Measuring the Digital Economy

A NEW PERSPECTIVE

OECD

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Foreword

Sound measurement is crucial for policy making. It helps policy makers to evaluate the efficiency of their actions and to reinforce the accountability of public interventions. The demand for new data and measurement tools is particularly high in the case of the digital economy, because of its growing role in everyday life and the fast pace of change.

Measuring the Digital Economy: A New Perspective selects indicators traditionally used to monitor the information society and complements them with experimental indicators that provide insight into areas of policy interest. Key objectives of the report are to highlight measurement gaps and propose actions to advance the measurement agenda.

Objectives and scope

Measuring the Digital Economy addresses the use of ICTs and the Internet at work in relation to the economy and society. It is designed to be a point of reference with respect to currently available statistics, and to mark progress towards the development of relevant new indicators on a broad range of issues. The aim is to:

- Review the current set of internationally comparable ICT indicators in light of OECD policy priorities in the area of the digital economy, as formulated in the 2008 Seoul Ministerial Declaration and the 2011 High-Level Meeting on the Internet Economy;
- Exploit the potential of existing official statistics and experiment with new metrics;
- Identify data gaps and foreground the measurement agenda; and
- Discuss the data infrastructure needed to measure ICT diffusion and impacts, including tools for the analysis of large datasets.

Structure

A Measurement Agenda For The Digital Economy

Based on the OECD's expertise in the development of ICT indicators, this section summarises the main weaknesses of the current measurement framework and identifies a number of key areas for action with a view to establishing a forward-looking international measurement agenda. The target audience of this section encompasses policy makers in search of sound evidence to support decisions, the broader research community in the area of ICTs, and statisticians involved in production of ICT data. This section of the publication builds on the following parts but it is placed at the beginning to bring discussion of a long-term strategy for measurement of the digital economy closer to the heart of policy making.

The Digital Economy Today (Chapter 1)

Chapter 1 sets the stage by pinpointing the evolving features of the digital economy and society. The target audience includes experts as well as the more general public (i.e. any person interested in obtaining a broader picture and key trends). The chapter highlights features such as the rise of mobile broadband access and applications; the increased offer of cloud computing services; the development of "smart" applications and associated sensor-based networks and machine-to-machine (M2M) communications; the rise of big data analytics; the role of ICT in innovation and the performance of ICT industries during the recent economic crisis.

Thematic Chapters (Chapters 2, 3, 4, 5)

The second section of the publication consists of four thematic chapters, which aim to reflect priorities for government action in the ICT area. They cover topics ranging from infrastructure availability to openness and participation in the Internet economy, cyber

security and privacy, protection and empowerment of consumers and citizens, and innovation and sustainability. These thematic chapters map existing indicators against current digital economy policy issues as reflected in the OECD Internet Policy Principles, as well as in the overarching objective to foster the role of ICT in promoting growth and jobs:

Chapter 2: Investing in smart infrastructure

Chapter 3: Empowering society

Chapter 4: Unleashing creativity and innovation

Chapter 5: Delivering growth and jobs

The target audience for the thematic chapters includes policy analysts with a certain level of sophistication in the use of indicators, as well as those engaged in producing indicators for policy making. The chapters also include a few "Gap Pages" that make a case for the development of new statistics in areas that lack high-quality, internationally comparable indicators. The "Gap Pages" discuss user needs, highlight the measurement challenges and propose ways forward:

• Improving the evidence base for online security and privacy (in chapter 2);
• Children online (in chapter 3);
• ICT and health (in chapter 3);
• Unleashing the potential of micro-data (in chapter 4); and
• Measuring quality in communication services (in chapter 5).

Acknowledgements

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Reader's Guide

Acronyms

ADE	Automated data exchange
ANACOM	National Communication Authority of Portugal (Autoridade Nacional de Comunicações)
AS	Autonomous system
ASN	Autonomous system number
BERD	Business enterprise expenditure on research and development
BLS	Bureau of Labor Statistics
B2B	Business-to-business
B2C	Business-to-consumer
B2G	Business-to-government
ccTLD	Country code top-level domain
CDN	Content distribution network
CDSS	Clinical decision support system
CERT	Computer emergency response team
CIS	Community Innovation Survey
CSIRT	Computer security incident response team
C2C	Consumer-to-consumer
DDOS	Distributed denial-of-service
DNS	Domain name system
DOS	Denial-of-service
DSL	Digital subscriber line
EDI	Electronic data interchange
EHR	Electronic health record
ERP	Enterprise resource planning
ESS	European Statistical System
EU	European Union
FCC	Federal Communications Commission
FTE	Full-time equivalent
FTTH	Fibre to the home
GDP	Gross domestic product
Gbit	Gigabyte
gTLD	Generic top-level domain
HDD	Hard disk drive
HTTP	Hypertext Transfer Protocol
ICT	Information and communication technology
IDS	Intrusion detection system
GFCF	Gross fixed capital formation
GPS	Global positioning system
IaaS	Infrastructure as a service
IC3	Internet Crime Complaint Center
ICIO	Inter-Country Input-Output
IP	Internet Protocol
IPC	International Patent Classification
IPv4	Internet Protocol version 4

ISC	Internet Systems Consortium
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
ISIC	International Standard Industrial Classification
ISP	Internet service provider
IT	Information technology
ITU	International Telecommunication Union
JST	Japan Science and Technology Agency
KISA	Korean Internet & Security Agency
LAN	Local area network
LTE	Long term evolution
Mbit	Megabyte
MHGE	Medium and high-growth enterprise
MNE	Multinational enterprise
MOOC	Massive open online course
M2M	Machine-to-machine
NAT	Network address translation
NFC	Near field communication
NIC	Network information centre
NSF	National Science Foundation
NSO	National statistical office
OFCOM	Office of Communications
OHIM	Office for Harmonization in the Internal Market
PaaS	Platform as a service
PCT	Patent Cooperation Treaty
PPP	Purchasing power parity
R&D	Research and development
RCA	Revealed comparative advantage
RCD	Registered Community Design
RFID	Radio frequency identification
RIR	Regional Internet registry
SaaS	Software as a service
SCM	Supply chain management
SIM	Subscriber identity module
S&T	Science and technology
SME	Small and medium-sized enterprise
SMS	Short message service
SNA	System of National Accounts
SSD	Solid-state drive
USD	United States dollar
USPTO	United States Patent and Trademark Office
VC	Venture capital
VoIP	Voice over Internet Protocol
Wi-Fi	Wireless fidelity
WIPO	World Intellectual Property Organization

Abbreviations

For most of the charts, this publication uses ISO codes for countries or economies.

AUS	Australia	**JPN**	Japan
AUT	Austria	**KOR**	Korea
BEL	Belgium	**LUX**	Luxembourg
BRA	Brazil	**LVA**	Latvia
CAN	Canada	**MEX**	Mexico
CHE	Switzerland	**MYS**	Malaysia
CHL	Chile	**NLD**	Netherlands
CHN	People's Republic of China	**NOR**	Norway
COL	Colombia	**NZL**	New Zealand
CRI	Costa Rica	**PAN**	Panama
CZE	Czech Republic	**PHL**	Philippines
DEU	Germany	**POL**	Poland
DNK	Denmark	**PRT**	Portugal
ESP	Spain	**ROU**	Romania
EST	Estonia	**RUS**	Russian Federation
FIN	Finland	**SAU**	Saudi Arabia
FRA	France	**SGP**	Singapore
GBR	United Kingdom	**SVK**	Slovak Republic
GRC	Greece	**SVN**	Slovenia
HKG	Hong Kong, China	**SWE**	Sweden
HRV	Croatia	**THA**	Thailand
HUN	Hungary	**TUR**	Turkey
IDN	Indonesia	**TWN**	Chinese Taipei
IND	India	**UKR**	Ukraine
IRL	Ireland	**USA**	United States
ISL	Iceland	**VGB**	Virgin Islands (British)
ISR	Israel	**ZAF**	South Africa
ITA	Italy		

Country groupings

BRIICS Brazil, the Russian Federation, India, Indonesia, China and South Africa.

EU28 European Union

OECD Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

ROW Rest of the world

WLD World

Executive Summary

With lacklustre growth across much of the globe, monitoring and understanding the role of ICTs and the Internet in the broader economy is a priority. *Measuring the Digital Economy* maps existing indicators against digital economy policy issues, identifies gaps in the measurement framework, assesses progress, and proposes a forward-looking international measurement agenda.

ICTs have triggered deep changes in economies and societies

The number of Internet users in OECD countries increased from fewer than 60% of adults in 2005 to about 80% in 2013, reaching 95% among young people, with large differences across and within countries. In 2013, more than 90% of individuals accessed the Internet in Luxembourg, the Netherlands, the Nordic countries, and Switzerland against 60% or less in Greece, Italy, Mexico and Turkey. The gap between Internet uptake among the elderly and the younger population generally remained high in the lagging countries compared to the leaders.

Fifteen-year-olds in the OECD spend about 3 hours on the Internet on a typical weekday and more than 70% use the Internet at school. In OECD countries, 62% of Internet users participate in social networks and 35% use e-government services. About half of individuals in OECD countries purchase goods and services online, and almost 20% in Denmark, Korea, Sweden and the United Kingdom use a mobile device to do so.

In 2012-13, 77% of enterprises in the OECD area had a website or home page and 21% sold their products electronically. Over 80% of enterprises used e-government services.

Technological developments are feeding further penetration

Higher speed Internet, lower unit prices and smart devices have favoured new and more data-intensive applications. Wireless broadband subscriptions in the OECD area increased over twofold in just four years: by December 2013, almost 3 out of 4 individuals in the OECD area had a mobile wireless broadband subscription.

Mobile broadband is also widely available in many emerging and less developed countries. In sub-Saharan Africa, for example, subscriptions grew from 14 million in 2010 to 117 million in 2013.

In less than two years, the number of pages viewed from mobile devices and tablets is estimated to have risen from 15% to over 30% of total. In 2013, over 75% of active Facebook users connected via a mobile device.

International differences in speed and prices remain significant, however, even among OECD countries. In December 2013, the share of high-speed broadband subscribers (above 10 Mbit/s) ranged from over 70% to under 2% across OECD countries. Depending on country, smartphone users in the OECD may pay up to seven times more for a comparable basket of mobile services.

ICTs are fostering innovations across industries and sciences

ICT-producing industries, together with publishing, digital media and content industries, accounted for about one-quarter of total OECD business expenditure on R&D (BERD) in 2011. In 2014, patents in ICT-related technologies accounted for a third of all applications to main patent offices. In the last ten years, the share of data mining in total patents more than tripled, and the share of machine-to-machine (M2M) communication patents increased six times.

Many emergent technologies rely on innovations in ICTs. In the OECD countries, about 25% of ICT patents also belong to non-ICT areas. For example the deployment of second-generation genome sequencing techniques with embedded data-mining algorithms resulted in the cost per human-like genome sequence dropping from a million to a thousand dollars in just five years (2009-14).

The digital economy has been resilient in the crisis

In 2012, information industries accounted for about 6% of total value added, around 4% of total employment and 12% of total fixed investment in the OECD area. Labour productivity in the information economy sector is about 60% higher than in the total economy.

The ICT sector outperformed the rest of the economy in terms of net business population growth between 2009 and 2012 and involved relatively high shares of medium and high-growth firms. New ICT enterprises have also higher survival rates than their counterparts in manufacturing and services.

The crisis does not seem to have significantly affected the revenues of the world's top-250 ICT firms. However, they have substantially reduced their R&D expenditures compared to the beginning of the decade, perhaps due to the shift from manufacturing to services.

Over 2000-12, computers and peripherals fell from almost 38% to under 30% of world ICT exports, while the share of communication equipment and consumer electronics grew from 26% to almost 35%. Over the same period, China's share in global ICT exports grew from 4.4% to above 30%. However, in terms of value added, China's share was only 17% since it has to import a significant amount of intermediate goods and services.

Employment creation has been sluggish

Despite the dynamism of the sector, employment in ICT industries never regained the 2001 peak of 4.1% of total employment and remained just below 3.8% in 2012. These sluggish employment dynamics reflected the downsizing of manufacturing and telecom services and the growth of IT services. Yet ICT industries account for less than half of ICT-related occupations in OECD countries.

From 2003 to 2013, employment in ICT occupations grew by 25% or more in Australia and Canada, about 15% in the United States, and 16% to 30% in OECD countries in Europe, performing better than total employment through the crisis. Yet, several studies highlight the potentially disruptive effects of ICTs on employment, given the progress in automation and machine learning.

New skills for workers, firms and users are required

While the use of ICTs at work is generalised, over 60% of the EU labour force reported their computer skills as insufficient to apply for a new job, rising to over 80% of people with low education compared to below 40% of those with a tertiary education. ICT industries employ on average 30% of business sector researchers, but only 3% of OECD tertiary graduates attained a degree in computer sciences in 2012.

The Internet has opened up new opportunities for education and training. In 2013, 9.3% of Internet users followed an online course in the 30 OECD countries for which data are available, and hundreds of universities now propose online programmes and massive open online courses (MOOCs).

Security skills also need to be improved. Security is cited as the main reason for not buying online by over one-third of Internet users in the European Union. However, in 2013 only about one-third of Internet users in the European Union had ever changed the security settings of their browsers. Similarly, in 2010 only 9% of adult Internet users in the European Union used a parental control or web-filtering software to protect their children online.

New statistical tools are needed to measure the digital economy

While existing statistics measure the diffusion of ICTs, they are less able to keep up with new and rapidly evolving technologies and usage by individuals and firms. A forward-looking international measurement agenda should be built around six areas:

- Improve the measurement of ICT investment and its link to macroeconomic performance;
- Define and measure skill needs for the digital economy;
- Develop metrics to monitor issues of security, privacy and consumer protection;
- Promote the measurement of ICT for social goals and the impact of the digital economy on society;
- Invest in a comprehensive, high-quality data infrastructure for measuring impacts; and
- Build a statistical quality framework suited to exploiting the Internet as a data source.

A MEASUREMENT AGENDA
FOR THE DIGITAL ECONOMY

THE DIGITAL ECONOMY: TOWARDS A MEASUREMENT AGENDA

Measuring the Digital Economy: A New Perspective maps existing indicators drawn from a wide range of areas including education, innovation, entrepreneurship and economic outcomes against current digital economy policy issues, as reflected in the OECD Internet Policy Principles OECD (2011b). By doing so, it identifies gaps in the current measurement framework and assesses progress made by some initiatives towards filling these gaps. The overarching objective of *Measuring the Digital Economy* is to advance the measurement agenda, including in areas highlighted by the OECD in its broadband metric checklist (see Box 1), so as to better monitor the pervasive role of ICTs and the Internet in the broader economy and their contributions to delivering jobs and growth.

This is a challenge. As the OECD and the broader international community develop international policy guidelines on the protection of personal data, children or consumers online, and address issues of cybersecurity, a key question concerns the extent to which existing metrics and measurement tools provide an evidence base to allow analysis of these policies and their impact across countries.[1]

The near ubiquitous diffusion of information and communication technologies has led to their convergence with other technologies such as biotechnologies and nanotechnologies, which in turn have led to innovations in advanced manufacturing, health care, environmental protection and other applications. The growing interdisciplinary nature of these technologies underscores the need for a consistent measurement framework.

For centuries, technological developments have made old skills obsolete and led to the demand for new skill sets. ICTs are at the forefront of this transition today and are generating policy interest about new skills needs and methods to develop these skills. This debate has raised a number of questions: What measures best capture the range of skills consumers and workers need? Is it possible to define such ICT skills based on existing metrics and statistics? Does the use of ICTs improve learning and educational outcomes? To what extent does education play a role in shaping the skills of future ICT users in the workplace and everyday life?

The digital economy extends beyond businesses and markets – it includes individuals, communities and societies. This broader conception encompasses new themes such as the rapid growth of social networks and free and rapid access to social media and other user-created content. This gives rise to a wide range of policy issues including cyber bullying, the right to have one's past forgotten and Internet "addiction", as well as on-going concerns about the protection of children online and persistent digital divides. The majority of current ICT metrics focus on the role of ICTs in business performance and fall short in terms of measuring the social impacts of ICTs and their contributions to social outcomes.

