ICT policy framework**



Note: Policy areas in *italics* relate to recommendations for "Seizing the Benefits of ICT" in OECD (2003), *Seizing the Benefits of ICT in a Digital Economy*, OECD, Paris. Policy areas with an asterisk (*) are examined in the *OECD Communications Outlook* and are beyond the scope of this chapter; promoting trust online is not dealt with in detail in this volume.

* Although 26 OECD countries plus Singapore and the European Commission replied to the questionnaire, detailed information covering all areas of the request is only available for 25 countries, including Singapore.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Table 8.1. **Summary of OECD country ICT policy responses, 2005, 2003 and 2001**

	Number of country responses		
	2005	2003	2001
Co-ordination and priority setting	**22**	**22**	**20**
Fostering ICT innovation	**24**	**26**	**20**
R&D programmes	22	26	19
Government development projects	20	21	12
Government ICT procurement	20	17	11
Venture finance	19	16	9
Innovation networks and clusters	22	18	N/A
Increasing diffusion and use	**24**	**25**	**21**
Technology diffusion to individuals and households	20	21	20
Technology diffusion to businesses	20	21	20
Organisational change	14	10	N/A
Demonstration programmes	17	10	17
Government on line, government as model user	23	22	19
Government programmes to promote or encourage e-procurement and/or e-invoicing*	15	N/A	N/A
ICT skills and employment*	**23**	24	N/A
Promoting IT education*	19	N/A	N/A
Industry-based and on-the-job training*	10	N/A	N/A
Foreign workers*	3	N/A	N/A
International sourcing*	3	N/A	N/A
Improving labour market information*	8	N/A	N/A
Digital content*	**23**	16	N/A
General digital content development*	19	N/A	N/A
Public sector information and content*	11	N/A	N/A
ICT business environment	**23**	**25**	**20**
Competition in ICT markets	18	19	N/A
Intellectual property rights	23	19	14
Trade and foreign direct investment	17	15	8
International co-operation	19	15	17
Enhancing the infrastructure	**24**	**26**	N/A
Electronic settlement/payment	18	22	19
Standards	21	20	11
Broadband	23	24	N/A
Policy assessment and evaluation	**15**	**17**	N/A
Programme evaluation*	15	N/A	N/A
Broadband evaluation*	5	N/A	N/A
Total responding countries	**25**	**30**	**21**

Note: * Indicates policy area new to the 2005 survey.

Source: OECD based on the 25 detailed responses to the OECD IT Policy Questionnaire, 2005, and the responses to the 2003 and 2001 surveys.

Developments and trends since 2003

Replies to the OECD IT Policy Questionnaire 2005 indicate that government policies (as measured by frequency of responses, summarised in Table 8.1) focus primarily on:

- Co-ordination and priority setting and setting the overall direction for IT policy and its contribution to more general economic policy goals.
- Fostering innovation in ICT (with special emphasis on R&D and on innovation networks and clusters).
- Increasing diffusion and use (with special emphasis on e-government).

- ICT skills and employment (in particular ICT education).
- Digital content.
- The ICT business environment (with special focus on intellectual property rights).
- Enhancing infrastructure (especially broadband infrastructure).

In 2005, there was even greater focus on mainstreaming ICT policies. Governments increasingly recognise that this entails greater co-operation and collaboration within and among government organisations. To increase government efficiency and service delivery, they increasingly focus on e-government and use of ICT to modernise the public sector.

The detailed 2005 responses also show that a number of countries have achieved high rates of Internet penetration and have therefore reduced their focus on basic ICT diffusion to businesses and households. Some countries have discontinued basic diffusion programmes altogether, and others have shifted the focus to broadband diffusion. However, these trends are not universal, and countries that have not yet achieved high rates of Internet penetration still prioritise basic diffusion and diffusion to less well-covered and disadvantaged groups.

The 2005 survey covered several new areas and extended others, notably ICT skills and employment and digital content. Both of these areas were considered very important. In terms of ICT skills and employment, the main focus was ICT education and training, with a lesser focus on industry-based training and improving market information. Only a few countries provided specific information on IT policy initiatives for foreign workers or international sourcing despite high general interest in these areas.

Nearly all countries have initiatives dealing with digital content, and while the main emphasis is on general digital content development, there are a large number of programmes for government content, including provision of information and regulations providing for the free (or low-cost) re-use of government information.

From 2003 to 2005 the number of policy assessment and evaluation activities has roughly remained constant, but countries that mention them are turning to more advanced techniques. However, with some exceptions, there is still little coherence of evaluation methodologies across countries, which makes comparison difficult. There is a continuing need to improve assessment and evaluation of policies and to make assessments publicly available. It is surprising that there is as yet little reported evaluation of broadband policies and broadband rollout given the amount of policy attention and general press attention that this has received, suggesting that much more policy analysis and evaluation are warranted.

Current ICT policy priorities and new directions

As part of the OECD IT Policy Questionnaire 2005, countries were asked to state their current policy priorities and indicate new directions. While 20 countries provided this information, response rates varied for specific sub-topics (Table 8.2). These priorities and new directions are discussed under each specific policy area. However, countries almost always responded that priorities were "continuing" or "increasing". This may be due, in part, to an overall increase in attention to ICT policy as a whole; many countries expressed increased understanding of its importance. However, it may also be due to the fact that it can be politically difficult to state that a policy is of "decreasing" priority. Only Finland and Switzerland gave details of any decrease in priorities.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Policies most commonly ranked as high priority include R&D, increasing diffusion to individuals and households, ICT skills and employment, competition in ICT markets, international co-operation, broadband and security issues. Those that enjoy increasing priority include R&D programmes, technology diffusion to business, intellectual property rights, and online trust issues, with high priorities tending to increase in priority. Increasing priority is also placed on some relatively lower priority programmes, notably venture finance and organisational change. Specific information on topics in which trends in priorities were identifiable is given below in the relevant sections.

Table 8.2. **Summary of country ICT policy priorities, 2005**

Numbers of responses

	High	Medium	Low	Total	Increased	Continued	Decreased	Total
Fostering ICT innovation								
R&D programmes	11	5	3	19	11	6	1	18
Government development projects	9	6	1	16	8	7	0	15
Government ICT procurement	8	6	2	16	6	9	0	15
Venture finance	4	7	5	16	6	9	0	15
Innovation networks and clusters	9	7	3	19	5	13	0	18
Increasing diffusion and use								
Technology diffusion to individuals and households	10	5	2	17	5	10	1	16
Technology diffusion to businesses	9	6	4	19	8	10	0	18
Organisational change	4	5	8	17	6	10	0	16
Demonstration programmes	4	4	10	18	5	12	0	17
Government on-line, government as model users	9	7	1	17	7	9	0	16
ICT skills and employment*	10	5	2	17	7	9	0	16
Digital content*	8	4	5	17	7	9	0	16
ICT business environment								
Competition in ICT markets	13	5	0	18	5	12	0	17
Intellectual property rights	6	12	0	18	9	8	0	17
Trade and foreign direct investment	8	6	3	17	5	11	0	16
International co-operation	12	5	0	17	4	12	0	16
Enhancing the infrastructure								
Electronic settlement / payment	6	4	8	18	5	12	0	17
Standards	9	5	3	17	5	11	0	16
Broadband	12	4	2	18	5	11	1	17
Promoting trust on line								
Security of information systems and networks	13	3	1	17	9	7	0	16
Privacy protection	9	6	2	17	10	6	0	16
Consumer protection	9	6	2	17	8	8	0	16
Total responding countries				**20**				**19**

Note: * Indicates policy area new to the 2005 survey.