Finally, measuring the digital economy and understanding the various dimensions of its impact often means improving measurement of the "traditional" economy. For example, price deflators for goods and services must be adjusted to reflect changes in quality induced by ICTs so as to permit measurement of changes in key aggregate statistics, such as productivity, and to assess the contribution of ICTs to overall economic performance.[2]

To understand the structural impact of ICTs and the changing nature of competition in the digital economy, it is important to consider price differentials between goods and services sold online versus offline, as well as measures of price dispersion across producers using the same distribution method. Furthermore, addressing the challenge of measuring and valuing outputs is essential in order to identify the impacts of ICTs in service sector industries where they play a key role.

In the short term, the challenge is to make statistical systems more flexible and responsive to the introduction of new and rapidly evolving concepts driven by ICTs. A number of options exist such as experimenting with satellite accounts, exploiting the potential of existing micro-data, adding questions to existing surveys, periodically augmenting existing surveys with topic-specific modules or developing short turnaround surveys to meet special needs. Experimental and flexible approaches could be developed to meet the specific priorities and resources of countries.

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1. The OECD Model Surveys on ICT Access and Usage by Households and Individuals and ICT Usage by Businesses were revised in 2014 to improve measurement in the areas of cybersecurity and privacy, notably the economics of personal data and security, prevention measures and incident response. The OECD is also working to improve the international comparability of data generated by Computer Security Incidents Response Teams (CSIRTs) (see 2.10). The overall objective of the work is to develop statistical definitions for a set of indicators (e.g. budget, personnel, skills and co-operation, along with specific kinds of incidents) that national CSIRTs could report on a voluntary basis, in addition to suggestions for CSIRTs to better leverage existing data, such as from third-party institutions, for statistical purposes.

2. In particular, the OECD is looking at the feasibility of hedonic prices as an approach to measuring quality changes in communication services across countries (see 5.5).

Good co-ordination will help prevent geographically fragmented research efforts and ensure that the international community takes up the results of successful experimentation by countries (OECD, 2011a).

Box 1. • **Key messages from the OECD Broadband Checklist**[3]

- Develop a broadband definition by speed tier that reflects national specificities, to be implemented in data collection.
- Measure the deployment of broadband networks, including by exploring metrics based on interactive Internet mapping.
- Improve the measurement of ICT investment, including investment in broadband infrastructure.
- Develop a harmonised methodology to measure broadband performance metrics, such as broadband speed delivered directly to consumers' routers.
- Review and update broadband competition metrics such as market shares.
- Improve indicators of mobile broadband uptake via subscription data, use by individuals and businesses as measured in ICT use surveys, data from mobile operators/regulators on connections, traffic and usage patterns, and other data from industry stakeholders.
- Improve the collection of mobile broadband supply-side metrics in terms of coverage, capacity, speed and competition based on data from service providers.
- Develop new approaches to measuring broadband service prices including, in the longer term, work on hedonic deflators for different broadband services bundles.
- Explore the reliability of using Internet-based statistics to develop timely metrics for traffic-flow data or use of the Web.
- Exploit available micro-data and linking of micro-databases for new indicators on the demand side, including intensity and sophistication of ICT usage and in particular broadband.
- Review the OECD Model Surveys on ICT usage by households/individuals and by businesses to provide a richer set of data for analysis of impacts, including on ICT-enabled innovation and the role of ICTs for social outcomes such as health and education.
- Build on existing initiatives to measure the effect of the Internet on business practices and public administration, using automated data mining where possible.
- Build on existing OECD productivity measures to improve the underlying statistics for ICT and content industries.
- Consider over the longer term the possibility of integrating broadband investment and prices within National Accounts frameworks or satellite accounts, so as to enable analysis of the impact of broadband on productivity at the macro level.

Source: OECD, summary based on OECD (2012a).

In the long term, the challenge for the statistical community is to redesign surveys to address the relevant unit of analysis. As ICTs and the Internet become basic infrastructure for business and society, it will be increasingly difficult to measure the digital economy as distinct from the overall economy. This is due in part to the fact that the Internet enables the creation of non-physical organisations and flexible outsourcing of business activities, within existing sectors of activity and across locations, thus blurring the boundaries between firms and markets and between work and social life. A higher level of granularity in data will therefore be needed to measure how businesses and individuals use ICTs on a continuous basis from any location for any type of activity (Lehr, 2012).

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3. In recent years the OECD has organised several technical workshops and debated at length emerging issues in metrics under the aegis of the Committee on Digital Economy Policy (CDEP) and its Working Parties. This led to the identification of some points for action which are summarised in the document DSTI/ICCP(2012)7. Some of these actions have already been implemented. For example, the WPCISP (Working Party on Communication Infrastructure and Service Policy) has adopted an international definition of broadband by speed tiers (OECD, 2012a) and has initiated work in the area of Internet mapping (see www.oecd.org/sti/broadband/broadbandmapping.htm) and speed tests (see www.oecd.org/sti/broadband/speed-tests.htm). The WPIIS (Working Party on Indicators for the Information Society), now the WPMADE (Working Party on Measurement and Analysis of the Digital Economy), has just completed a major revision of its Model Surveys on ICT Access and Usage by Households and Individuals (OECD, 2014a) and ICT Usage by Businesses (OECD, 2014b) to take into account, among others, some of the priorities highlighted in the broadband metrics checklist, including the definition of speed tiers (256 Kbit/s to less than 1.5/2 Mbit/s; 1.5/2 Mbit/s to less than 10 Mbit/s; 10 Mbit/s to less than 25/30 Mbit/s; 25/30 Mbit/s to less than 100 Mbit/s; 100 Mbit/s to less than 1 Gbit/s; and 1 Gbit/s and above).

The exploitation of official statistics at the "micro" level (enterprise/establishment/organisation, worker, household/individual) and the use of administrative data will need to become the norm, and existing data collections will need to be reviewed to maximise data-linking opportunities for research and analysis.[4] This will mean finding ways to provide researchers with access to micro-data while responding to concerns about confidentiality.

The envisaged measurement framework will have to be developed and implemented gradually with the involvement of stakeholders outside the statistical community. Policy makers in co-operation with other stakeholders will need to define user needs. Researchers will have to analyse the data, ascertain impacts, and help to develop the appropriate metrics and data infrastructures. Engagement with organisations, businesses, universities and the public sector will be indispensable, as the statistical system can only collect what can feasibly be measured inside organisations. Attention must be paid to minimising the reporting burden by carefully selecting questions, exploiting other official and administrative data, and making use of new sources of data generated through the use of ICTs.

The *OECD Internet Policy Making Principles* call on the international community to promote the digital economy and to develop stakeholder capacity to bring publicly available, reliable data into the policy making process. The task of *Measuring the Digital Economy* is to propose indicators that can inform policy making in this area, as well as to offer a fresh perspective by highlighting new data sources, gaps and measurement challenges. The following paragraphs present key messages and actions to advance the measurement agenda for the digital economy.

Action 1
Improve the measurement of ICT investment including broadband investment and its link to macroeconomic performance

ICTs need to be implemented in business processes together with other assets to drive performance, and need to be analysed in the broader context of their contribution to aggregate jobs and economic performance. To this end, business and individual surveys on ICTs need to be reviewed regularly to take into account the role of ICTs, in particular broadband, as enablers of innovation and contributors to business performance and consumer welfare. ICT survey and administrative data need to be aligned with aggregate economic measures to allow the integration of ICTs within the System of National Accounts (SNA).

The business, statistical and research communities are encouraged to:
- Improve measurement of ICT investment and internationally comparable deflators for hardware, software and communication infrastructure, including the pricing of broadband services bundles;
- Measure and value digitised data as an intangible asset, and analyse its contribution to productivity and business performance;
- Review regularly the measurement framework for ICT usage to identify and prioritise areas for survey design and re-design in line with on-going developments and policy priorities.

Action 2
Define and measure skills needs for the digital economy

The development of the digital economy and its applications, such as "big data" analytics, cloud computing and mobile applications, may raise demand for new skills, leading to skills shortages in the short term. At work, shortage of ICT programmers may be compounded by managerial challenges to the development of new business models, new organisational structures and new working methods. Among users, the capacity to search among a myriad of mobile applications or protect against digital security risks is increasing demand for new types of skills. Traditionally, official statistics have used educational attainment or occupational categories as a proxy for skills, but this approach seems too narrow to address the issue of demand for new skills. More could be gained by exploiting and harmonising finely detailed national surveys on tasks and skills,[5] and by working with the business community to define new metrics for skill shortages.

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4. The OECD, for instance, has pioneered a distributed approach to micro-data analysis, where the Organisation provides a common research framework and researchers from different countries run the analysis on their own country's micro-data. The OECD has also developed a micro-data lab, which compiles and links large-scale non-confidential administrative and commercial datasets at the micro level (see 4.4).

5. Such as the Occupational Information Network (O*NET) in the United States, the UK Skills Surveys (UKSS), the Canadian Essential Skills program (ES) or the German Qualification and Career Surveys (carried out by the Federal Institute for Vocational Education and Training - BIBB).

The business, statistical and research communities are encouraged to:

- Exploit the potential of existing public and private statistics on skills, occupations and industry classifications, and to promote the harmonisation of existing national sources on tasks and skills;
- Better exploit existing cross-country surveys (e.g. the European Survey of Working Conditions and the OECD's Programme for the International Assessment of Adult Competencies), and promote the linking of datasets containing information on skills, jobs and activities at the individual level;
- Improve access and use of private online vacancy datasets (e.g. Help Wanted Online by the United States Conference Board) to measure vacancies in ICT-related occupations, their duration and rate of filling;
- Promote the harmonisation of national programmes currently in place in several OECD countries to assess skills supply and forecast skills demand.

Action 3

Develop metrics to monitor issues of security, privacy and consumer protection

Management of security and privacy risk online has become a key policy issue as individuals, businesses and governments shift large parts of their daily activities to the Internet. The analytical framework developed by the OECD to classify statistics and empirical data related to security and privacy risk highlights the potential for better indicators in this area, building on an underexploited wealth of empirical data (OECD, 2012b). While some aspects are currently being developed, such as the harmonisation of statistics from CSIRTs (Computer Security Incidents Response Team), others need to be explored further.

Statistical information related to online security and privacy risks relies either on self-reporting (e.g. in response to a survey or assistance sought from a CSIRT) or on Internet-based data, (e.g. malware activities recorded by a firewall). Measures based on self-reporting suffer from the drawback that not all incidents are identified in a comparable manner or reported because victims are often reluctant to expose their reputation when facing privacy and security incidents. Internet-based data is less susceptible to these issues, but its utility is limited because of restricted coverage of Internet activities as well as multiple security aspects and privacy risks.

A number of steps can be undertaken to address these shortcomings and improve measurement in the areas of online security and privacy risk, and consumer protection.

The statistical community, regulators and other stakeholders, such as CSIRTs and Internet intermediaries, are invited to work together and with relevant partners to:

- Test and improve the privacy and security modules in the ICT Users Surveys by Individuals and by Businesses to increase the quality and rate of response;
- Develop guidance for CSIRTs to produce and report internationally comparable statistics;
- Develop new indicators on the various factors and dimensions of security and privacy risk (including threats, vulnerabilities, incidents, impact, prevention, response), building on the above-mentioned analytical framework;
- Promote a statistical and regulatory framework for Internet-based data on online security and privacy risk, as well as consumer protection (see Action 5 below).

Action 4

Promote measurement of ICTs for social goals and impacts of the digital economy on society

The current measurement framework focuses on the role of ICTs in economic performance. It has limited capacity to measure the extent to which new ICTs can help address social goals, such as those associated with health, ageing population or climate change.

Governments as well as statistical and research communities are encouraged to:

- Develop new statistical tools including self-perceptions surveys to monitor the impact of ICT use by adult individuals and children[6];
- Promote wider implementation of the OECD Model Survey on the Adoption and Use of ICTs in the Health Sector[7]

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6. See 3.5 for the measurement challenges related to the activity and protection of children online.

7. This survey is an important outcome of a multi-stakeholder initiative launched by the OECD in 2010 to improve the availability and quality of health ICT data and guide measurement efforts (see 3.11).

and build on existing medical surveys of hospitals, practitioners and patients to improve measurement of the effects of e-health;

- Develop the ICT model usage surveys to improve measurement of consumer trust and behaviour in the digital economy;
- Improve measurement of the impact of ICTs on the environment by enhancing statistical linkages among ICT-use surveys, consumer expenditure surveys, supply-use tables and industry-level data.

Action 5
Invest in a comprehensive, high-quality data infrastructure for measuring impacts

The first and best evidence of economic impacts is likely to come from micro-data (data about firms, workers or consumers) before it shows up in macro-data. To date, measurement has focused mostly on access to and adoption of ICTs. Since economic effects arise as a consequence of ICT usage, the statistical infrastructure in most OECD economies, which details adoption behaviour across firms, households, individuals and their characteristics, provides a good basis for analysing impacts.

It is important to be able to link together existing datasets and exploit the potential of existing administrative records. This can improve understanding and reduce respondent burden. For example, the ability to link ICT surveys to datasets (surveys or administrative data) containing information on skills, jobs and activities at the individual level can substantially improve empirical research on the impacts of ICTs on jobs and skills. The linking of ICT surveys to business registers and innovation surveys can help to improve understanding of the role of ICTs in driving innovation and business performance.

Governments and statistical and research communities are encouraged to:
- Promote the exploitation of official statistics at the "micro" level (enterprise, establishment, organisation, worker, household/individual);
- Explore the statistical potential of administrative records;
- Review existing data collections to maximise data-linking opportunities for research;
- Improve the research community's access to this infrastructure while ensuring data confidentiality.

Action 6
Build a statistical quality framework suited to the Internet as a data source

Given the pace of technological change it is understandable that institutions collecting economic data tend to fall behind in measuring the magnitude and scope of ICT impacts on the economy. However, ICTs are themselves generating enormous flows of information at an unprecedented pace. Statistical information is no exception to this trend. ICTs have reduced the complexity and costs of collection, storage and treatment of data. Furthermore, Internet traffic flows and Web-based data provide a timely source of information on economic and social activities across the digital economy.

While offering great opportunities for statistics, Internet-based data also raise a number of issues regarding statistical quality, security, privacy and costs. Addressing these issues requires a significant range of expertise.

National Statistical Offices (NSOs), regulators, Internet Service Providers (ISPs) and the Internet community at large are invited to work together to:
- Develop international statistical standards for the collection of Internet-based data (e.g. sampling) and the development of statistical indicators (e.g. treatment of Web search results);
- Assess alternative models of co-operation among businesses, Internet intermediaries and NSOs for the collection and treatment of Internet-based data;
- Promote the emergence of a regulatory framework for the collection and treatment of Internet-based data, based on consensus among regulators, Internet intermediaries and the Internet technical community;
- Explore technical and regulatory solutions to preserve user security and privacy in the collection and use of Internet-based data.

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Chapter 1

THE DIGITAL ECONOMY TODAY

THE DIGITAL ECONOMY TODAY

Mobility, cloud computing, social networking, sensor-nets and big data analytics are some of the most important trends in the digital economy today. Collectively these trends are making possible the future of "smart everything" (i.e. grids, homes, business processes, energy, healthcare, transport and government), as well as empowering businesses, consumers and society at large.

These new and future applications rely on the widespread availability of fixed and wireless broadband networks to meet the growing demands of economies and societies with a concomitant rise in the number of devices connected over the Internet. In the OECD area, the number of connected devices in households is projected to increase from an estimated 1.7 billion today to 14 billion by 2022 (OECD, 2013a).

Collection of data will be facilitated by the expansion of machine-to-machine (M2M) communications with large-scale processing delivered by "cloud computing" services. New data analytics will be able to process and analyse large volumes of data, frequently termed "big data". These phenomena together form the "building blocks of smart networks". The numbers of devices, data and elements involved in smart networks are orders of magnitude larger than in previous periods (OECD, 2013a).

The pace at which ICT applications are evolving poses particular challenges for measuring the digital economy. To date, measurement has focused on the availability and adoption of ICT technologies, in particular Internet access. However, as the Internet evolves and becomes basic infrastructure, and the simple "adoption" of ICTs saturates, metrics for specific (more sophisticated) applications become increasingly relevant (Lehr, 2012).

**Towards universal diffusion of the Internet**

On average about 80% of 16-74 year-olds in OECD countries were Internet users in 2013, compared with less than 60% in 2005. Differences among countries and among individuals are still large (Figure 1). Internet users are 90% and above of the adult population in Luxembourg, the Netherlands, the Nordic countries and Switzerland but less than 60% in Greece, Italy, Mexico and Turkey. These differences are wider for older generations. Over 75% of 55-74 year-olds in Denmark, Iceland, Luxembourg, the Netherlands and Sweden reported using the Internet against less than 10% in Mexico and Turkey.

Education appears to be a much more relevant factor for older people than for younger people. Usage rates for 55-74 year-olds with tertiary education are generally in line with those of the overall population, and in leading countries approach that of 16-24 year-olds.

However, these gaps are closing steadily. At the bottom of the OECD range, Mexico currently has an Internet penetration rate of 40%, while nearly half of all elderly people in the OECD are now online. The near future will see a further narrowing of these gaps as technology continues to reduce the cost of online access and as today's "digital natives" become adults.

Figure 1. Internet usage trends in the OECD and differences by country (top panel) and by age groups (bottom panel), 2005-13

Inter country gap: Percentages of 16-74 year-olds; Age gap: 16-24 vs. 65-74 year-olds
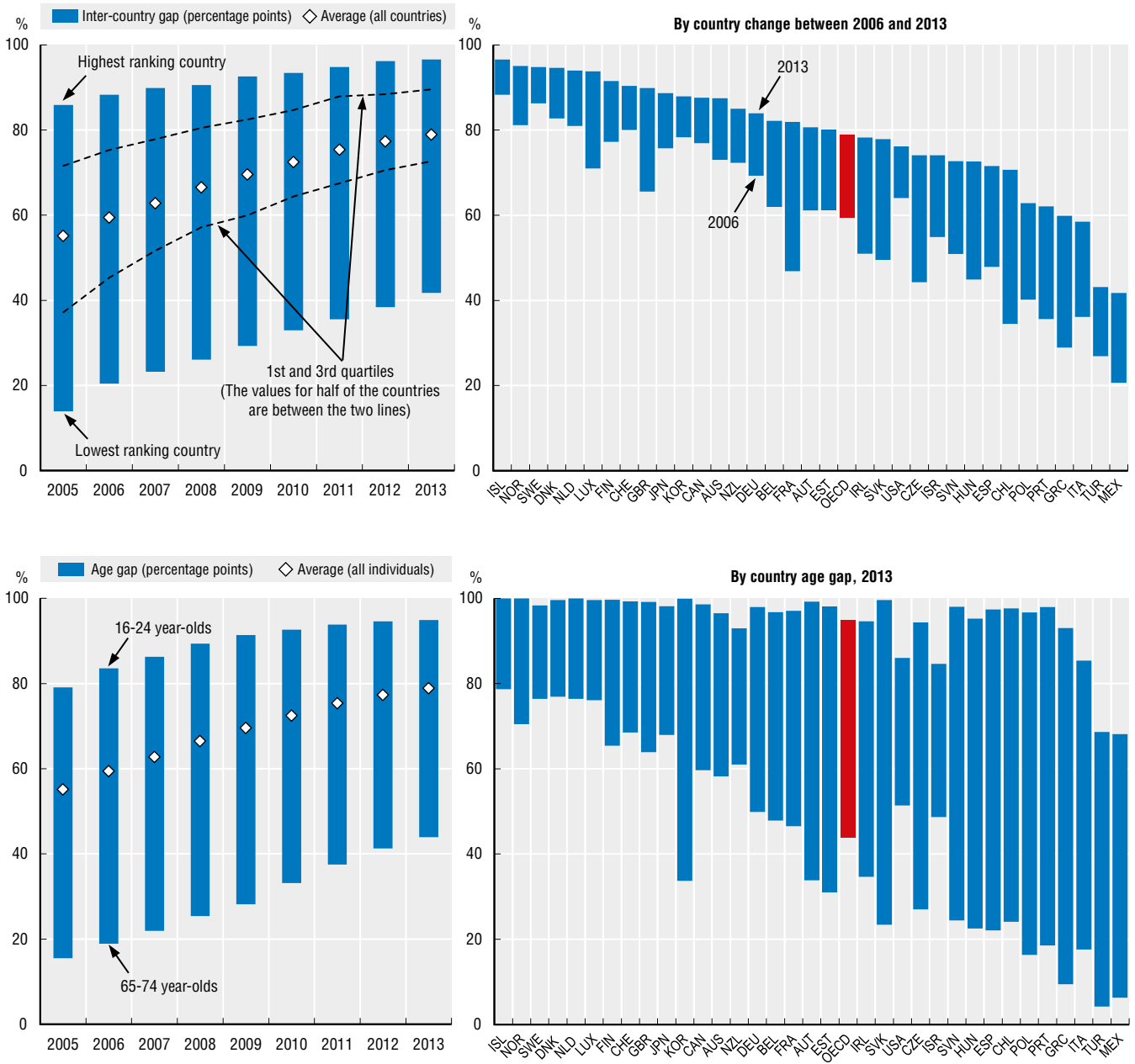
Source: OECD computations based on OECD, ICT Database and Eurostat, Information Society Statistics, July 2014. See chapter notes.

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The explosion of mobile broadband access...

Increasing Internet uptake has greatly benefited from the development of mobile infra-structures and falling access prices. Wireless broadband subscriptions in the OECD increased over twofold in just four years, from about 250 million to 850 million between 2008 and the first half of 2013. Mobile broadband connectivity is also widely available in many emerging and less developed countries, enabling these economies to make substantial increases in Internet access. For example, in sub-Saharan Africa mobile broadband subscriptions grew from 14 million to 117 million between 2010 and 2013, and are estimated to exceed 170 million in 2014.[1]

Despite the broad diversity in prices and quality of fixed and mobile broadband services across the OECD, average broadband speeds have risen. Fully reliable datasets for wired and wireless broadband are not yet available across the OECD (see 2.1 and 2.2). However, according to data recorded by a major Content Distribution Network (CDN), speeds increased from about 1.5 Mbit/s to 4 Mbit/s over a four-year period in Mexico, the OECD country at the bottom of the range, while Korea, the country at the top of the range, enjoys speeds in 2013 that are about five times faster (22 Mbit/s) (Figure 2).

Figure 2. Trends in broadband speed across the OECD, Q4 2009-13

Average download speed in Mbit/s, All technologies combined
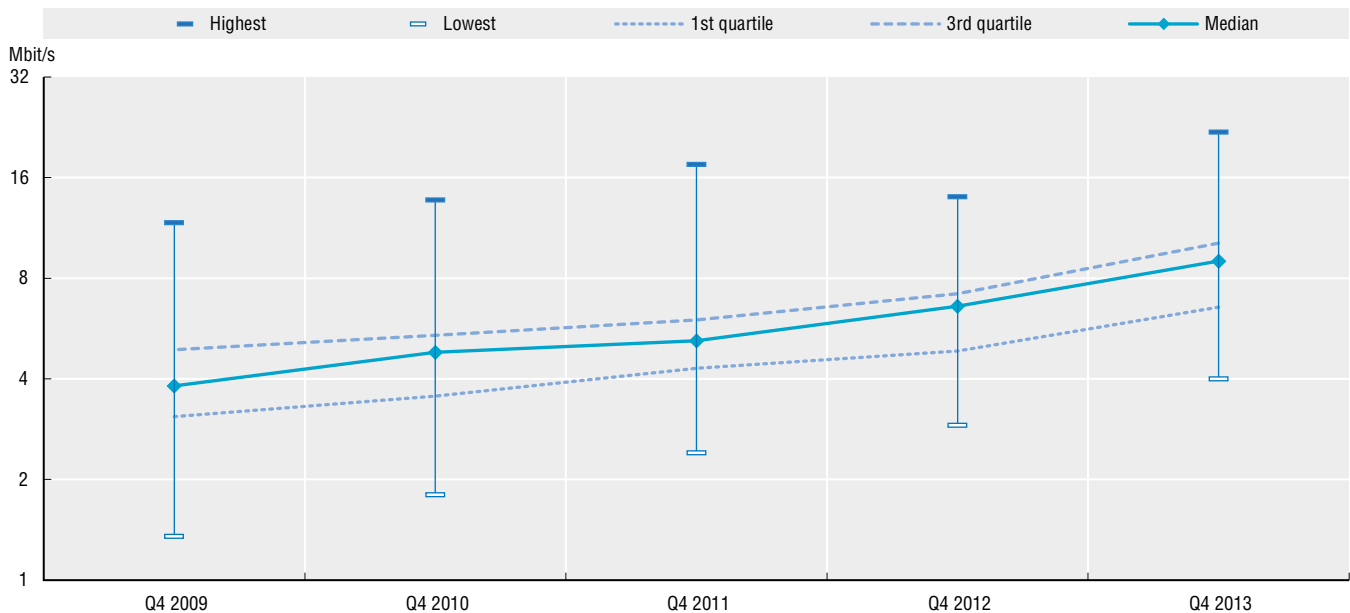
Source: OECD computations based on Akamai, The State of the Internet, various years, May 2014. See chapter notes.

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... and related applications

Progress in the quality of mobile broadband and the massive spread of Wi-Fi over fixed networks has allowed mobile devices to expand the array of applications used over the Internet, affecting the everyday life of millions of users across the OECD. In less than two years, the number of pages viewed from mobile devices, on a sample of 3 million websites monitored by Statcounter (gs.statcounter.com, June 2014), rose from 11.7% to 24.3% worldwide, and from about 15% to more than 30% when tablets are included.

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1. International Telecommunication Union (ITU), World Telecommunication/ICT Indicators Database (www.itu.int/en/ITU-D/Statistics/Documents/statistics/2014/ITU_Key_2005-2014_ICT_data.xls).

The use of mobile devices is proportionally greater where fixed broadband deployment is scarce: for example, in Africa and Asia page views by mobiles and tablets increased from about 15% and 20% respectively in 2012, to about 40% in 2014. In Europe, North America and Oceania, where the development of both fixed and mobile infrastructures is more advanced and average income comparatively high, there has been a significant rise in the use of tablets, which now account for up to 10% of web page views.

The same page-view metrics can be applied to individual websites. Wikimedia, the not-for-profit corporation managing Wikipedia, publishes this information on a monthly basis. Worldwide figures for Wikipedia show 20 billion page views per month, making it one of the top ten most visited websites across nearly all OECD countries. Page views on handheld device platforms (tablet and smartphone) grew from about 1 billion per month at the beginning of 2011 to more than 4 billion per month at the end of 2013, accounting for about 20% of total page views. Much of this growth came from views of pages in languages other than English (Figure 3).

The development of mobile usage affects the ICT economy in different ways, sometimes displacing other segments in ICT markets. For instance, active Facebook users connecting to the social network with a mobile passed from 28% of all users at the end of 2009 to over 75% at the end of 2013, while the revenue Facebook declared from mobile advertising rose from 13% of total revenues in 2012 to 40% in 2013.[2]

Figure 3. Wikipedia monthly page views on mobile platforms, by language, 2010-13

Percentages (left-hand scale), number in billions (right-hand scale)
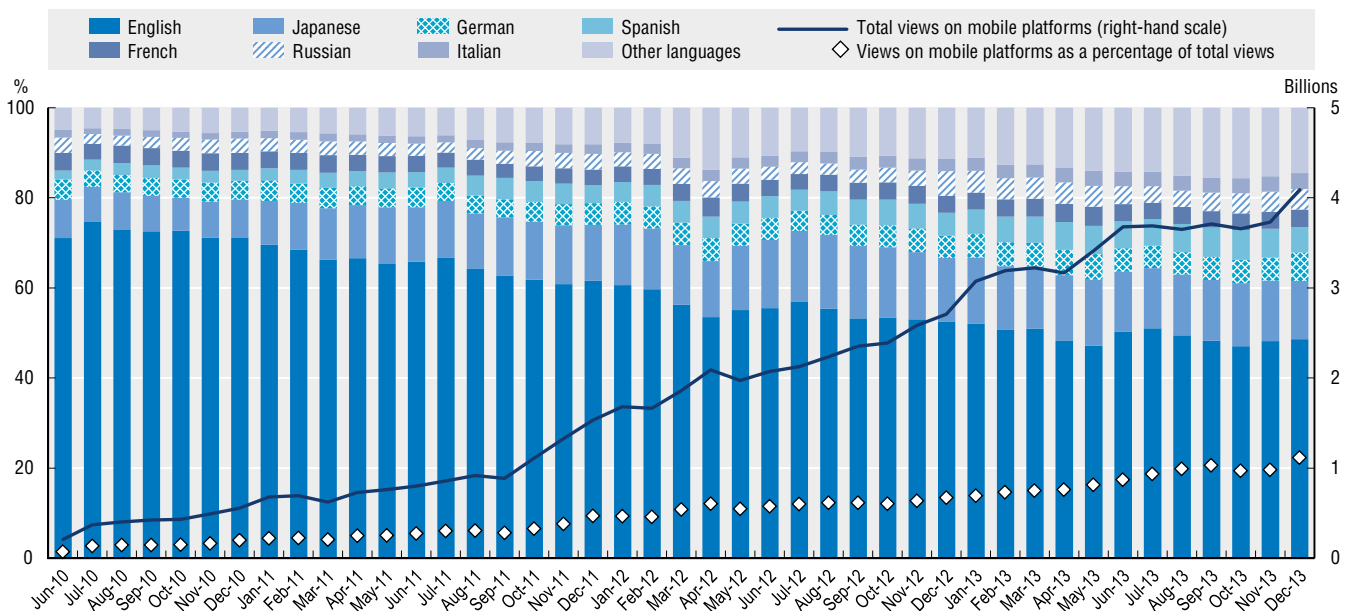
Source: OECD computations based on data from Wikimedia Foundation Statistics, stats.wikimedia.org, June 2014.

StatLink ⟨⟩ http://dx.doi.org/10.1787/888933147790

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2. In March 2014, Facebook claimed to have 802 million active users a day, 609 million of which connect via a mobile device. It is worth noting that these figures do not portray mobile-only users.

The progression of cloud computing

The development of communication infrastructures is opening the market to an array of new business processes, among which cloud computing (i.e. the centralised provision of IT infrastructures and software to end users over a network) is considered one of the most promising applications. Cloud computing is becoming a more viable alternative for storage and computing capability with the provision of *infrastructure as a service* (Iaas) offers and, increasingly, *software as a service* (Saas) and *platform as a service* (Paas) – the latter incorporating the other two. The appeal for businesses is potential flexibility and effectiveness. Cloud services are a substitute for investment and offer seamless scalability and *pay as you use* contracts that can lead to a reduction in personnel costs. Private source forecasts of market size for these different areas are far from consistent and ought to be considered as indicative only. These estimates suggest an increase in the global cloud market from about USD 120-150 billion in 2013 to USD 200-250 billion in 2017.[3] SaaS is predicted to account for about 15% of this total value with the private cloud (where infrastructure is dedicated to the customer) forecast to be the leading type of architecture.

Official statistics on cloud computing, while still scattered, largely confirm that adoption is spreading rapidly, in particular among larger enterprises. For example, 54% of larger Canadian businesses in 2012 used cloud services against 28% of businesses with less than 50 employees. The 2012 share of large companies using cloud solutions was almost 30% in Korea and 36.4% in Japan, up from 28.7% a year earlier. Comparable information in this area will be available in early 2015 for countries under the European Statistical System (ESS), with a special module on the use of cloud services by enterprises incorporated in the 2014 survey. Broader availability of information will permit monitoring of the growth in cloud services and analysis of its drivers and impacts on firm performance. At present, private sector estimates report around 10-20% savings on IT costs for businesses using cloud services, although such data ought to be considered with caution.[4]

The integration of functionality in devices and the growth of apps with increasing performance

Devices are becoming increasingly powerful and affordable (Figure 4). Mobile phones now have significant computing power and functionality, with cameras and music players as standard, and a wide range of available applications. Smartphones now employ touchscreen technology and include location and speed sensors, as well as an array of other sensors to improve the user experience.[5] Wi-Fi and Bluetooth connectivity for data transmission is also standard, while RFID transponders allowing near field communication (NFC) for mobile payments are also likely to see an increase in use.