Source: OECD based on 20 detailed responses to the OECD IT Policy Questionnaire, 2005, on IT policy priorities and new directions.

ICT policy environment: co-ordination and priority setting

In terms of the ICT policy environment, most countries focus on co-ordination and priority setting. This is a natural step from the main trend in 2003, mainstreaming ICT. Governments have recognised that government organisations have overlapping and sometimes repetitive ICT initiatives and are now taking steps to co-ordinate and set priorities. Most countries now have clear objectives for the information economy as a whole, and priorities are closely linked to overall goals (see Box 8.1).

Box 8.1. **ICT as a key to broader goals**

Most countries now view ICT as a key component of innovation and development, as well as a tool to achieve other policy outcomes. However, the policy outcomes they hope to achieve vary significantly (see also Chapter 7).

Australia: ICT for growth in the broader economy. Australia's ICT policy has four elements: use of ICT to deliver general policy outcomes (health, education, taxation); facilitating the growth of ICT capability (products and services based on electronics and software such as digital content, medical technology, software solutions); creating an environment that encourages innovation with ICT (intellectual property, standards, e-security); and initiatives to create a more integrated e-society (digital content and strategies).

Finland: ICT for competitiveness, productivity, social and regional equality, welfare and quality of life. The Information Society Policy Programme aims to keep Finland among leading producers and users of ICT by focusing on these objectives. It also seeks to increase trust in the information society by improving information security and privacy.

Germany: ICT for innovation, growth and employment. In March 2006, the Federal Ministry for Economic Affairs was charged with the development and execution of the new information society policy, "Germany 2010 (iD2010)". The main objectives of the new ICT policy include: rapid and universal deployment of broadband, the furthering of digital broadcasting and new content services, a competitive environment with a sound telecommunications policy and a modern spectrum allocation policy, modernisation of media legislation in light of digital convergence, support to new multimedia technologies, ICT security, modern e-government services, and fostering citizen participation in the information society and ICT skills.

Japan: To be the world's most advanced IT nation. Japan's ICT policy priorities entail four steps: development of basic infrastructure, promotion of effective ICT utilisation, acceleration of ICT utilisation, and a final push towards becoming a true IT nation from a user perspective.

Korea: A ubiquitous network society. Policies are being established and carried out through consultations and co-ordination among various agencies. The government has actively pursued "u-Korea" as a national strategy to lay a solid foundation for its "ubiquitous network society".

Norway: Economic growth, value creation, prosperity and welfare. The new eNorway 2009 plan was launched in June 2005. eNorway has three targets: individual use of ICT, innovation and growth in business and industry, and a co-ordinated and user-adapted public sector.

Singapore: An intelligent nation powered by ICT. The iN2015 ten-year plan launched in June 2006 focuses on using ICTs for innovation, integration and internationalisation, to transform key economic sectors, government and society, establish a pervasive intelligent infrastructure and develop a competitive ICT industry and workforce.

Source: Responses to the OECD IT Policy Questionnaire, 2005.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

In addition, a number of countries specifically cited their ICT policies as an agent of change and a tool for transformation (see Box 8.2). This is a new development and is reflected in specific policies and programmes.

Box 8.2. ICT as an agent of change

In 2005, a number of countries specifically adopted ICT policy as an agent of change. ICT is viewed as a tool for transforming government and business models and/or for the creation of an "information society". These priorities reflect governments' recognition of ICT's potential for transforming organisational structures (both within and outside of government), increasing innovation, providing additional opportunities for citizens, and improving competitiveness and economic performance as a whole.

Canada: Transforming business models. Canada is developing strategies to transform business models and organisational structures with a view to generating continuous streams of productivity gains and product innovations and renewing Canada's collective commitment to an effective policy agenda for the e-economy to succeed in an intensely competitive, global marketplace.

Mexico: e-Mexico as an agent of change. The e-Mexico National System aims to expand the coverage of basic services in education, health, economy, government, science, technology and industry, as well as other services for the community.

Turkey: The e-Transformation Turkey Project. This high priority project aims to accelerate Turkey's transition to an information society. It was launched as part of Turkey's commitment to join the European Union and to increase Turkey's growth potential. The State Planning Organisation (SPO), under the Prime Minister, has responsibility for the project, and all public institutions and NGOs are affiliated. It is co-ordinated by the SPO's Information Society Department.

Source: Responses to the OECD IT Policy Questionnaire, 2005.

Government efficiency has been another focus in several countries, and Canada, Finland and the United Kingdom have held comprehensive cross-government efficiency reviews. These reviews are designed to systematically evaluate cost savings arising from ICT investment across government.

Specific ICT policies and programmes

This section covers six areas of the 2005 questionnaire: fostering ICT innovation, increasing diffusion and use, skills and employment, digital content, the ICT business environment and enhancing the infrastructure. Promoting trust on line is no longer covered in detail in the IT policy questionnaire, but it is covered in the priorities discussed above; Box 8.14 discusses security policy.

Fostering ICT innovation

Fostering innovation in ICT continues to be of major importance to countries. Almost all have specific initiatives for R&D and innovation networks and clusters. Over three-quarters have government development projects, initiatives for government ICT procurement and policies to support or encourage venture finance. Overall this was the area, along with the ICT business environment, in which most countries reported having a broad range of activities.

R&D programmes

According to the 2005 survey, almost all responding countries have initiatives to foster R&D and innovation in ICT, and this has held stable since 2003. The vast majority focus on product and process development, innovation and commercialisation, and/or promising growth areas including support for development of next generation networks. Only a handful mention policies for basic research. Switzerland has discontinued the R&D "softnet" programme, which provided support to the Swiss software sector.

Out of the 19 countries that indicated the relative importance of R&D policy, 11 state that it is of high priority, and 11 listed policies for fostering ICT R&D as of "increasing" importance. Moreover, in 2005 countries increasingly focus specifically on ICT R&D, whereas in 2003 many supported R&D more generally. The main orientations of ICT R&D policies in 2005 are the facilitation of partnerships between industry and science, direct support for ICT R&D and innovation, development of research networks and infrastructure, and specific support (*e.g.* interactive and digital media). Other policies also mentioned include user-driven innovation, ICT R&D incubators and provision of information and guidance.

Government development projects

Over three-quarters of respondents have government ICT development projects (see Box 8.3). As in 2003, most of these focus on e-government initiatives. Specific e-government projects mentioned include citizen and business portals, governmental IT architectures and standard operating environments for connected government. Technical development projects include e-signatures, electronic ID cards, electronic vote counting, electronic data interchange, and invoicing and e-payments. All of these projects can have a major impact on the use of ICT and the Internet by businesses and citizens.