Innovations in the pipeline include sensors for monitoring air pollution, ambient conditions (via UV light sensors) and health diagnostic tools – from microscopes to heartbeat, pressure and temperature sensors – that would ideally allow for constant monitoring of physical conditions, including from remote locations. The integration of new functionality and information has also given birth to a smartphone and tablet ecosystem comprising an extensive array of new software applications for mobile operating systems, commonly known as "apps".[6] The growing ubiquity of these applications has also drawn attention to the importance of effective protection of personal information.

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3. Estimates combine different forecasts of private sources, including IHC-technology (press.ihs.com/press-release/design-supply-chain/cloud-related-spending-businesses-triple-2011-2017), IDC (www.idc.com/getdoc.jsp?containerId=prUS24298013), Gartner (Forrester Research report quoted in blog.trendmicro.com/forrester-cloud-market-to-hit-240-billion-by-2020/#.U9fM6ygvjl8).

4. Among sources claiming potential savings in this order of magnitude, see for instance the recent report by Computer Economics (www.computer-economics.com/custom.cfm?name=postPaymentGateway.cfm&id=1931).

5. These typically include a global positioning system (GPS) chip and a magnetometer/digital compass for orientation, often complemented by a barometer for altitude. These are accompanied by sensors for measuring movement and angular rotation (accelerometers and gyroscopes), with light sensors to adapt to visibility conditions while saving battery power, and proximity sensors to avoid accidental hitting of the touchscreen when in free hands mode.

6. The contraction "app" for software application predates the introduction of mobile apps, but is now mostly used in reference to them. In general, an app (mobile app) is a lightweight software that either aids browsing (i.e. it facilitates interaction with a commercial website by hosting some of the information on the device) or allows for specific functionalities (e.g. gaming or use of tools embedded in the device to offer functions such as speed measurement).

The Android platform currently boasts the highest number of available applications. Apps in the Android market grew almost 60% in the year to May 2014, reaching about 1.2 million units. Of these, 1 million are (in principle) available for "free", while 200 000 are paid.[7] The size of the world mobile (and tablets) market for apps can be estimated at around USD 20-25 billion dollars in 2013, with strong growth perspectives. Sales and employment forecasts related to apps are highly diverse and sensitive to underlying methodology.[8]

Figure 4. The progress of smartphones, 2010-13

Quarterly global shipping trends
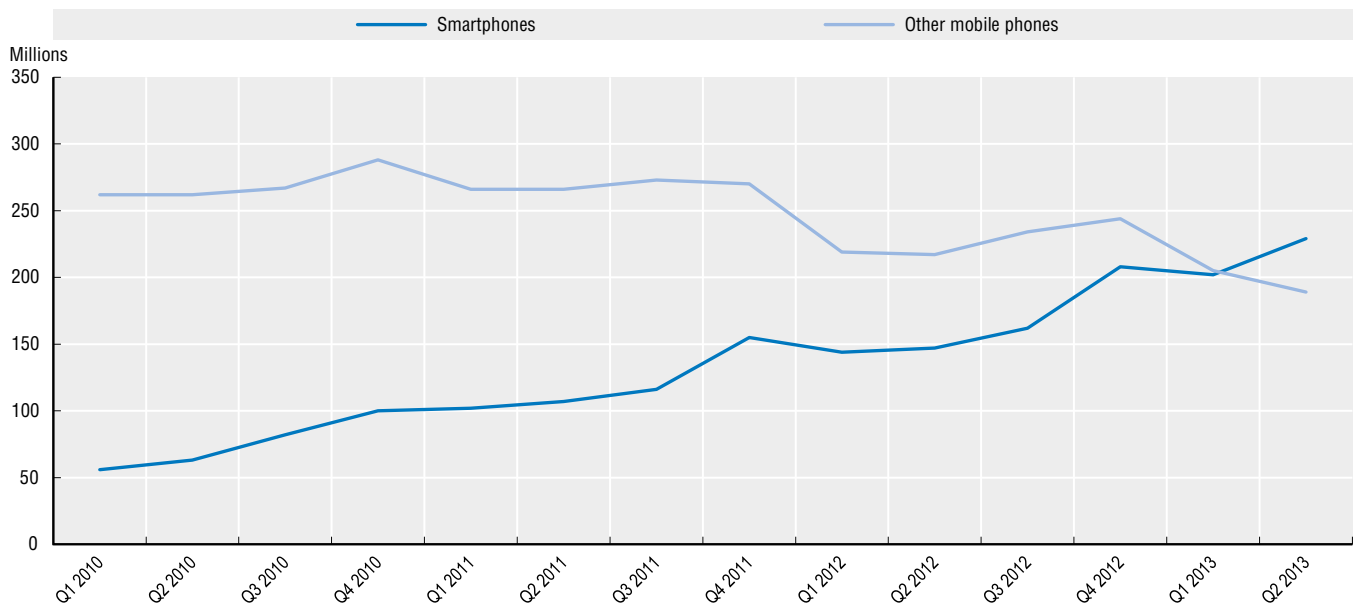
Source: ABI research, based on information from the 14 largest mobile producers, July 2014. See chapter notes.

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7. It must be stressed that many free-to-download apps might charge a fee for usage or upgrade. Also, in comparing these figures with those from Apple, it should be noted that the latter exert a somehow tighter control on the publication of apps for its devices, such that almost 20% of apps available on the Android market are identified as "low quality" (either useless or harmful) and are thus candidates for removal from the platform.

8. Corporate apps create value for developers even when free to users. Most banks, newspapers and commercial chains produce them for almost all popular operating systems (or platforms) to attract customers and increase their fidelity. However, these represent only a fraction of the apps being developed. The majority of apps make little or no money with only a few going viral and making a profit. Hence, a significant part of the market for apps functions essentially as a lottery. This is made possible by the low investment required to develop and distribute a single app, while the lack of interoperability between platforms multiplies the total number of apps. From the consumer's perspective, moving from one platform to another (or owning devices with different operating systems) implies an extra cost, potentially "locking in" customers to platforms.

A study released in the last quarter of 2012 by the Canadian Information and Communications Technology Council (ICTC, 2012), extrapolating national data based on information from both direct (including official survey) and indirect sources, put the world market for apps at about USD 23 billion in 2012, including about USD 4 billion from advertisement revenue. Portioresearch.com in their Mobile Applications Futures 2013-2017 placed it at USD 20 billion in 2013, corresponding to about 82 billion downloads during the year. Gartner and ABI Research placed it at USD 26 billion and USD 27 billion, respectively, the former forecasting growth of up to USD 77 billion in 2017. With respect to employment, a study commissioned by TechNet in 2012 (Mandel, 2012) estimates just above 300 000 jobs for the United States, of which half comprised technicians (the ICTC study for Canada comes to a similar share). These are then inflated to almost half a million counting for indirect employment with a 1.5 multiplier.

The emergence of big data analytics and its potential applications

Higher speed Internet, lower unit prices and smart devices have favoured deployment, access and use of new and more data-intensive applications. Cisco estimates an increase in the yearly growth rate of data traffic of about 20%, from 70 exabyte (EB = 1 billion Gigabytes or 1 trillion [i.e. 1000^6] bytes) per month in 2014 to about 120 EB in 2017, with the share of mobile traffic growing from 4% to more than 9%. Though this is a significant increase, the growth rate is considerably lower than that of the previous period.

Potential applications of *data analytics* techniques to treat this increasing wealth of information are also being advertised to the general public, and popularised as "big data".[9] The declining cost of data storage and processing have facilitated the collection of large data volumes and the adoption of data analytics. Cost decline in data storage is illustrated by the average cost per gigabyte of consumer hard disk drives (HDDs), which dropped from USD 56 in 1998 to USD 0.05 in 2012, an average decline of almost 40% a year (Figure 5). With new generation storage technologies such as solid-state drives (SSDs), the decline in costs per gigabyte was even faster (51% over 2007-12).

"Big data" solutions such as Hadoop are used primarily by enterprises in the ICT sector, but their applications extend to the whole economy. Studies in this field draw mainly on anecdotal information, although more structured evidence is accumulating.[10] Societal applications are even wider, ranging from disaster management[11] to healthcare applications.[12] Data analytics can also be a driver for innovation in a number of scientific areas (see Figure 11 below concerning genome sequencing) and is used increasingly in collaborative and crowd-based projects.[13] Exploiting the potential of big data also requires access to specific skills, in terms of new analytical techniques such as parallel processing or visualisation tools. In many cases, the transition also requires changes in the organisational practices of both enterprises and institutions, as well as the development of rules for data storage and exchange (e.g. health records).

Reliable information on the development and market value of emerging applications is still limited. Consequently, other approaches may be better suited to tracking development at this early stage.

Bibliometric and patent analysis may offer a better proxy of scientific progress in this area. A text search performed on one of the largest repository of scientific publications shows that data mining-related articles doubled their weight during the last decade (Figure 6).

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9. Data analytics consists of the use of data mining and similar exploratory techniques to support decisions. One well-known example is that of targeted online advertising, which uses results from individual profiling based on information on websites visited by means of cookies or other devices. There are several definitions of big data, which refer to the volume, variety and other aspects of information, as well as to techniques and tools (including parallel computing) to treat such large unstructured datasets.

10. The UK innovation agency (NESTA) undertook a survey, followed by a modular study on enterprises using data analytics, whose more advanced results are published in Bakshi *et al.* (2014a) with respect to the impact on firm performance, and in Bakshi *et al.* (2014b) with respect to the type of human resources used and activities performed. For an overview of these and other empirical works, see OECD (2015). With a view to gathering more robust and comparable evidence in this field, the OECD also introduced an experimental module on data analytics in the 2014 revision of its Model Survey on ICT Usage by Businesses.

11. For example, the US National Science Foundation (NSF) and the Japan Science and Technology Agency (JST) are currently working on a joint programme to optimise the use of big data and massive computing in disaster management. JST-NSF (2014) provides a preliminary assessment, which served as a basis for the collaborative research programme. A synopsis of the latter is available at www.nsf.gov/funding/pgm_summ. jsp?pims_id=505035.

12. In healthcare, data analytics can lead to improvements in the quality and effectiveness of treatments while saving resources. The availability of personal health records can help to diagnose conditions and identify and fine tune the most effective treatments with respect to individual patients, as well as providing insights into co-morbidities and risk factors. Data analytics solutions are already embedded in some clinical decision support system software (CDSS) – a key application of artificial intelligence in medicine. The OECD is also promoting an international action to leverage big data with respect to Alzheimer's disease.

13. See www.oecd.org/health/dementia.htm. The *Citizen Science Projects* promoted by Zooniverse (www.zooniverse.org) provide some examples of the use of big data-combined distributed participation.
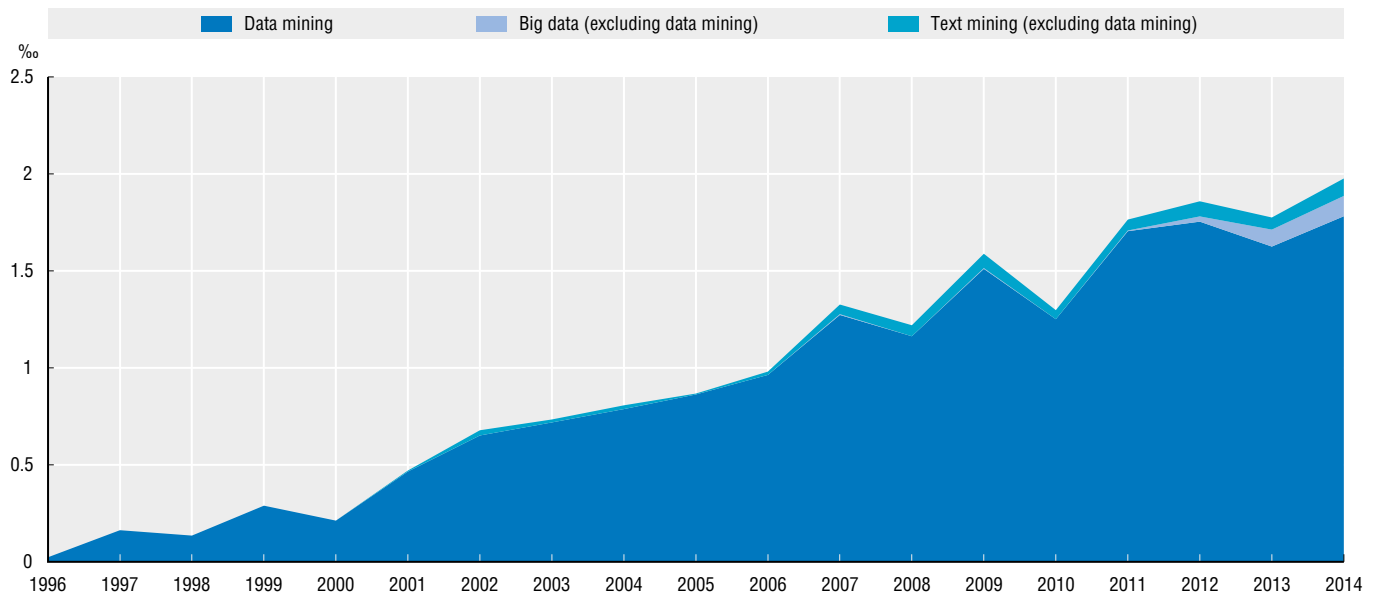
Figure 5. Average data storage cost for consumers, 1998-2012

Per Gbit
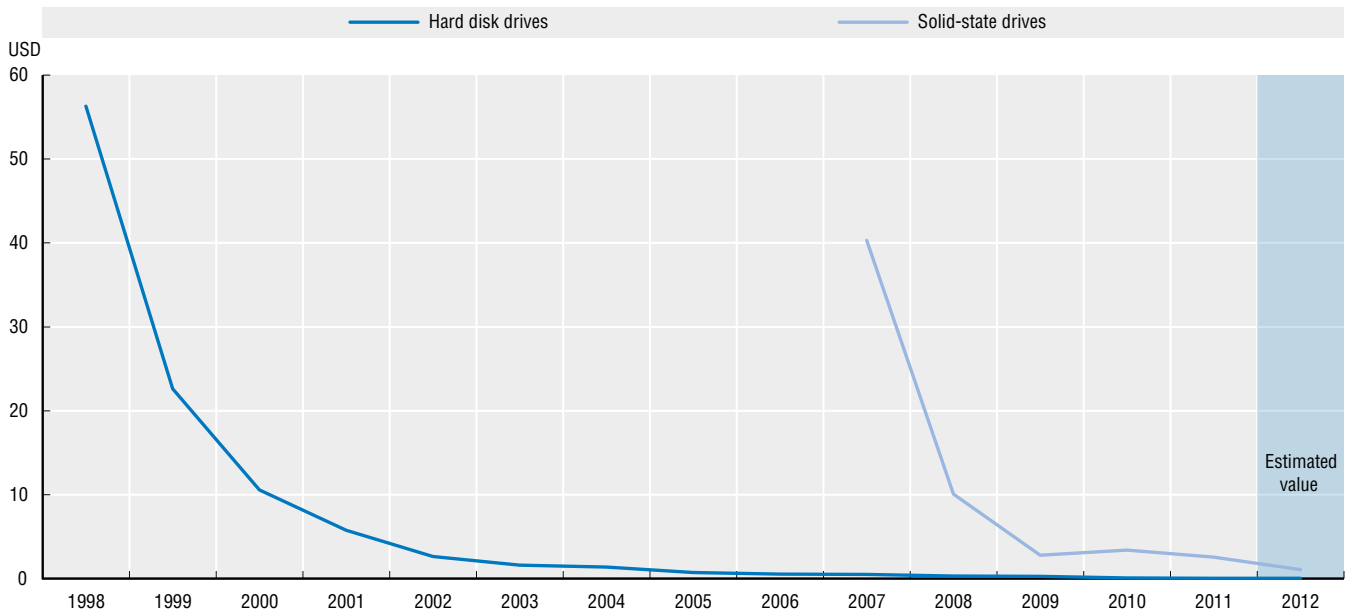
Source: OECD, based on Royal Pingdom blog, December 2011. See chapter notes.

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Figure 6. Data mining-related scientific articles, 1995-2014

Per thousand articles

Source: OECD computations based on on ScienceDirect repository, www.sciencedirect.com, July 2014.

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Information industries lead in innovation activities...

ICTs play a key role in today's innovation activities. While innovators tend to be more intensive users of ICTs, businesses in the *information economy* sector[14] are leading across all types of innovation activities, especially but not only those related to R&D. Indeed, the ICT sector is among the most R&D intensive and, combined with publishing, digital media and content industries, accounts for about one-quarter of total OECD business expenditure on research and development (BERD) (Figure 7).

Figure 7. R&D intensity and contribution to total BERD by industry in the OECD, 2011

R&D expenditure as a percentage of value added and of total BERD
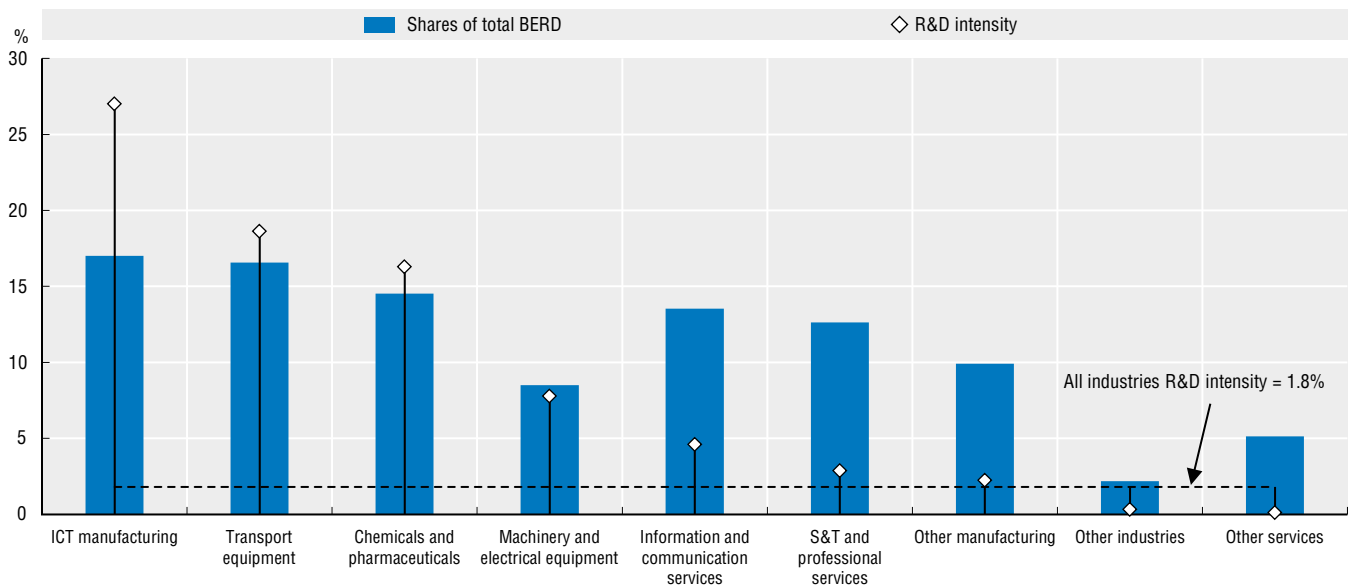
Source: OECD estimates based on OECD, ANBERD Database, www.oecd.org/sti/anberd, June 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933147838

... innovation practices and performance

Innovative businesses generally use innovative practices and foster creativity in the workplace through a variety of methods. Innovation surveys measure some of these practices, which include brainstorming, forming multidisciplinary or cross-functional teams, providing financial or other incentives to workers for developing new ideas, and encouraging job mobility within the organisation.

Innovators in information industries, both in manufacturing and information services, have a higher than average propensity to successfully adopt all of these practices (Figure 8).

Firm-level data on ICT usage and innovation reveal that enterprises introducing product, process or organisational innovations are more likely to adopt key ICT applications than non-innovators.[15] As ICT uptake becomes generalised, as in the case of broadband use and website presence, the difference between the two groups tends to disappear, while it remains sizeable for the practice of e-commerce and the use of Enterprise Resource Planning (ERP) software tools in business processes (Figure 9).

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14. The OECD in 2007 defined the information economy sector (see OECD, 2011) as the aggregate combining ICT and digital media and content industries. Here these are all referred as *information industries*. This aggregate includes ISIC Rev.4 Division 26 (Manufacture of computer, electronic and optical products) and Section J (Information and communication services), consisting of Divisions 58-60 (Publishing and broadcasting industries), 61 (Telecommunications) and 62-63 (Computer programming and information services). ICT trade and repair activities (in Groups 465 and 951) are also included, but are not considered here due to issues of data availability.

15. This evidence was gathered by the Eurostat project ESSLait (ESSnet on Linking of Microdata to Analyse ICT Impact), finalised in 2013 (see Eurostat, 2013). Fourteen countries participated in the project overall: Austria, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Slovenia, Sweden and the United Kingdom. In 2014, Australia and Canada will publish indicators comparable to those produced within this project. The evidence presented refers to all project countries pooled, except Germany, for which it was not possible to link ICT usage and innovation micro-data.

Figure 8. Methods to stimulate creativity across 22 European countries in information industries vs. other sectors, 2010

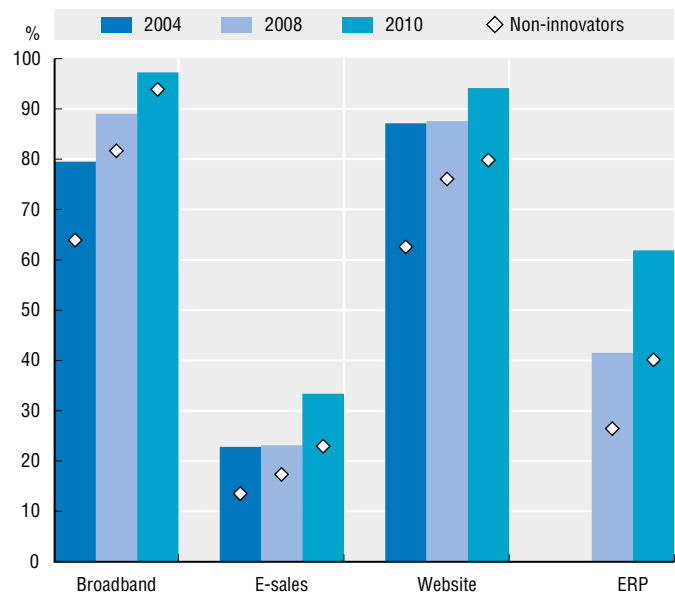*Percentage of innovators by method and industry*
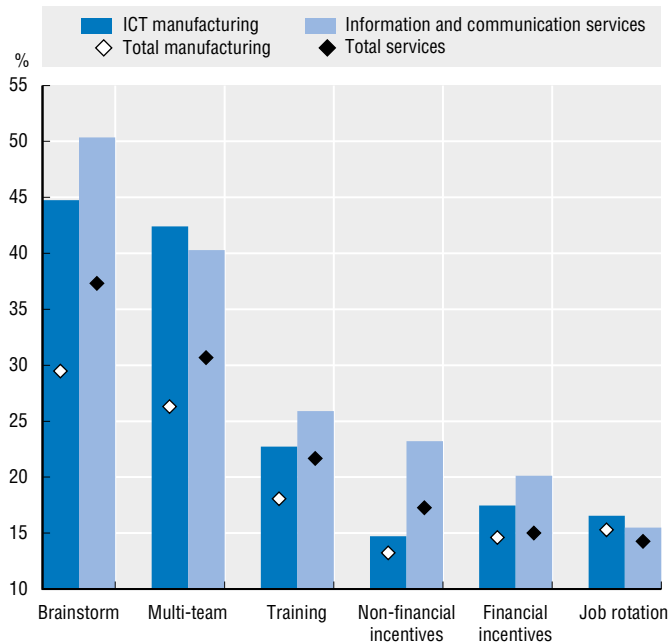
Figure 9. ICT uptake among process and organisational innovators and non-innovators in 13 European countries, 2004, 2008 and 2010

Percentage shares of adopters of selected technologies

Source: OECD computations based on Eurostat, Community Innovation Survey (2010), June 2014. See chapter notes.

StatLink ᔖ *http://dx.doi.org/10.1787/888933147849*

Source: OECD based on the EU ESSLAIT project Micro Moments Database, June 2014. See chapter notes.

StatLink ᔖ *http://dx.doi.org/10.1787/888933147857*

ICTs are driving the next wave of innovation

Today, patents in ICT-related technology classes account for about one-third of all applications to main patent offices. Keyword text searches on international patent filings to the World Intellectual Property Organization (WIPO), for example, provide insights into the relative importance and dynamics of inventive activity in emerging areas like data mining, 3D-printing and M2M communication (Figure 10).[16] All three of these technology areas, while still minor in patenting activity, show an upward trend in terms of weight in the total number of patents filed, particularly in the case of M2M.[17]

Many of the emergent technology groupings owe a debt to ICT-related technologies which are blending with other technologies to create innovations that are "in silico". In the OECD, about 25% of inventions attributed to an ICT-related technology class by patent examiners are also labelled under other (non-ICT) technology areas (OECD, 2013b).[18] Genome sequencing is a noticeable example of the application of ICTs to other fields. The deployment of second-generation sequencing techniques with embedded data-mining algorithms has resulted in a spectacular fall in cost in the three years to mid-2011, from USD 1 million to about USD 10 000 per human-like genome, and a further decrease to less than USD 5 000 in early 2014 (Figure 11).

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16. This technique represents a more effective tool than class analysis when applications cannot be clearly attributed to one or few classes only, and/or when these also encompass other types of applications. Text string searches were performed on the *abstract* and *claim* areas of the file, which are generally considered to be a good compromise between full description (too broad) and title (too narrow) searches. Multiple strings were used jointly for each item to address possible differences in wording (e.g. 3D printing, 3D print, 3D printer, etc.).

17. The spike observed for 2014 should be considered with caution, as it is based on partial information.

18. The acceleration in the development of patented technologies, or patent "burst", corresponds to periods (i.e. years) characterised by a persistent increase in the number of patents applied for in a certain technology field. The intensity of the burst reflects the pace at which the acceleration occurs. Technology bursts are identified at the 4-digit level of the International Patent Classification (IPC). Accelerations in co-developments are detected by looking at the application patterns and bursts of all possible pairs of 4-digit IPC classes contained in patent documents. Top patent bursts are selected by comparing the intensity of the accelerations observed. Technology areas are identified on the basis of content analysis of the IPC classes considered.

Figure 10. Patents on M2M, data analytics and 3D printing technologies, 2004-14

Per million PCT patent applications including selected text strings in abstracts or claims
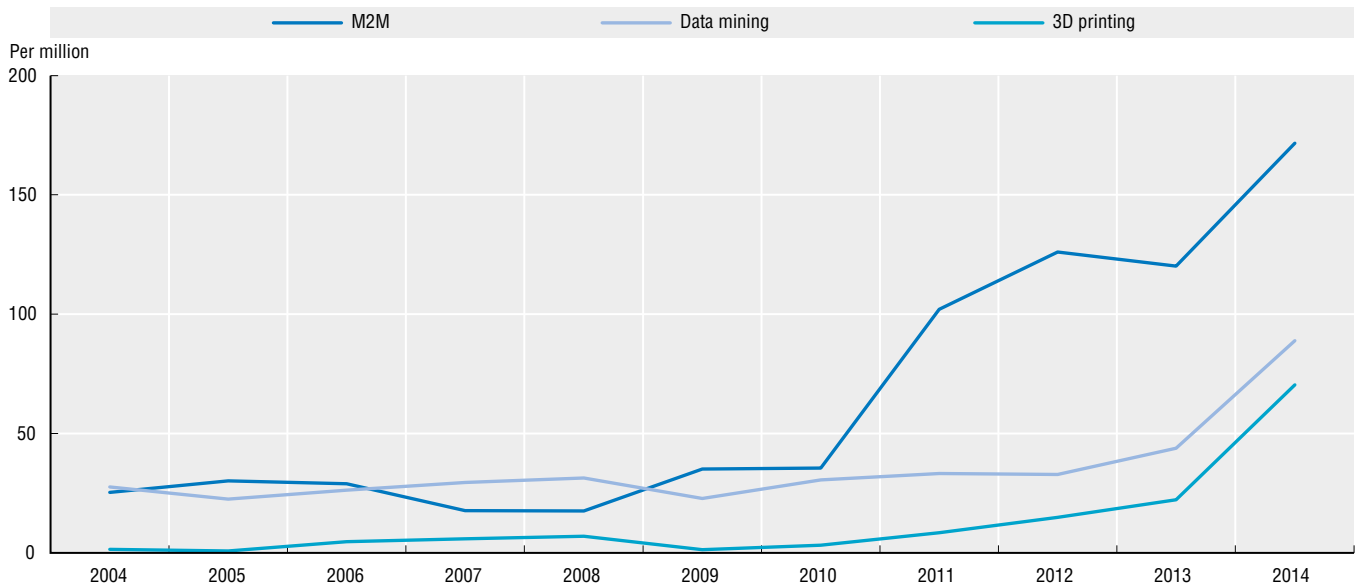
Source: OECD computations based on WIPO Patentscope Database, patentscope.wipo.int, May 2014. See chapter notes.

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Figure 11. Cost of genome sequencing, 2001-14

Cost per genome, logarithmic scale
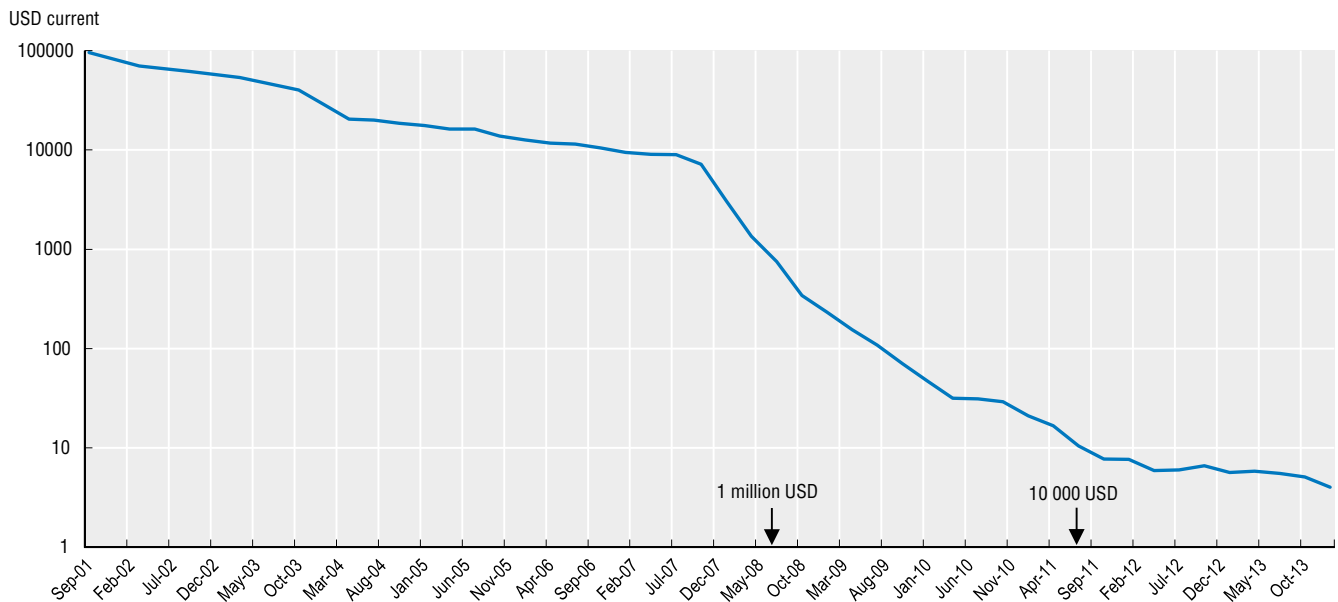
Source: OECD on NHGRI, Genome Sequencing Program (GSP), www.genome.gov/sequencingcosts, July 2014.

StatLink ᕵᑫᕵ *http://dx.doi.org/10.1787/888933147871*

**The weight of the Information economy sector and ICTs in the economy**

While the role of ICTs in science has become pervasive and demand for products from the information industries has increased significantly over the last decade, the aggregate weight of these activities declined slightly in the average of OECD economies, to little less of 6% of total value added and 3.7-3.8% of employment. This was accompanied by an important shift in the composition of the sector. IT services increased their share due to rising demand for applications and management of IT infrastructure, while ICT manufacturing and, to a lesser extent, Telecommunication services saw their importance diminish as production shifted to other (mostly non-OECD) economies, and unit prices fell as a result of productivity growth and increased competition (Figure 12). Indeed, information industries have maintained a lead in labour productivity (see 5.4). For all OECD countries for which data are available, this figure is higher than the productivity level for the total economy and in the majority is also higher than the OECD average total economy level (Figure 13).