Box 8.3. **Government development projects and e-government in the Netherlands**

The Dutch programme for ICT and lowering administrative costs for companies is considered an important step towards modernising government. It is based on the principle of once-only provision of data, facilities for secure communication and a virtual front office for supplying government information.

Since 1 January 2005, it has been possible to log on to Web sites of various government authorities and use the offered services through a single user name and password combination (DigiD). The Inland Revenue Service, CWI (Centre for Work and Income), UWV (which implements employee insurance schemes) and the Social Insurance Bank (SVB) started using this facility to provide their services in 2005. The aim was to connect at least 50 municipalities in 2005.

In May 2005 the "Progress Report on e-Government" was presented with a view to ensuring that autonomous authorities and implementing organisations keep up with the introduction of electronic government.

Source: Netherlands' response to the OECD IT Policy Questionnaire, 2005.

Government ICT procurement

Government ICT procurement can be a tool for innovation, as many governments set procurement requirements and e-procurement processes in line with overall ICT policy goals in the framework of their e-government programmes. The share of respondents with programmes for ICT procurement has risen since 2003, and in 2005 over three-quarters have government procurement initiatives (compared to just over half in 2003). Most ICT procurement is now aggregated with other government procurement and not separately and specifically designated, although some specific topics, such as open source software, have particular support (see Box 8.4). As in 2003, many countries also have included preferential treatment or quotas for small and medium-sized enterprise (SME) participation in e-procurement.

Box 8.4. **ICT procurement and open source software**

In 2005, a number of countries mention specific ICT procurement and open source software policies.

Austria: In Vienna, the municipal administration is migrating its ICT workplaces from Windows to Open Office of Linux.

Hungary: Hungary has specific programmes to encourage the use of open source software and tools. Steps have been taken to eliminate the disadvantages of open source (and free) software in communal usage (central and local administration as well as the civil sector).

Korea: Korea has several measures to promote open source software, including market facilitation, technology development, human resource development and international co-operation.

Turkey: The "Public Sector Linux Competency Center" was founded to provide the technical staff of government institutions opportunities for training in the Linux operating system.

Source: Responses to the OECD IT Policy Questionnaire, 2005.

Venture finance

Three-quarters of the countries surveyed in 2005 have venture finance initiatives, a share that has increased from about half in 2001 and 2003. Germany, Italy, Korea, Mexico, Portugal and Singapore state that these have increased in priority since 2003. The main types of venture finance programmes are direct start-up and growth funds, facilitation and support for partnerships, programmes to foster spin-offs from research organisations, and support for venture capital firms (see Box 8.5).

Innovation networks and clusters

In 2005 most respondents stated that they have programmes to support clusters and networks to foster innovation (a notable increase from 2003). Many focus on building networks to encourage the exchange of information among government, academia and industry. Several countries focus on physical infrastructure for the development of innovation networks and clusters to support the growth of specific regions. A few have programmes for advanced research networks and developing a high-capacity research backbone (see also the section on broadband).

Box 8.5. **Venture finance initiatives in selected countries**

France: Priority has been given to co-operative projects involving both the public and private sectors. Networks for Research and Innovation Technologies is the main tool and aims to favour co-operation in public and industrial research.

Italy: The Action Plan for Digital Innovation in Enterprises includes special short-term measures to facilitate access to venture capital for new business and for SMEs in disadvantaged areas. Government-supported venture funds to finance innovative ICT projects are allocated to banks or other financial institutions to enable them to acquire small or temporary holdings.

Sweden: Swedish venture capital has tended to concentrate on traditional manufacturing sectors. The Swedish venture capital market is shifting towards high-technology sectors, building on the country's comparative advantage in the telecommunications and health-care industries.

Turkey: Venture capital is a commercial and private sector activity for industrial technology projects. It is considered an important income-generating activity of the Technology Development Foundation of Turkey (TTGV).

United Kingdom: The Department of Trade and Industry (DTI) has worked on issues relating to venture capital and intellectual property in order to improve productivity and competitiveness. It has also worked to improve the regulatory and tax framework to facilitate venture capital initiatives. The DTI's main venture finance initiative is the UK High Technology Fund, which encourages institutions to invest in early-stage, high-technology venture capital specialist companies and to increase the amount of finance available for investment in technology-based businesses.

Singapore: As part of the iN2015 plan, Singapore is launching post-start-up funding as well as start-up attraction programmes for foreign entrepreneurs.

Source: Responses to the OECD IT Policy Questionnaire, 2005.

Increasing diffusion and use

Nearly all responding countries have initiatives to increase ICT diffusion and use. The most popular focus for these initiatives is government online/government as model user. Other popular initiatives include technology diffusion to households and individuals, diffusion to businesses and demonstration programmes. Programmes to foster organisational change were less common. Initiatives aimed at increasing ICT skills were also commonly mentioned as a means of increasing diffusion and use. They are discussed in the next section.

Technology diffusion to individuals and households

A large majority of responding countries have initiatives for technology diffusion to individuals and households, an increase over 2003, but down from nearly all in 2001. In 2001, policies largely focused on increasing ICT penetration at home, work, school and public access points. In 2003, Internet access rates had increased in many countries, and initiatives increasingly focused on ICT literacy, targeting specific groups and central infrastructure. In 2005, these trends have continued and intensified, with the main focus on specific hard-to-reach groups and on building demand for the Internet through the development of content and capabilities, increasing use of broadband, and stimulating demand by providing services over other forms of access such as digital TV and mobile phones. Well over half of responding countries cited technology diffusion to individuals and households as of "high" priority.

Only the Czech Republic, Hungary, Mexico, Turkey and Singapore maintain initiatives to increase basic ICT penetration at home, work, school and public access points and for hard-to-reach and poorer social groups (see Box 8.6); there are also extensive public access initiatives in Mexico. Switzerland also has such initiatives, but has decreased funding for them owing to budget constraints. The primary focus of diffusion and use initiatives appears to shift as basic Internet penetration rates rise, with countries with lower penetration rates maintaining basic initiatives, and those with higher access rates (Australia, Norway, Sweden, United Kingdom) reducing the focus on such initiatives. While diffusion remains a high priority, the only countries stating that ICT penetration to individuals and households has increased in priority are Korea, Portugal, the Slovak Republic, the United Kingdom and Singapore; Korea, the United Kingdom and Singapore focus largely on broadband and connecting hard-to-reach groups. Box 8.7 gives examples of technology diffusion initiatives in Ireland and the United States.

Half of the countries indicating the relative priority of policies stated that the importance of diffusion to individuals and households has been maintained. One country said that the relative importance had decreased.

Box 8.6. **Public Internet access points in Portugal**

Portugal: To provide all citizens free access to multimedia computers and the Internet, along with trained personnel (monitors) to offer support and explanation, the government has opened 260 public internet access points (PIAP) since 2001. These are equipped with at least six work stations, one of which is equipped for use by citizens with various types of physical disabilities. The government plans to double the number of PIAPs within two years to target the more densely populated areas and groups such as elderly citizens and immigrants.

Source: Portuguese response to the OECD IT Policy Questionnaire, 2005.

Box 8.7. **Technology diffusion in Ireland and the United States**

Ireland: An eInclusion fund has been available since 2004 to provide funding for priority areas such as building ICT capacity in the community and voluntary sector, promoting ICT access; learning and skills; and to measure inclusive information society development and raise awareness. A new strategy to drive the eInclusion agenda over the next two to three years is being developed with stakeholders and will be part of the new national eStrategy.

United States: The United States has several initiatives for technology diffusion and focuses more on targeting specific groups and use of broadband. Grants for technology diffusion are being phased out. Current initiatives focus on rural development, distance learning, telemedicine and loans. There is a broadband loan programme for rural broadband providers, "Community Connect grants" for broadband and a DTV transition programme.

Source: Irish and US responses to the OECD IT Policy Questionnaire, 2005.

Technology diffusion to businesses

In 2005, a large majority of respondents mentioned initiatives for technology diffusion to businesses. As in the case of ICT diffusion to individuals and households, the main focus is no longer basic ICT diffusion. Only Austria and Korea cite initiatives to increase business access to ICT. Instead, nearly all countries with technology diffusion programmes cite policies and initiatives to increase the use of e-business (especially among SMEs). A handful of countries cite initiatives for the creative use of ICT for innovation, efficiency and value creation (see Box 8.8).

Box 8.8. **ICT for business innovation, efficiency and value creation**

Australia: The Australian government provides companies with access to consultants, grants for co-operative business-to-business innovation projects, grants for the commercialisation of innovation, funding for new energy technology, for ICT centres of excellence, and funding to accelerate the adoption of e-business by SMEs.

France: One objective is to improve competitiveness of SMEs through better use of ICT. In particular, "ICT SME 2010" will support the implementation of tools to create a "digital supply chain" for the integration of internal processes and external relations with suppliers and clients.

Hungary: Hungary focuses on improving efficiency of processes within and among companies as well as improving network security and quality of services. It provides opportunities for SMEs to use modern IT-based business solutions and improve their operational efficiency and the processing and accessibility of information.

Italy: Initiatives include a portal for enterprises, an action plan for digital innovation in SMEs, encouragement of e-business, supply-side measures for the IT industry, promotion of open source software, a tax credit for IT investments in e-commerce, and direct intervention in southern Italy.

New Zealand: New Zealand's Digital Strategy aims to promote innovation in New Zealand business.

Norway: The BIT programme, managed by Innovation Norway, seeks increased value creation in SMEs, both in and outside the central regions of the country, through efficient use of ICT.

Source: Responses to the OECD IT Policy Questionnaire, 2005.

Organisational change

The share of countries citing programmes for organisational change has risen dramatically since 2003, from one-third to over half, and increasing priority is given to what had been a relatively low policy priority. As in 2003, the focus of these initiatives took two forms:

- Initiatives to promote or foster telework and/or flexi-work:
  - ❖ Australia is establishing a government advisory taskforce on teleworking.
  - ❖ In Hungary, the Telework Council promotes ICT-related work practices, and new legislation removes barriers to atypical forms of employment, especially ICT-related work practices. Support is available to enterprises and organisations for the creation

of new tele-workplaces or for reshaping traditional workplaces to use ICT and telework.

- Support, information and guidance for organisational change:
  - ❖ The Czech Republic's Innovation Programme supports projects to improve the technical and economic value of goods and services; improve the efficiency of manufacturing processes and provision of services; introduce new management methods; and carry out fundamental organisational change and thereby strengthen long-term competitiveness.
  - ❖ The Finnish Workplace Development Programme (FINWDP) is the first national initiative exclusively focused on work organisation. It aims to promote productivity growth and better quality of working life by furthering innovation-supporting modes of operation and improving employee skills at Finnish workplaces. FINWDP funds workplace development projects, method development projects and learning networks; disseminates information on workplace development; and makes available expertise on workplace development. Grants cover the fees of researchers and consultants who work as experts for the projects.
  - ❖ Mexico's programmes to support organisational change include the National Committee of Productivity and Technological Innovation (to promote productivity, competitiveness and social responsibility in SMEs in conjunction with the use of new technology); the Regional Centre for Enterprise Competitiveness (which offers services to SMEs); the Digital Mexico Foundation (to promote the adoption of IT in specific production chains); and recognition of innovation through the INNOVA and Intragob awards.
  - ❖ In Sweden, many activities of NUTEK address structural change in production, and aim at increasing the understanding of the need for change. This message is diffused through seminars, etc.

Demonstration programmes

The percentage of countries citing demonstration programmes has doubled since 2003, from about one-third to over two-thirds. The main focus in 2005 is on the following:

- Guides for using ICT, such as guides for knowledge management systems, use of broadband-based education, etc.
- Promotion and public relations through the use of broadcasting, media, road shows and seminars to demonstrate the benefits of ICT use.
- Government-sponsored projects, including digital platforms, directories, smart cards, etc.

Most countries (12 out of 17) indicated that the policy importance of demonstration programmes has been roughly constant since 2003. However, Italy, Portugal, the Slovak Republic and the United Kingdom stated that these policies have increased in priority.

Government on line, government as model user

Government online initiatives have increased since 2003 from three-quarters of respondents to almost all. In 2003, the primary focus was on portals, specific high-impact services and e-government infrastructure. In 2005, portals and high-impact services remain important, but a large number of countries specifically cite a move towards citizen-centric government. This change in focus largely reflects concern about the lack of take-up of e-government services under the previous (government-centric) model. In practice, this means a shift towards "one-stop shops" and the mainstreaming of e-services via a move towards integrated multi-channel service delivery strategies.

Citizen-centric government takes several forms, including measuring user satisfaction (Australia), a move to "self-service" government (Canada, Denmark), and user-friendly services, including to businesses (Canada, Japan, Norway, United Kingdom). Other areas of e-government mentioned in 2005 are a focus on return on investment (see Box 8.16) and transformation of the public service (New Zealand).

Government programmes to promote or encourage e-procurement and e-invoicing

A topic new to the 2005 survey is government programmes to promote or encourage e-procurement and e-invoicing. More than half of respondents cited such initiatives, with the main focus on government use of e-procurement for more effective government, better access and reduced costs for suppliers and industry, and a demonstration effect for wider business adoption.

ICT skills and employment

Since initiatives for ICT skills and employment were so significant in 2003, the OECD 2005 IT Policy Questionnaire addressed this area in greater detail. In 2005, almost all countries reported programmes for ICT skills and employment, a slight increase from 2003. By far the most important area for government policy is promotion of IT education. However over one-third have initiatives for industry-based/on-the-job training, and around one third mentioned improving labour market information. A smaller number of countries have initiatives for international sourcing or foreign workers.