These changes are also reflected in the dynamics of international trade. From 2000 to 2012, China's share in global ICT exports grew from 4.4% to over 30%, partly owing to the shifting of production offshore, amounting to a tenfold increase in USD terms. The OECD area in 2009 accounted for 55% of global ICT exports, or 63% when calculated in value added terms. This measure takes into account the share of imported intermediate inputs embodied in a country's exports and provides a new perspective on the international fragmentation of production.[19] By both measures the OECD area's relative share has declined in the last decade, by 18 and 17 percentage points, respectively (Figure 14).

Between 2000 and 2012 there was also a major shift in world trade and consumption patterns. The share of computers and peripherals in world exports fell from almost 38% to less than 30%, while the combined share of communication equipment and consumer electronics grew from 26% to almost 35%.

Figure 12. The relative size of information industries in the OECD, 2000 and 2012

Percentage points of total value added and employment, simple average
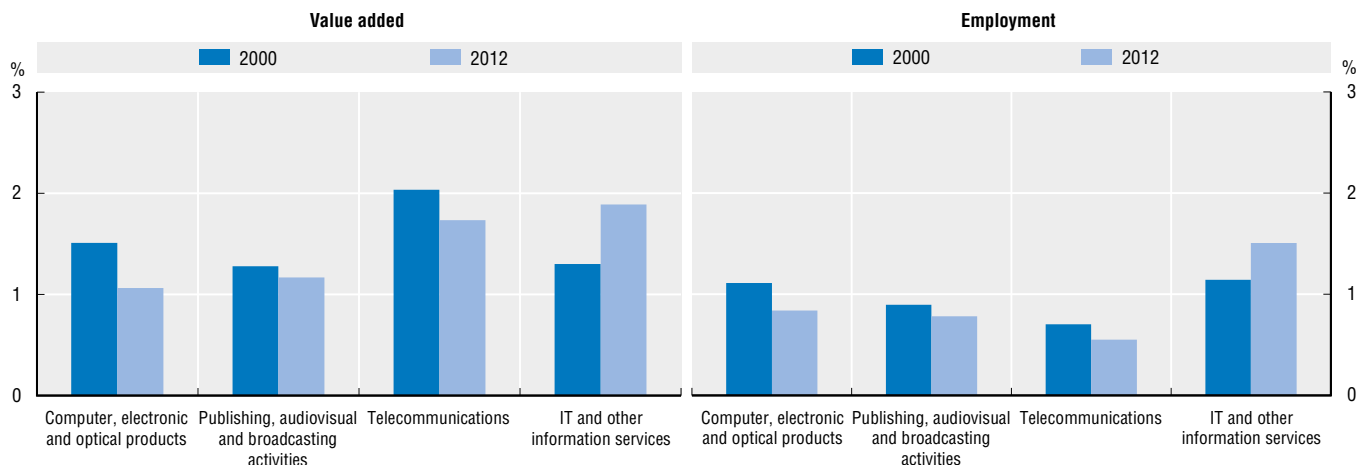
Source: OECD estimates based on OECD, STAN, ISIC Rev.4 Database, www.oecd.org/sti/stan and Eurostat, National Accounts Statistics, June 2014. See chapter notes.

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19. The international fragmentation of production has expanded rapidly in the last two decades and production processes in many economies have specialised in specific tasks and activities. To understand this development it is not enough to compare direct imports to measures of domestic production. A producer that imports components may also purchase components from domestic providers that, in turn, use intermediate imports in their production processes. Moreover, imports may contain elements produced in the domestic economy. The OECD-WTO Trade in Value Added (TiVA) Database, developed in response to demand from policy makers, offers new insights on international trade patterns and dynamics. For example, indicators of the foreign value added content of exports reveal the extent to which countries have become more dependent on imports from a greater number of countries in order to maintain or improve their export performance (see OECD, 2013b).

Figure 13. Apparent labour productivity levels, information industries vs. total economy, 2012

OECD total economy level = 100
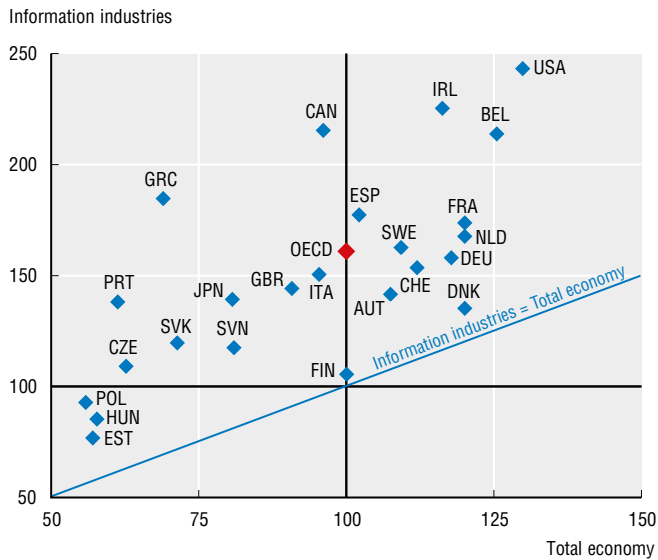
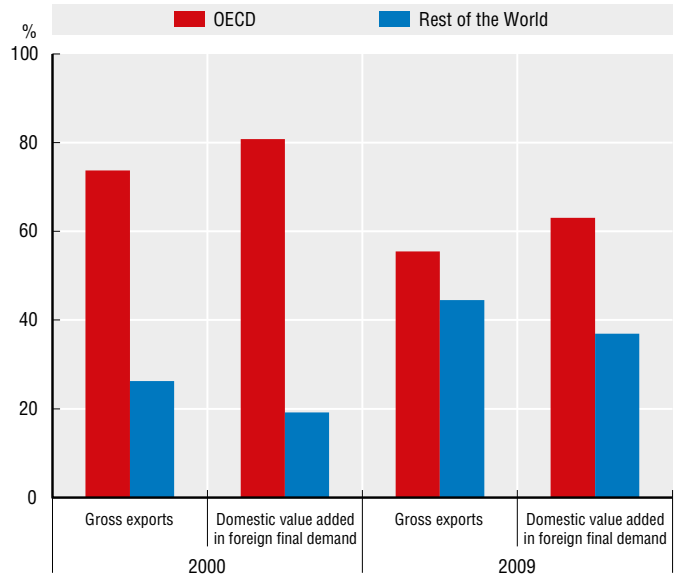Source: OECD estimates based on OECD, STAN, ISIC Rev.4 Database, www.oecd.org/sti/stan and Eurostat, National Accounts Statistics, May 2014. See chapter notes.

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Figure 14. OECD shares in global exports of ICT goods and in underlying value added, 2000 and 2009

Percentage shares of world totals

Source: OECD, Inter-Country Input-Output (ICIO) Database, May 2013.

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Top ICT players and new entrants

The recent crisis does not appear to have significantly affected the income or revenues of the major ICT players (the top 250 ICT firms monitored by the OECD).[20] However, on aggregate, companies belonging to this group have substantially reduced R&D expenditures compared to the beginning of the decade – perhaps due to the shift from manufacturing to services. When the "dot-com bubble" burst in 2000-01, these firms experienced negative incomes which did not return to 2000 levels until 2004. In contrast, during the last crisis income fell by 30% in 2008 only, but recovered immediately afterwards. Employment dynamics were more sluggish: after a fall in 2002-03, employment returned to its 2000 level in 2008 and continued to grow steadily thereafter. R&D spending, however, decreased only marginally in the aftermath of the dot-com bubble but never returned to pre-crisis growth rates. As a result, in 2013 R&D spending in current USD remained below the 2000 level (Figure 15).

The ICT sector is extremely vital in terms of enterprise creation with new enterprises exhibiting higher survival rates than their counterparts in manufacturing and services. Between 2009 and 2012, net business population growth in the ICT sector was about 4.5% on average as compared to 1% in the business economy overall (see 5.2).

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20. Enterprises in the "top 250" group mainly operate in activities such as manufacturing of telecom equipment and chipsets in hardware, pre-packaged software for office applications, search engines and social networks. For more information on the methodology used to compute the variables on top 250 ICT firms, see OECD (2012).

Promising start-ups attract funds from venture capitalists and in recent decades the largest share of this funding has gone to ICT industries. The dynamics of venture capital (VC) in the United States – leading by far in terms of the size of VC market and ICT industries' share in VC investment flows – provide an insight into the expansion and collapse of the dot-com bubble, and also highlight the shift towards funding for IT services companies (Figure 16).[21]

Figure 15. Performance trends of top 250 ICT firms, 2000-13

*Revenue, employment, R&D spending and net income*

Source: OECD computations based on annual reports, SEC filings and market financials, May 2014. See chapter notes.

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21. Although ICT businesses remain at the forefront in terms of capacity to attract VC, this considerably reduced in size and overall importance following the 2000 peak, when total VC investment reached over USD 100 billion and information industries (ICT and media) accounted for the large majority of total VC in major economic areas (European data ranging from almost 30% of the United States value in 2008 to about 15% in 2012). The recent crisis impacted only marginally on VC overall size. However, VC investment failed to recover fully during the last decade. ICT industries, in particular, have progressively lost ground, decreasing to half their former total to about USD 10 billion in 2009, recovering marginally in the years to 2012. In the meanwhile, an important shift towards IT services occurred (Figure 17).

Figure 16. **Venture capital investment in the United States, by industry, 1995-2012**

Percentage shares (left-hand scale) and total in USD billions (right-hand scale)
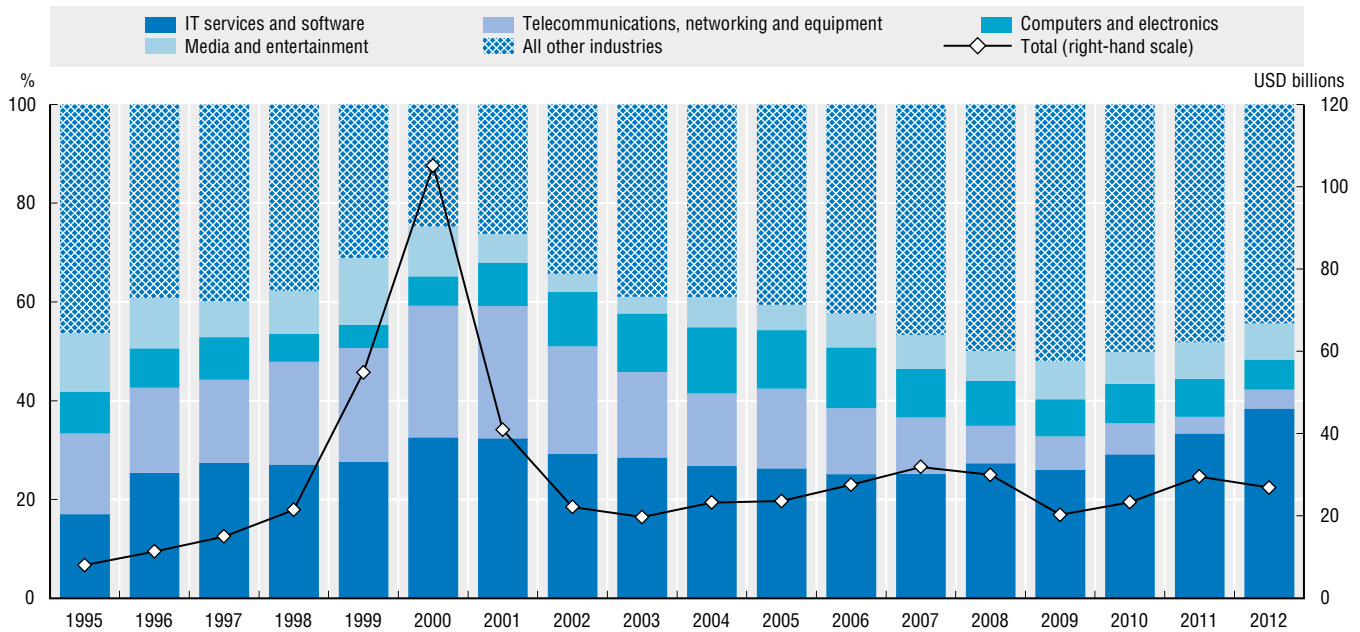
Source: OECD on PricewaterhouseCoopers/National Venture Capital Association MoneyTree™ Report based on Thomson Reuters data, July 2014.

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ICT employment...

Between 1995 and 2012, ICT sector employment in the OECD area increased by 10%, against about 8% for total employment, thus marginally increasing its share from 3.7% to 3.8% of total employment. This increase is the result of very wide fluctuations, with employment in ICT industries growing at higher rates than the whole economy during business cycle upturns, but also suffering more pronounced downswings. The fall in ICT employment during the 2008-09 crisis was less pronounced and shorter in duration than the drop following the dot-com bubble burst of 2001, while the subsequent recovery was steadier than for total employment. However, employment in the ICT-producing sector never regained the 2001 peak of 5.8% of total employment, and currently sits at just above 3.7% (Figure 17).

These employment trends reflect the downsizing of manufacturing and telecom services and the dynamism of IT services in more recent years (see 5.8). However, employment in ICT industries does not accurately reflect the importance of ICT-related employment in the economy, nor can it reflect the generalised diffusion of ICTs in the workplace and underlying skill needs.

Today, ICT-related occupations account for only about half of total employment in ICT industries. However, such jobs have now spread throughout the economy with the majority of ICT-related jobs now found outside the ICT sector. From 2003 to 2013, employment in ICT occupations grew 25% or more in Australia and Canada, about 15% in the United States, and between 16% and 30% for 25 European OECD countries,[22] performing better than total employment through the crisis (Figure 18). On the other hand, several studies highlight the potentially disruptive effects of ICTs on employment across most occupations throughout the economy, given progresses in machine learning.

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22. In these countries, namely Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom, a major break in series occurred in 2011, due to the adoption of the new ISCO-08 classification. The lowest rate resulted from the break in the series, and likely represents an underestimation. The highest rate corresponds to the transposition of the old series dynamics on the values of the new series, assuming that no changes occurred between 2010 and 2011.

Figure 17. The dynamics of ICT sector employment in the OECD, 1995-2012

Annual growth rate (left-hand scale) and percentage share on total employment (right-hand scale)
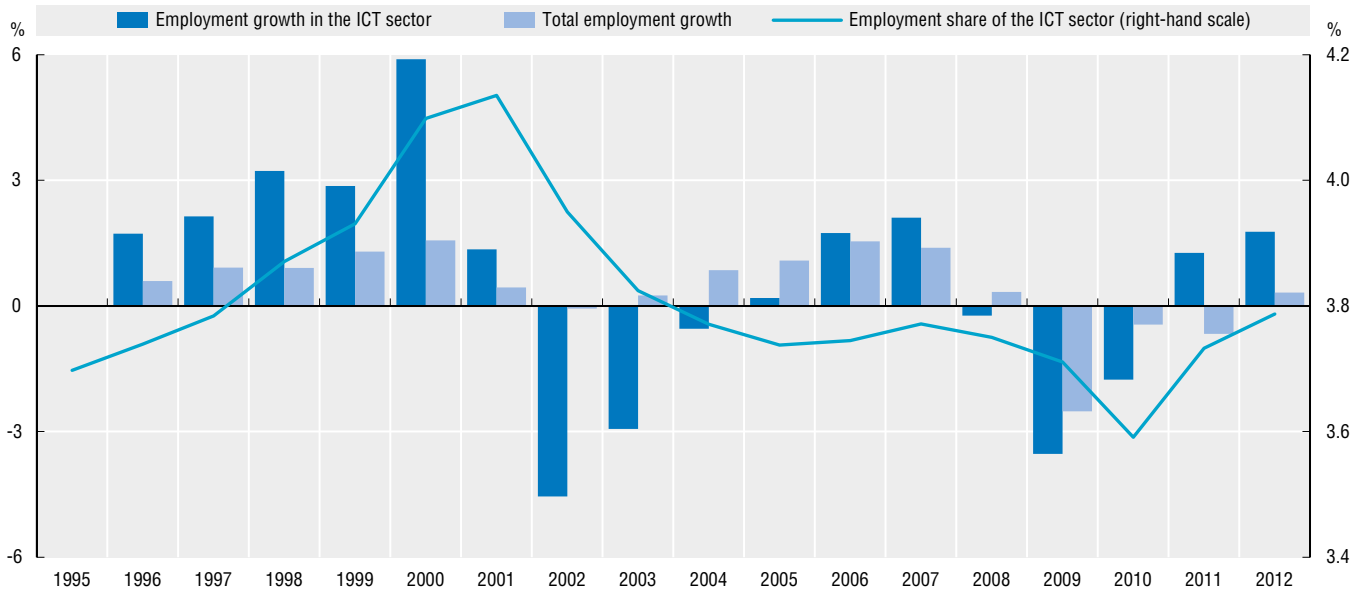
Source: OECD estimates based on OECD, STAN, ISIC Rev.4 Database, www.oecd.org/sti/stan and Eurostat National Accounts Statistics, July 2014. See chapter notes.