Promoting IT education

Most responding countries have programmes for promoting IT education. The programmes mentioned all aim at improving quality and spreading skills more widely, but are diverse, and each country has its own specific focus. Initiatives include the following:

- Basic IT education for the population. The Czech National Programme for Computer Literacy consists of practical, two-hour courses to teach participants the fundamentals of computer work, Internet access, the basics of searching via the Internet and work with e-mail.
- IT education in schools and universities. The Spanish Avanza Plan covers education in the digital era, with a specific focus on integrating ICT technologies in the educational process. The initiative includes measures to increase use of the Internet by those engaged in the education fields and to improve trust in technology.
- Training for specific groups such as the unemployed, women or the elderly. Korea has IT training initiatives that target the disabled, the elderly, low-income earners, North Korean defectors and the illiterate.
- Training for government workers. The Italian CNIPA Programme for e-learning in the public administration includes a series of e-learning projects divided into three categories: top managers, middle managers and clerks. The ultimate goal is to create a virtual public administration school.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

- Teacher training and the use of ICT for broader education. Hungary promotes the development of basic ICT skills, competencies and abilities in pre-school and school education by supporting in-service training of teachers and experts, thereby enabling the delivery of competency-based education and training.
- Distance learning. Belgium has an initiative for distance learning, focusing on just-in-time courses that are relevant for specific job requirements.
- Setting IT skill standards. Japan's METI published "IT Skill Standards" to indicate the abilities required to provide IT services. The Skill Framework summarises 11 careers and 38 job categories related to the information service industry. It classifies seven levels based on the abilities and experience of individuals in each career and job category.
- Promoting awareness for career development. In the ICT sector, Canada's Department of Human Resources and Skills Development (HRSDC) is financing a number of programmes with the Software Human Resource Council (SHRC). SHRC also addresses career awareness and skills development with the goal of providing lifelong career development and quality education and training for Canadians active in the IT sector.

Industry-based and on-the-job training

Over one-third of countries reported initiatives for industry-based or on-the-job training. Most initiatives focus on using professional bodies and industry associations, though apprenticeship programmes and national awareness campaigns were also mentioned, along with ICT training and certification for non-ICT workers (see Box 8.9).

Box 8.9. **Industry-based training in Portugal and the United Kingdom**

Portugal: Since 2002, the Institute for Employment and Professional Training (IEFP) includes an ICT module which is applied in IEFP courses from level I to level IV. The module furnishes students with skills that allow them to enter the labour market with a good basis in computer use, text processing, Internet use, database and presentation tools.

United Kingdom: IT4All is an initiative to improve ICT user skills in the UK workforce. The Institute of Directors (IoD) and UK Online for Business are working closely to provide ICT awareness and skills as part of courses and support aimed at company directors. In the White Paper Opportunity for All in a World of Change, the Secretaries of State for Trade and Industry and for Education and Employment stated that "our ambition is to make the UK the number one country for the supply of advanced ICT and related skills".

Source: Portuguese and UK responses to the OECD IT Policy Questionnaire, 2005.

Foreign workers

Only Canada, Korea and Singapore cited special initiatives for foreign ICT workers apart from general immigration programmes.

- Canada has a programme to streamline the entry of workers whose skills are in high demand in the software industry and whose entry into the Canadian labour market would have no negative impact on Canadian job seekers and workers. As well, Canada has published its offer to lower barriers for temporary work of "Computer Specialists" under the General Agreement on Trade in Services.

- Korea's initiatives focus on international exchange projects, such as inviting leading foreign IT scholars and students to Korea and an overseas training programme for Korean professors to strengthen global competitiveness.
- Singapore has set up specialised ICT talent exchanges between local and foreign enterprises, research institutes and tertiary institutions, and is encouraging foreign talent to work in Singapore.

International sourcing

Hungary, Korea and Switzerland mentioned initiatives to encourage international sourcing. The Koreans use international sourcing to supply IT specialist services to small, medium and venture enterprises. Several other countries are promoting teleworking (see above). Several countries mentioned that international sourcing was not a separate policy and that policy responses were part of more general economic adjustment policies.

Improving labour market information

Just under one-third of responding countries cited initiatives to improve labour market information with regard to ICT skills and jobs. These initiatives focus on information surveys, improving information exchange between industry and educational/ training institutions, developing common competency frameworks, vacancy databases and platforms for job announcements and recruiting.

Digital content

In the 2005 questionnaire, nine out of ten responding countries reported having specific initiatives for digital content, a considerable increase from 2003, when just over half of responding countries reported such initiatives. While the main focus of these initiatives is general content, over half of respondents also have initiatives for the creation or re-use of government content. In many cases, general initiatives focus on areas where government content and information are very important, *e.g.* education, research, culture.

OECD analysis shows that governments employ a wide range of direct and indirect measures that affect content development and use, with initiatives in the areas of: innovation and technology; value chains and business models; enhancing the infrastructure; the business and regulatory environment; supply and use of public sector information and content; and conceptualisation, classification and measurement (see Chapter 5 and OECD (2006), "Digital Broadband Content: Digital Content Strategies and Policies", DSTI/ICCP/IE(2005)3/FINAL, May (*www.oecd.org/dataoecd/54/36/36854975.pdf*).

For general approaches to content policy, the most popular initiatives include the promotion of cultural heritage, education and the digitisation of existing content (*e.g.* scientific, historical, scholarly), and support for the content industry such as games and film and video (see Box 8.10). Other initiatives mentioned include legislation/regulation to promote content, making content more accessible and easy to use, and encouraging supply and demand. The European eContentPlus initiative was frequently cited.

Initiatives specifically for exploiting public-sector information and content were somewhat less common, and focus on two main themes: re-use of government content and development of new government content. Some countries see better access and use of existing public sector information and content as their main, or a major component of, their content strategy (see Box 8.11).

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Box 8.10. **General content initiatives**

Austria: Austria provides financial aid to SMEs for preparation costs for participation in eContentPlus projects. The initiative Multimedia Business Austria also supports the Austrian content industry, with a goal of increased participation in international expert networks and the formation of a national cluster.

Denmark: Denmark has many initiatives for digital content for literature, music, research, museums and cultural heritage.

Netherlands: Content development is primarily market-driven (commercial), but in specific areas, such as education, digital heritage and e-culture, the government supports production and distribution.

New Zealand: The One Digital Strategy initiative aims to achieve better online content by developing an online cultural portal.

Singapore: Under the iN2015 plan the interactive and digital media sector will receive special R&D support. Singapore will continue to support the Games Exchange Alliance to accelerate commercialisation, a digital media and entertainment hub for technology creation and commercialisation that provides storage, trade and distribution services for digital assets, and infrastructure for processing, management and delivery of content services.

Source: Responses to the OECD IT Policy Questionnaire, 2005.

Box 8.11. **Public-sector content initiatives**

Belgium: Flanders has set up a framework for re-use of public information. The government produces, brings together and distributes information related to areas such as tourism, economic development, education, etc.

Denmark: The public sector produces a wide variety of information on areas such as geography, weather, business, statistics and traffic. In 2001 the Danish government agreed with local and regional government organisations that all public organisations have a right to re-use data from other public organisations at marginal cost. In June 2005, the Danish Parliament passed a law on the re-use of public sector information by citizens and businesses which further improves access to data for the private sector and sets marginal cost as the maximum price for data.

Spain: Action is being taken to establish a co-operation framework with the digital content industry to allow information generated by the public sector to be used for business purposes.

Switzerland: The Swiss Federal Statistical Office offers a broad range of statistics on line, while e-geo.ch is a project to establish a national geo-data infrastructure with a view to networking data, facilitating access and encouraging use. To promote sustainable development in planning and decision making, e-geo.ch makes the range of national geo-information services available at *www.geocat.ch*.