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Figure 18. The dynamics of ICT-related occupations in OECD countries, 2003-13

Index numbers (left-hand panel) and percentage shares in total employment (right-hand panel)
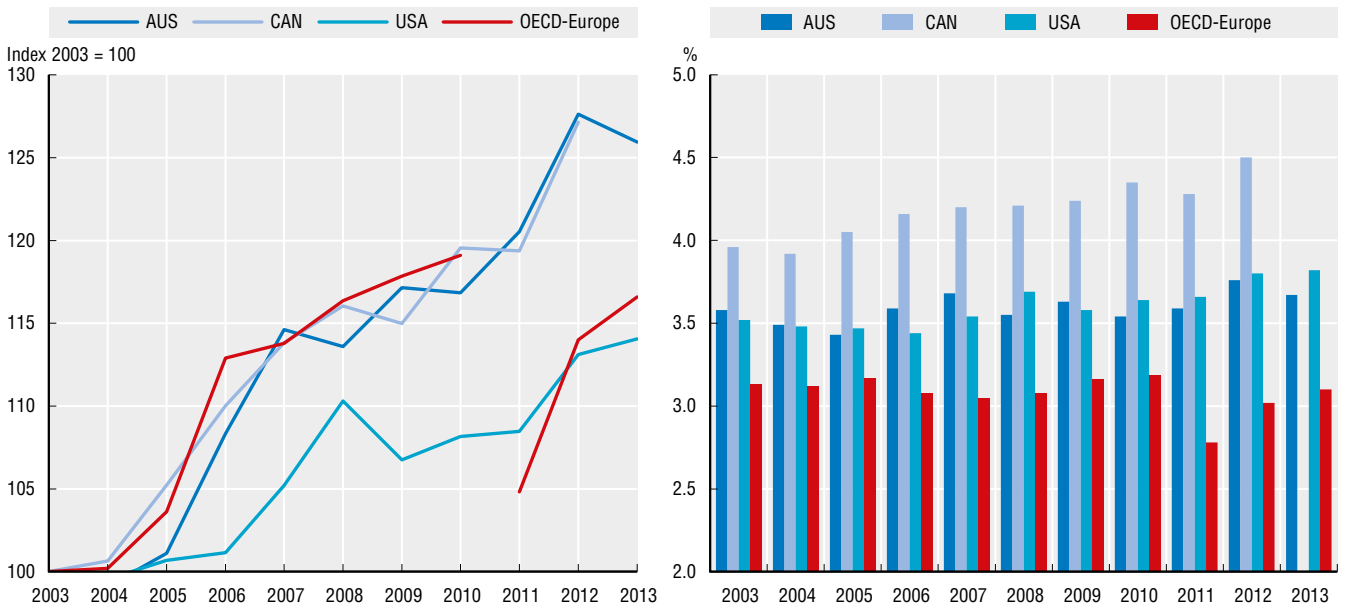

Source: OECD computations based on Australian, Canadian and European labour force surveys and United States Current Population Survey, June 2014. See chapter notes.

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... and the spread of ICT skills across professions

The new OECD PIAAC survey results for 21 countries reveal that about 45% of workers require a moderate to complex (advanced user to programming) level of ICT interaction for their work (Figure 19), with country-level values ranging from almost 60% of workers in Sweden to about 30% in Poland. Conversely, on average only 30% of workers did not use computers on the job. These shares range from 17% in Norway to 50% in Italy.

Figure 19. Computer use at work in OECD countries, by level of sophistication, 2012

Percentage shares of all workers
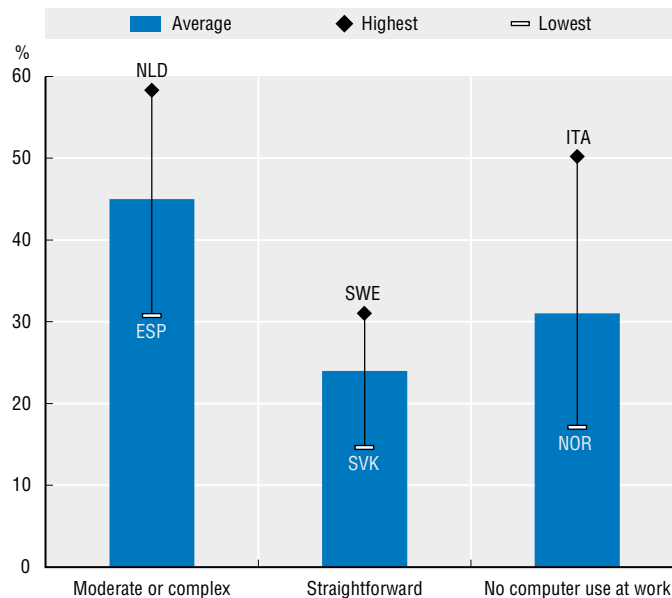
Source: OECD, PIAAC Database, July 2014.

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Skills gaps and opportunities for training

While the use of ICTs at work is now generalised, more than 60% of adults in the EU countries assessed their ICT skills as being below the level required to find or change a job. Across all countries, this gap is inversely related to the educational attainment of individuals, with an average rate below 40% for those with a tertiary education, and over 80% for low-educated respondents (see 3.7). However, the Internet has opened up new opportunities for education and training in all fields, including ICTs. In 2012-13, across 30 OECD countries, on average about 9.5% of individuals reported having followed an online course in the previous quarter (see 3.6). This educational channel is now reaching maturity with hundreds of universities proposing online programmes, and massive open online courses (MOOCs) flourishing within and outside established educational institutions, in many cases making (often high-quality) training and education freely accessible worldwide.

The spread of E-commerce

ICT skills are also vital for individuals to participate in and benefit from e-commerce transactions. Between 2007 and 2013, online purchases by individuals increased from about 31% to almost 50% of the adult OECD population, although for some countries this figure stands at 10% (Figure 20); recently individual purchases via mobile phones also started being recorded in many countries (see 3.8). Progress for enterprises has been less striking: in 2012, only 21% of OECD enterprises with ten or more persons were engaged in e-sales, representing a slight increase of about 5 percentage points since 2008, as a result of lower e-commerce propensity rates for smaller businesses in most countries (see 5.6).

Developments in e-commerce and m-commerce bring gains in consumer welfare and business opportunities, but also pose new challenges. In particular, intermediary (brokering) service platforms provide customers with easy access to a wide variety of sellers via and SMEs with an opportunity to increase their market reach. Conversely, such brokers might restrain choice for consumers, while these developments challenge operators in traditional distribution channels. In some cases, traditional businesses may be displaced by online services (e.g. bookshops) or find their margins eroded by these intermediaries (e.g. hotels), whose commissions benefit from the oligopolistic nature of the information-search market.

Statistical information on consumer and operator behaviour and on the impacts of online markets is still scarce, and requires improvement in geographic coverage and representativeness to assess the costs and benefits in this area.

Figure 20. Participation in e-commerce by individuals and enterprises, 2007-08 and 2012-13

Individuals who ordered goods or services online, by age (left-hand panel) and enterprises engaged in sales via e-commerce, by employment size (right-hand panel), averages
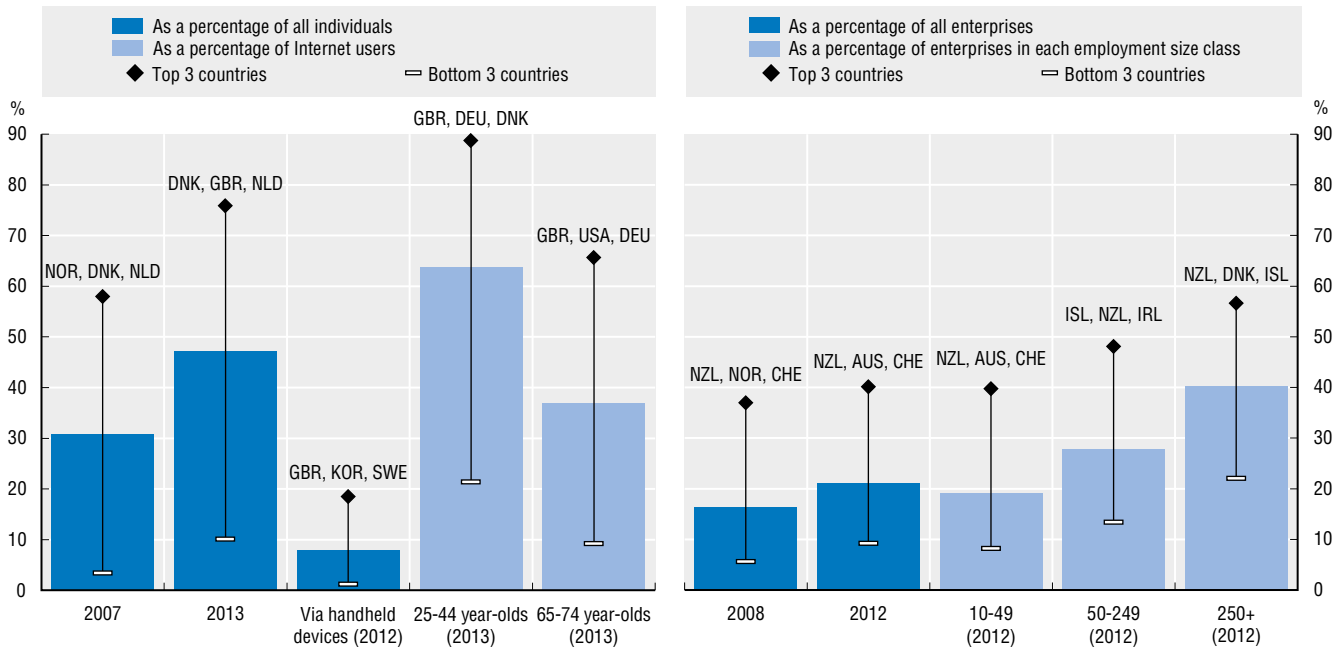
Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, July 2014. See chapter notes.

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But security, privacy and consumer protection also need to be improved

Online transactions by final consumers (especially cross-border transactions) and e-payments or mobile payments pose a number of issues for consumer protection. The latest cybercrime report by Symantec put the overall cost for consumers at more than USD 110 billion in 2013 (out of which almost one-quarter stems from the cost of repairs) and set the total number of victims at almost 400 million.[23]

These estimates do not include business and ought to be considered with caution, as public sources on complaints result in much smaller figures.[24] The most recent, albeit outdated, data available on the use of ICT security facilities by businesses show that awareness is generalised, but that the implementation of facilities depends strongly on the size of operations (see 2.8).

While security issues are high on the policy agenda, the production of reliable statistics will require further work of data collection and harmonisation, making it a key topic for the measurement agenda.

23. The *Norton Report* (go.symantec.com/norton-report-2013) is based on data collected in 24 countries: Australia, Brazil, Canada, China, Colombia, Denmark, France, Germany, India, Italy, Japan, Mexico, the Netherlands, New Zealand, Poland, the Russian Federation, Saudi Arabia, Singapore, South Africa, Sweden, Turkey, the United Arab Emirates, the United Kingdom and the United States. The costs include money lost due to credit card theft as well as estimates on expenses for restoring of devices and information loss.

24. In the United States, 33% of the 2.1 million complaints filed at the Federal Trade Commission in 2013 (up 43% from 2010) stemmed from an initial email contact, and 15% from visiting websites (Federal Trade Commission, 2014). More specifically, in 2013 the Internet Crime Complaint Center (IC3) recorded less than 300 hundred thousand complaints (slightly down from previous years), corresponding to certified losses of over USD 100 000, totalling almost USD 800 million, and representing a 26% growth over the previous year. Note that IC3 receives a small number of complaints also from countries other than the United States.

Notes

Israel

"The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities or third party. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

"It should be noted that statistical data on Israeli patents and trademarks are supplied by the patent and trademark offices of the relevant countries."

Figure 1. Internet usage trends in the OECD and differences by country (top panel) and by age groups (bottom panel), 2005-13

Data exclude Chile and Israel.

For 16-24 and 65-74 year-olds, data exclude Japan and the United States.

For country-specific notes, see 3.1 in Chapter 3.

Figure 2. Trends in broadband speed across the OECD, Q4 2009-13

Akamai measures the broadband speed through the amount of time required to download various files from their servers, averaging all technologies and locations.

Figure 4. The progress of smartphones, 2010-13

Data are extracted from www.fiercewireless.com/europe/special-reports/analyzing-worlds-14-biggest-handset-makers-q2-2013.

Figure 5. Average data storage cost for consumers, 1998-2012

Data for 1998-2011 are based on average prices of consumer-oriented drives (171 HDDs and 101 SSDs) from M. Komorowski (www.mkomo.com/cost-per-gigabyte), AnandTech (www.anandtech.com/tag/storage) and Tom's Hardware (www.tomshardware.com). The price estimate for SSD in 2012 is based on DeCarlo (2011) referring to Gartner.

Figure 7. R&D intensity and contribution to total BERD by industry in the OECD, 2011

The OECD has recently undertaken an analysis to establish a new classification of economic activities on the basis of R&D intensity.

Data refer to Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Japan, Korea, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, the United Kingdom and the United States.

"Other industries" include Agriculture, ISIC Rev.4 Divisions 01-03 (A); Mining, 05-09 (B); Utilities, 35-39 (D and E) and Construction, 41-43 (F).

Figure 8. Methods to stimulate creativity across 22 European countries in information industries vs. other sectors, 2010

Data refer to Belgium, Bulgaria, Croatia, the Czech Republic, Estonia, Finland, France, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Norway, Poland, Romania, Serbia, the Slovak Republic, Slovenia, Sweden and Turkey.

For Estonia, Finland and Luxembourg, Information and communication services aggregates are OECD estimates based on ISIC Rev.4 Section J, excluding J59-60. For Ireland, this aggregate includes Information services only (and excludes Publishing and Telecommunications) and for Turkey it includes telecommunication services only.

Variables cover brainstorming sessions, multidisciplinary or cross-functional work teams, training of employees on how to develop new ideas or creativity, financial and non-financial incentives for employees to develop new ideas, and job rotation of staff. All the above cases refer to "successful methods to stimulate creativity".

Figure 9. ICT uptake among process and organisational innovators and non-innovators in 13 European countries, 2004, 2008 and 2010

The figure shows simple averages for all reporting countries across reference years in which the Community Innovation Survey (CIS) and the Community Survey on ICT Usage in Enterprises were performed.

Data refer to Austria, Denmark, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Slovenia, Sweden and the United Kingdom.

Cell values for each variable are reweighted to represent the business structure by employment size in each country.

Data for ERP in 2010 are limited to Finland, France and Luxembourg.

Figure 10. Patents on M2M, data analytics and 3D printing technologies, 2004-14

Patent abstracts and/or claims were searched for the following:

M2M: "machine to machine" or "M2M";

Data mining: "data mining" or "big data" or "data analytics";

3D printing: "3D printer" or "3D printing".

For 2014, coverage is limited to the available data as of 31 May.

Figure 12. The relative size of information industries in the OECD, 2000 and 2012

Data refer to 2008 for Japan, to 2009 for Canada, to 2010 for Switzerland, and to 2011 for Germany, Greece, Luxembourg, Poland, Portugal, Sweden, the United Kingdom and the United States.