Source: Responses to the OECD IT Policy Questionnaire, 2005.

The ICT business environment

Governments recognise that a favourable economic climate for ICT business is essential for supporting innovation and entrepreneurship and economic growth. In 2005, in contrast to 2003, intellectual property rights (IPR) policy was the most common policy cited in relation to the ICT business environment. Policies for international co-operation and trade and FDI were also mentioned more often.

Competition in ICT markets

The number of countries with specific policies on ICT sector competition held steady from 2003 to 2005, with about two-thirds of respondents citing initiatives in both years. However, the focus in 2005 shifted somewhat towards measures to increase effective competition (rather than telecommunications liberalisation) and towards new regulations and organisations to monitor and improve competition.

Intellectual property rights

The focus on IPR policies has increased. In 2001 and 2003, the main focus of IPR policies was software protection (whether software should be protected based on code or the function it performs) and reducing digital piracy. In 2005 the main focus was on strengthening the legal protection of intellectual property, the harmonisation of IPR and enabling better exploitation of digital content. Only the Czech Republic specifically mentioned the debate on the form of IPR protection for software.

Only six out of 18 countries stated that IPRs are a "high" policy priority, although none said it was low priority. Canada, Finland, Germany, Hungary, Korea, Mexico, Singapore, Spain and Sweden stated that IPRs are of "increasing importance" along the lines indicated above.

Trade and foreign direct investment

Countries' focus on trade and FDI has risen since 2003 (from half to two-thirds of those responding). The main focus in 2005, as in 2003, was on:

- Promoting ICT exports and seeking export opportunities. This includes offices abroad to facilitate exporting, participation in international fairs, participation in free trade agreements, etc.
- Attracting investment and otherwise providing support for the local ICT industry. This includes agencies whose role is to attract investment and incentives for foreign investment (*e.g.* matching funds, subsidies, local partners, pilot projects, cash grants and tax benefits).

International co-operation

Over three-quarters of responding countries have programmes for international co-operation (compared to half in 2003 and four-fifths in 2001). The focus continues to include co-operation with international bodies such as the OECD, the United Nations (including the World Summit on the Information Society – WSIS), regional initiatives for the EU and Asia, and support of ICT for development (with a particular focus in 2005 on Africa and the Middle East). ICT policy at the European Commission provides a framework for ICT policy in European countries and was frequently mentioned by them (see Box 8.12, below).

Box 8.12. **ICT R&D support at the European Commission**

In many countries European-level programmes now feature prominently in the national policy environment. For R&D support in particular, IST and EUREKA consortia now represent a structural component of European applied research at upstream (pre-competitive) levels. Especially for R&D support, various public agencies often advise and assist domestic entities when applying to European programmes.

IST is funded centrally by the European Commission (through the Information Society Directorate General) while EUREKA projects are funded directly by national governments. Thus, EUREKA is often the most directly relevant in terms of national policies for the ICT sector.

Through a variety of instruments ranging from grants to loans, governments subsidise the participation of domestic firms and research undertakings in EUREKA consortia. It is impossible to determine the extent to which some of the projects now undertaken in EUREKA consortia would formerly have been carried out at national level with national funding. Nevertheless, several governments define at least part of their role in stimulating the competitiveness of domestic ICT suppliers in terms of promoting participation in this programme. France, Germany and the Netherlands are particularly active in funding R&D in this way. For national governments, the obvious advantages of the EUREKA approach are that recognised consortia (*i.e.* those awarded the official EUREKA label) allow domestic entities to receive government assistance that does not contravene EU State Aid rules while allowing national governments to prioritise this aid to areas considered strategic for their own ICT sectors. Also, the risks of upstream (pre-competitive) research can be distributed among several governments.

Programmes in support of the ICT sector can be found virtually on all levels to varying extents, from the European IST and EUREKA programmes, to large national programmes, to numerous activities on regional and local levels. However, the centre of gravity for policy in support of ICT competitiveness in most European countries lies at the national level.

Source: European Commission, "Benchmarking national and regional policies in support of the competitiveness of the ICT sector in the EU 2004".

Enhancing infrastructure

Nearly all responding countries have specific programmes for enhancing infrastructure, most often for broadband, although many also have initiatives on standards and electronic settlement/payment.

Electronic settlement/payment

The number and share of countries mentioning electronic settlement/payment has been decreasing steadily since 2001. This is probably due to the fact that these systems and mechanisms have become widespread in countries' business and financial sectors, hence there is less need for specific government programmes and initiatives. Nevertheless, Hungary, Korea, Mexico, Spain and Sweden state that this area has increased in importance. Most responding countries that mentioned such programmes referred to programmes that have been in existence for some time. Only Norway and Singapore mention initiatives that are not yet fully in place. Australia and Korea, however, are taking their initiatives a step further by focusing not on the development of electronic settlement and payment but on widespread uptake and use (see Box 8.13).

Box 8.13. **A focus on widespread uptake and use of electronic settlement/payment**

Australia: The Department of Communications, Information Technology and the Arts (DCITA) has initiated a research project to investigate the longer-term potential of the future electronic payments system and promote the widespread uptake of efficient and flexible electronic payments instruments. The project is expected to inform policy makers and commercial strategists on possible pathways to a future electronic payments market.

Korea: The government and a research institute developed a 32-bit card and transferred the technology to the private sector. The government supports the development of the core technology for e-payment as an aid to industry. Currently, the government is encouraging a switch from cash cards to credit cards to ensure transaction security and prevent fraud, counterfeiting and cloning of cash and credit cards. Initiatives also exist for public transport, highways and micropayment.

Source: Responses to the OECD IT Policy Questionnaire, 2005.

Standards

The focus on ICT standards has increased steadily since 2001. Most countries cited initiatives to develop national operational standards (and Belgium and Switzerland specifically mentioned standards for operation between different levels of government), and harmonisation with international standards and practices. Norway mentioned a specific policy to promote open standards and Sweden a policy for technological neutrality.

Broadband

Broadband policies have become even more widespread since 2003, and the focus has expanded as broadband uptake grows. The most common policies involve access in remote and rural areas and access for specific target groups. In addition, countries cited broadband initiatives for: central infrastructure, research infrastructure, development of very high-speed broadband including next generation networks, stimulating applications and/or use and demand of broadband, market-based development and general access.

With regard to policy priority, 12 out of 18 responding countries cited broadband policy as of high priority. Mexico, Portugal, Singapore, the Slovak Republic and Spain indicated its increasing importance and the four OECD countries still lag OECD averages on broadband penetration. Nearly all other countries indicated that broadband policy is of continuing importance; only Finland said its relative priority was decreasing.

Promoting trust on line

Promoting trust on line was not covered in the 2005 IT Policy Questionnaire, although it was included in prioritisation (Table 8.2). Box 8.14 is drawn from work of the Working Party on Information Security and Privacy.

Policy assessment and evaluation

The importance of evaluation procedures in formulating (and reformulating) policy goals and instruments is clearly acknowledged in OECD countries, and evaluation has

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Box 8.14. **Promotion of a culture of security in OECD countries**

The last ten years have seen increasing reliance on information systems and networks in our societies. In the wake of business-to-business and business-to-commerce e-commerce, systems and networks of all kinds, including those supporting energy, transport and finance, are increasingly connected to the Internet and governments are developing extensive online services to remain responsive to the needs of citizens and enterprises. This migration towards Internet Protocol-based systems and networks, the technical evolution towards instant access anytime and anywhere to systems and networks, and the risks to an Internet-dependent infrastructure all contribute to the importance of security and trust-building policies for the continuing growth of the digital economy.

Priority areas for implementing national information security policies include e-government and national critical information infrastructures. Common policy trends include the recognition that a national co-ordinated strategy associating all stakeholders is necessary to address information security effectively. In OECD countries, significant progress has been made in a number of domains, including awareness-raising campaigns for all stakeholders, adaptation of legal frameworks for combating computer and network-related crime, and information sharing via and among computer emergency response teams (CERTs). However, further efforts and investments are needed to support R&D for information security, to measure the effectiveness of national policies, to meet the needs of SMEs and individual users and, finally, to strengthen international co-operation, for example to help improve the global reach of CERT networks and share "best practices", including with non-OECD countries.

Source: OECD (2005), "The Promotion of a Culture of Security for Information Systems and Networks in OECD Countries".

become a more common policy tool. The number of countries reporting policy assessment and evaluation for ICT-related initiatives has roughly held steady since 2003, at over half of responding countries. In 2005, initiatives for policy assessment and evaluation are more detailed and more comprehensive, and rely on a variety of sources and indicators. Only a few countries apply the same methodology across the board. Several countries have specific policy assessment and evaluation activities for broadband, but to the extent that broadband initiatives are evaluated, general programme evaluation methods are most often used.

Programme evaluation

All countries that undertake ICT policy assessment and evaluation mention individual programme evaluations. These evaluations have become more widespread and more systematic, and several countries are actively promoting a "culture of evaluation" and methodologies that can be applied to multiple policy areas (see Box 8.15).

Countries are also developing increasingly sophisticated business cases for specific government investments, such as the business case for e-government (see Box 8.16).

Broadband evaluation

Only Australia and Korea detailed specific initiatives for evaluating their broadband strategies. Australia is conducting case studies to evaluate the social and economic impact of the Coordinated Communications Infrastructure Fund (CCIF) and the Demand

Box 8.15. **ICT programme evaluation in selected countries**

All responding countries demonstrate a trend towards more advanced and more in-depth ICT programme evaluations.

Austria: A platform for research and technology policy evaluation has been formed to encourage more, better and more transparent evaluations and to develop a culture of evaluation. Most IT programmes now undergo extensive evaluation, including *ex ante*, ongoing, interim and *ex post* evaluation.

Japan: The Expert Committee on IT Strategy Evaluation is an agency composed of private-sector experts. It is introducing an achievement of goals system to check the status of policies and respond to problems in a timely manner.

New Zealand: A combination of qualitative and quantitative measures is used to assess performance. Statistics New Zealand has developed several surveys, three of which examine the use and uptake of ICTs in households, businesses and government, while two others examine the performance of the New Zealand ICT and ISP sectors. Statistics New Zealand has plans to develop an ICT satellite account and publication on the state of ICT in New Zealand. Qualitative tools likely to be used in measuring the performance of the Digital Strategy are focus groups, case studies and interviews.

Norway: The government is developing methods and tools for evaluating the realisation of goals and benefits in government agencies. Before major ICT projects are started, a socioeconomic analysis is performed, and ongoing projects must be evaluated on the basis of precise indicators and regular reporting in order to show progress and reveal areas for improvement.

Source: Responses to the OECD IT Policy Questionnaire, 2005.

Aggregation Broker (DAB) projects on regional and rural communities. Owing to the importance of Korea's broadband strategy, the government collects numerous statistics on the progress of its broadband strategies.

Conclusion

National ICT strategies have shown considerable continuity in the two years since the *Information Technology Outlook 2004*, although there is a push for further integration of IT policy and an increased recognition of ICT as a source of innovation, economic growth and improved competitiveness. Countries increasingly recognise that to maximise effectiveness, policy must be co-ordinated both vertically, across layers of government, and horizontally, across ministries and agencies. An additional shift is towards greater depth. As countries achieve high levels of access, basic skills and content, the focus has shifted to deepening these achievements (broadband, more advanced skills and more sophisticated content).

The overall shift in policy priorities reflects these changes, with a more specific focus on economic development and growth (Table 8.3). The most frequent policy initiatives, often with high and increasing priority, are in the areas of R&D for innovation and government applications (increasingly ICT-specific), increasing diffusion and use of ICT (especially in terms of broadband and online government), raising ICT skills and employment (especially ICT education), expanding digital content and applying intellectual property rights, and promoting trust on line. The development of this policy framework and trends in policy priorities provide important general lessons for OECD and non-OECD countries alike for policies to underpin growth and improve competitiveness.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Box 8.16. **The business case for e-government**

E-government is now widely regarded as fundamental to reform, modernisation and improvement of government. In order to identify its impact, many governments are beginning to change the way in which e-government projects are implemented and managed, requiring projects to be supported by a strong "business case", which incorporates consistent evaluation and monitoring of the costs and benefits into planning and investment.

Preparation of standardised pre-investment business cases that outline the impacts of e-government initiatives, coupled with sound post-investment evaluation of these impacts, enables decision makers to rank and compare proposals for e-government investments, and to hold implementers accountable for delivering projected benefits within proposed costs.

There is consensus that more cost-benefit analysis of e-government can help countries better target scarce funds, build support and political will for e-government in government and among users, and decrease the risk of failure. Current data show the greatest benefits from "transformation" initiatives, which change the way government does business. These benefits exist for users of government and for government itself; e-government also provides broader benefits to society as a whole (such as increased trust in government through transparency of government processes). So-called public benefits provide a strong argument for countries' increased investment in e-government, but they are difficult to measure and are generally not included in e-government evaluations. However, some countries are beginning to incorporate these elements into their evaluation methodologies.

Nearly half (14) of OECD member countries have evaluated the impact of their e-government projects and policies, but many have only begun evaluation activity in the last two years. As e-government evolves, governments will need to invest in services and systems whose benefits will be less readily apparent to policy makers and to the public and will require changes in public-sector structures and culture. The need for sound and systematic evaluation of the real costs and benefits of e-government will only increase.

Implementation of e-government can be costly; its success depends on strong ICT programmes coupled with the ability to manage change within and across organisations, to redefine business processes, and to cross cultural boundaries. It is therefore critically important to base e-government investment decisions on business cases using consistent methodologies.

Source: OECD e-Government Studies: e-Government for Better Government (OECD, 2005).

The area of assessment and evaluation remains an important weakness in current IT policy. In spite of the emphasis on broadband rollout, few countries report evaluation of broadband policies, and techniques for evaluating the effectiveness of IT policy need to be shared and improved. In particular, until there is more coherence of evaluation methodologies across governments, it will be difficult to compare assessments from one country to another and improve policy performance.

Table 8.3. **Changing ICT policy priorities for growth and competitiveness**

Most widely mentioned policy areas, of **high** and/or *increasing* priority

R&D programmes
Government development projects
Innovation networks and clusters
Technology diffusion to business
Government on line
ICT skills and employment
Digital content
Competition in ICT markets
Intellectual property rights
Broadband
Promoting trust on line

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

ISBN 92-64-02643-6
OECD Information Technology Outlook 2006

Annex A

Methodology and Definitions

This annex describes the definitions and classifications adopted in *Chapters 1 and 2* of this edition of the *Information Technology Outlook*. These definitions and classifications, and the data collected on the basis of these definitions and classifications, 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

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.

Major ICT firms

See Annex 1.A1 for definitions and further details.

Semiconductors

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 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. 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 *e.g.* OECD, 2005, *Science, Technology, and Industry Scoreboard 2005*). When such data were not available, the footnotes clarify the scope for each country. The full official ISIC (International Standard Industrial Classification of All Economic Activities) Revision 3 codes are:

Manufacturing

3000 Manufacture of office, accounting and computing machinery.

3130 Manufacture of insulated wire and cable.

3210 Manufacture of electronic valves and tubes and other electronic components.

3220 Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy.

3230 Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods.

OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

3312 Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment.

3313 Manufacture of industrial process control equipment.

Services: goods-related

5150 Wholesale of machinery, equipment and supplies.[1]

7123 Renting of office machinery and equipment (including computers).

Services: intangible

6420 Telecommunications[2]

7200 Computer and related activities

Research and development

To the extent possible, data on R&D expenditure in the ICT sector were collected according to the official OECD industry-based definition, excluding ISIC Revision 3 codes 3130, 3312, 3313, 5150, 7123. Footnotes explain actual coverage.

ICT markets

Data on markets were compiled directly from WITSA *Digital Planet,* available at *www.witsa.org/digitalplanet/*.

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: *http://www.oecd.org/dataoecd/5/61/22343094.pdf.*

For ICT goods, the ICT commodities list is more accurate than the industry-based sector definition used previously, which only approximated the ICT sector. For ICT goods, trade data were extracted from the OECD International Trade Statistics Database (ITS). Following the OECD proposed classification, the present publication groups the detailed codes of ICT goods into five broad categories: Telecommunications equipment, Computer and related equipment, Electronic components, Audio and video equipment, and Other ICT goods.

Software goods, which are not included in the ICT goods classification listed above, were defined using the Harmonised System (HS) Rev.2 and include the following product groups:

- 852431: discs, recorded, for laser reading systems, for reproducing phenomena other than sound or image.
- 852439: discs, recorded, for laser reading systems, for reproducing sound and image or image only.
- 852440: magnetic tapes, recorded, for reproducing phenomena other than sound or image.

- 852491: recording media (excluding those for sound or image recordings, discs for laser reading systems, magnetic tapes, cards incorporating a magnetic stripe and goods of Chapter 37).
- 852499: recorded media for sound or image reproducing phenomena, including matrices and masters for the production of records (excluding gramophone records, discs for laser reading systems, magnetic tapes, cards incorporating a magnetic stripe and goods of Chapter 37).

ICT services

For ICT services, an industry-based definition was used. The two ICT services sectors correspond to the following Balance of Payments Coding System (BPM5) categories (for a full list, see *www.imf.org/external/np/sta/bopcode/topical.htm*):

- 245: communications services
- 262: computer and information services.

Trade performance indicators

Revealed comparative advantage

$RCA_i^j = \frac{\left(X_i^j / X_T^j\right)}{(X_i^o / X_T^o)}$ where X_i^j stands for exports for industry *i* from country *j*, X_T^j stands for total manufacturing exports from country *j*, and X_i^O denotes total OECD exports for industry *i*.

Grubel-Lloyd Index

$GLI_i = \left[1 - |M_i - X_i| / (M_i + X_i)\right]$ where M_i and X_i stand for imports and exports for industry *I* respectively.

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
- Radiocommunications (including mobiles) and radar: 764.3, 764.8, 764.9, 874.1.
- Telecommunications: 764.1, 764.9, 763.8.
- Consumer equipment: 763.8, 764.8, 761.1, 761.2, 763.3, 763.8, 762.1, 762.2, 762.8, 881.1, 885.3, 885.4, 885.7, 898.2.
- Components: 776.2, 776.3, 776.4, 776.8, 771.1, 771.2, 778.6, 772.2, 772.3, 772.4, 772.5, 764.2, 764.9, 898.4, 761.1.

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

FDI flows

FDI data from the OECD *International Direct Investment Statistics Yearbook* cover the following ICT-related sectors (the corresponding ISIC Rev. 3 codes are in parentheses):

- Office machinery, computers, radio, TV and communication equipment (30, 32).
- Telecommunication services (642).

Mergers and acquisitions

Detailed analysis of cross-border M&As is based on Dealogic data (*www.dealogic.com*). Chapter 2 endnotes provide information on definition, and on industry and geographical coverage.

Notes

1. Where available, countries should only include those subsectors of this industry that directly provide ICT wholesaling services. This will avoid the inclusion of extraneous wholesaling activity. For example, using the NACE nomenclature, only NACE categories 5143, 5164 and 5165 should be included.
2. In those instances where countries include telecommunication activities as part of radio and television activities (ISIC 9213), radio and television activities (9213) should be included in this definition. Otherwise, they should not be included.

OECD PUBLICATIONS, 2, rue André-Pascal, 75775 PARIS CEDEX 16
PRINTED IN FRANCE
(93 2006 05 1P) – ISBN 92-64-02643-6-0 – OECD 2006

Information and Communications Technologies

OECD Information Technology Outlook

Information technology (IT) and broadband are major drivers of economic change, restructuring businesses, affecting skills and employment, and contributing to growth and consumer benefits. This volume describes recent market dynamics and trends in industries supplying IT goods and services and offers an overview of the globalisation of the information and communication technology (ICT) sector and the rise of ICT-enabled international sourcing.

It analyses the development and impact of the changing global distribution of services activities and the rise of China and India as significant suppliers of ICT-related goods and services. ICT skills across the economy are also examined to provide insights into the dynamics of job creation and international sourcing.

This edition of the *OECD Information Technology Outlook* also looks at the increasing importance of digital content in selected industries and how it is transforming value chains and business models. The potential of technological developments is examined: ubiquitous networks, location-based services, natural disaster warning systems, the participative web and the convergence of information technology with nanotechnology and biotechnology.

Finally, this volume analyses changes in IT policies in OECD countries and the emergence of new priorities to meet new challenges.

National information technology policy profiles are available on the OECD Information Economy website at ***www.oecd.org/sti/information-economy***.

The full text of this book is available on line via this link:
http://www.sourceoecd.org/scienceIT/9264026436

Those with access to all OECD books on line should use this link:
http://www.sourceoecd.org/9264026436

SourceOECD is the OECD's online library of books, periodicals and statistical databases. For more information about this award-winning service and free trials ask your librarian, or write to us at **SourceOECD@oecd.org**.

www.oecd.org

OECD

OECDPUBLISHING

ISBN 92-64-02643-6
93 2006 05 1 P

9 789264 026438

2006