Figure 13. Apparent labour productivity levels, information industries vs. total economy, 2012

Data refer to 2008 for Japan, to 2009 for Canada, to 2010 for Switzerland, and to 2011 for Germany, Greece, Luxembourg, Poland, Portugal, Sweden, the United Kingdom and the United States.

Apparent labour productivity is defined as value added per person employed.

Figure 15. Performance trends of top 250 ICT firms, 2000-13

Indicators are based on averages for those firms reporting in 2000-13. Values for 2013 are estimated based on interim reports where annual reports were not available.

Figure 17. The dynamics of ICT sector employment in the OECD, 1995-2012

The figure includes data for Australia, Austria, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom and the United States with partial coverage for some countries (e.g. Canada, 1998 to 2010).

Figure 18. The dynamics of ICT-related occupations in OECD countries, 2003-13

The OECD-Europe aggregate includes Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

There is a break in series between the data points of the OECD-Europe aggregate for 2010 and 2011.

2013 data are provisional estimates based on the 1st semester or 9 months.

Figure 20. Participation in e-commerce by individuals and enterprises, 2007-08 and 2012-13

All indicators are computed on the basis of countries with available data for the specific year or the subpopulation considered. To increase the coverage, in some cases, data for contiguous years or for similar age (individuals) and size (enterprises) brackets were also used.

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Chapter 2
INVESTING IN SMART INFRASTRUCTURE

Chapter 2
INVESTING IN SMART INFRASTRUCTURE

Key findings

Broadband communication networks and the services provided over them support existing economic and social activities and hold potential for tremendous innovation.

Broadband diffusion remains uneven across OECD economies but continues to increase everywhere. Progress has been particularly swift in mobile (terrestrial wireless) broadband. Since the end of 2009 the rate of mobile wireless broadband penetration has more than doubled for the OECD area, reaching 72% in December 2013.

Penetration rates reached over 100% in Australia, Denmark, Finland, Japan, Korea and Sweden and the United States. Australia edged into the second place after a 13% surge in smartphone subscriptions in the first half of 2013. Mobile wireless broadband penetration stood at 32% or less in Hungary, Mexico and Turkey, but progress to date and the universal diffusion of standard mobile subscriptions indicate strong potential for catch-up by lagging economies.

Fixed (wired) broadband subscriptions in the OECD area reached 339 million as of December 2013, giving an average penetration rate of 27%, up from 23% at the end of 2009.

Take-up for fixed broadband has increased at a slower pace than for mobile, and in some countries this latter has been substituting fixed broadband rather than complementing it. The general trend, however, indicates significant improvement in available technologies.

Deploying fibre closer to the home has been an on-going process in all OECD countries for many years. More recently, network operators have started to evaluate whether to bring fibre directly to a premise or to a nearby point and use existing or upgraded DSL and cable infrastructure. The majority of fixed wired broadband connections are currently provided over DSL (51%) and cable modem (31%) technologies. In December 2013, the share of direct fibre connections in the OECD area was 17%, up from 11% in December 2009.

Two-digit growth in fibre over the December 2012-13 period was sustained by increases in large OECD economies with low penetration levels, such as France (73%), Spain (84%), Turkey (85%) and the United Kingdom (116%). Japan and Korea remain the OECD leaders, with fibre making up 70% and 65% of fixed broadband connections.

> **DID YOU KNOW?**
> In December 2013, almost 3 out of 4 OECD inhabitants had a mobile wireless broadband subscription.

Definitions

Broadband penetration indicators comprise the number of subscriptions to fixed wired and mobile wireless broadband services, divided by the number of residents in each country.

Fixed (wired) broadband includes DSL, cable, fibre to the home (FTTH) and other fixed wired technologies.

Mobile wireless broadband includes satellite, terrestrial fixed wireless and terrestrial mobile wireless (standard mobile and dedicated data).

All components include only connections with advertised data speeds of 256kbit/s or more.

A standard mobile subscription is counted as an active broadband subscription only when it allows for full access to the Internet via HTTP (subscriptions that only offer walled gardens or email access are not counted) and when content or services were accessed using the Internet Protocol (IP) during the previous three months.

All active mobile subscriptions are counted. Hence, penetration rates can be over 100%. For fixed subscriptions saturation is reached at much lower rates, as these typically consist of one per household.

Measurability

Fixed (wired) and mobile wireless broadband subscriptions for OECD countries are collected according to agreed definitions and are highly comparable.

Data for wireless broadband subscriptions improved greatly in recent years, especially with regard to measurement of standard mobile and dedicated mobile data subscriptions.

In the case of standard mobile subscriptions, these need to be active during the last three months before the date of measurement, which can pose difficulties. Data respecting these standards are now available for most OECD countries.

Mobile wireless broadband penetration, by technology, December 2009 and 2013
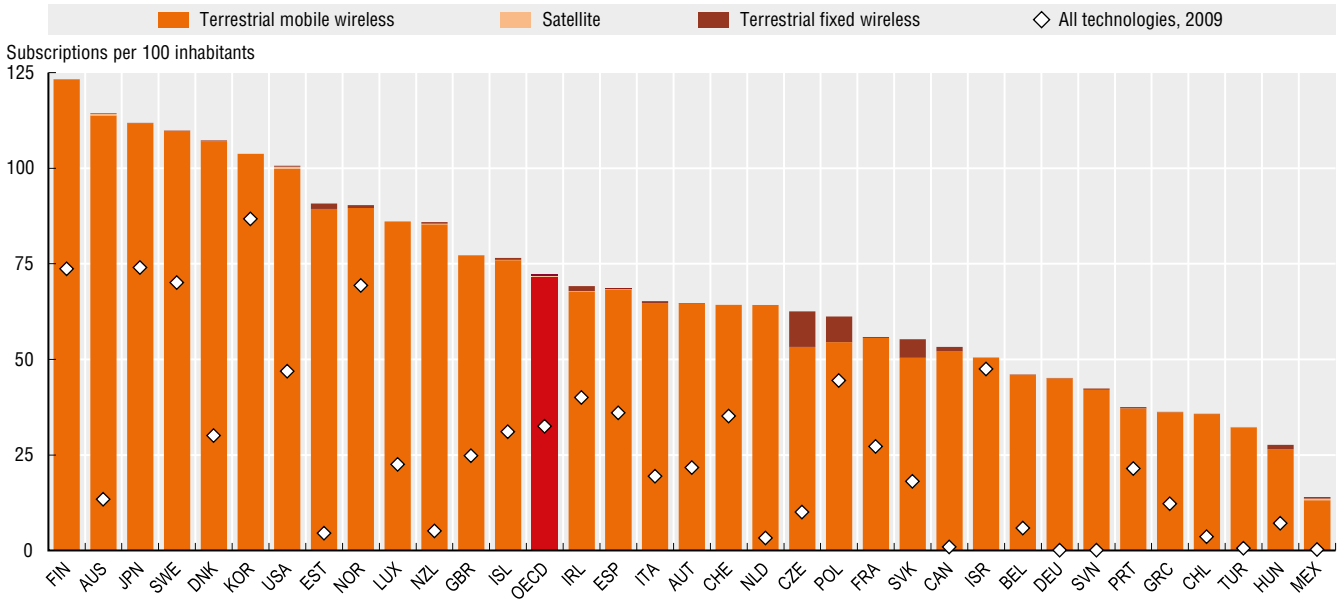
Subscriptions per 100 inhabitants

Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm, July 2014.

StatLink ⌐📊 http://dx.doi.org/10.1787/888933147973

Fixed (wired) broadband penetration by technology, December 2013

Subscriptions per 100 inhabitants

Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm, July 2014.

StatLink ⌐📊 http://dx.doi.org/10.1787/888933147981
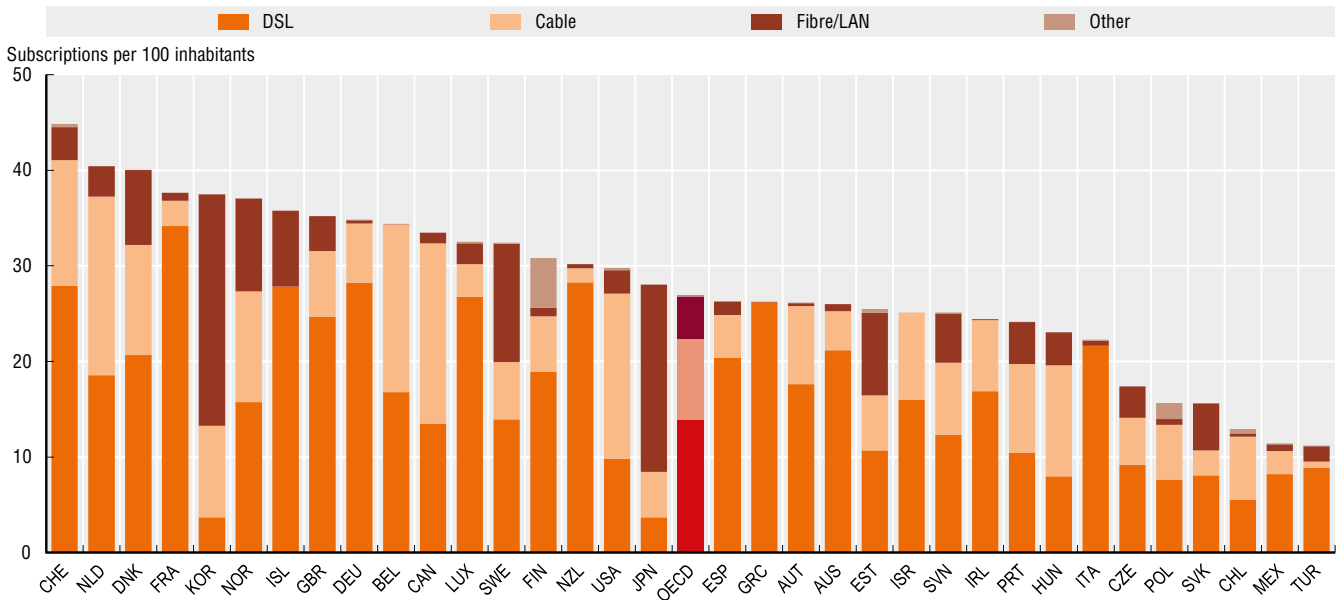
Key findings

The popularity of smartphones has stimulated greater use of mobile Internet. The average subscription rate of mobile Internet access in OECD countries rose to 72.4 per 100 inhabitants in December 2013, up from just 32.4 in December 2009.

Mobile broadband subscriptions represent 73% (910 million) of all broadband access paths in the OECD. Broadband mobile penetration was highest in Australia, Finland and Japan and lowest in Hungary, Mexico and Turkey.

In calculating the number of mobile connections it is important to factor in users that have more than one subscription. Some people use multiple SIM cards to take advantage of different tariffs or for different uses, for example, a mobile handset with a separate dedicated mobile data connection, such as a mobile broadband dongle, data card or data-only SIM.

While a large majority of mobile broadband subscriptions in the OECD include a voice connection, an increasing number are now dedicated data connections with subscribers using a mobile device primarily to access the Internet (although telephony is still possible via a VoIP application). In December 2013, about 128 million mobile subscriptions were dedicated data, almost double that of December 2009.

SIM cards for machine-to-machine (M2M) usage account for a growing segment of mobile data subscriptions. These are dedicated exclusively to communication between equipment at a distance and are not intended for interpersonal communications. Some of the functionality of M2M communications is built into navigation services for automobiles, access to the Internet and emergency communications, among others. These devices connect millions of sensors and actuators, providing ever-greater amounts of "big data" to facilitate the monitoring of machines, environments and people's health.

Some telecommunication operators now have specific offers for M2M data services, which are used for e-book readers, vehicles and smart meters. OECD countries are examining or have started to liberalise access to SIM cards for M2M applications independent of mobile operators. This allows users to switch mobile operators or use multiple networks at the same time. The Netherlands is the first country to change regulation in this area. In 2012, there were 35.8 million M2M SIM cards in the 18 OECD countries for which data are available. Sweden is an outlier for M2M penetration with 511 M2M SIM cards per 1000 inhabitants. Finland, Denmark, Italy and France follow with over 100 M2M SIM cards per 1000 inhabitants.

Definitions

Mobile broadband connections are used together with a voice connection (standard subscriptions) or are dedicated to mobile broadband services exclusively (dedicated subscriptions).

Subscriptions to dedicated data services over a mobile network are purchased separately from voice services, either as a stand-alone service (modem/dongle) or as an add-on data package to voice services, which requires an additional subscription. All dedicated mobile data subscriptions with recurring subscription fees are included as "active data subscriptions", regardless of actual use. Prepaid mobile broadband plans require active use if there is no monthly subscription.

A segment of *M2M communication* relies on mobile wireless networks and, as with mobile telephony, is based on the use of SIM cards for authentication and telephone numbers for connectivity. SIM card numbers and telephone numbers are obtained from regulators who, as of recently, require that mobile operators use different telephone number ranges for M2M.

Measurability

International comparability of mobile communications statistics is limited by the fact that not all countries are able to comply with the same definitions. For example, the number of standard mobile subscriptions should include only subscriptions in use over the previous three months; however, not all countries are able to provide this information.

In addition, coverage of dedicated data mobile statistics tends to vary across countries, which may contribute to explaining the very high penetration rates found in some of them. A few countries do not report separate statistics for standard and dedicated mobile subscriptions.

Finally, there is not yet an official methodology to define the limits of M2M SIM cards. National telecom regulators in some OECD countries have begun to release M2M SIM cards figures along with mobile and wireless broadband subscriptions. However, M2M use may still be mixed in with other subscriptions. Therefore, the indicators presented here are still at an initial stage.
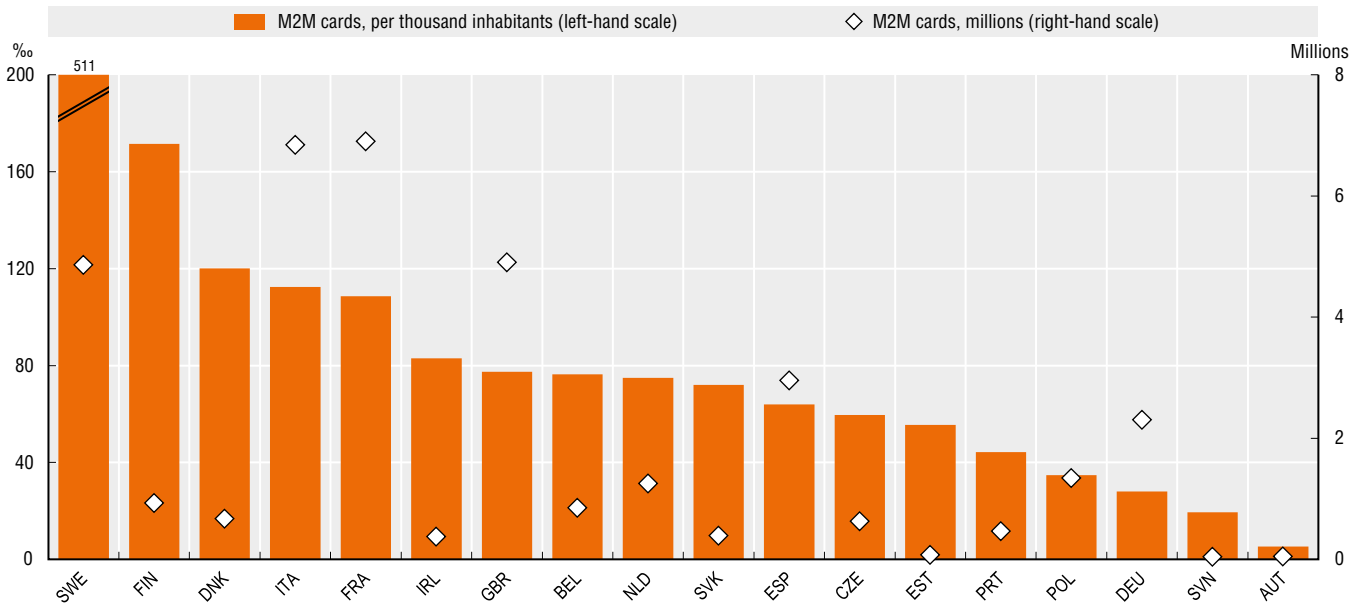
Mobile data subscriptions, by type, December 2013
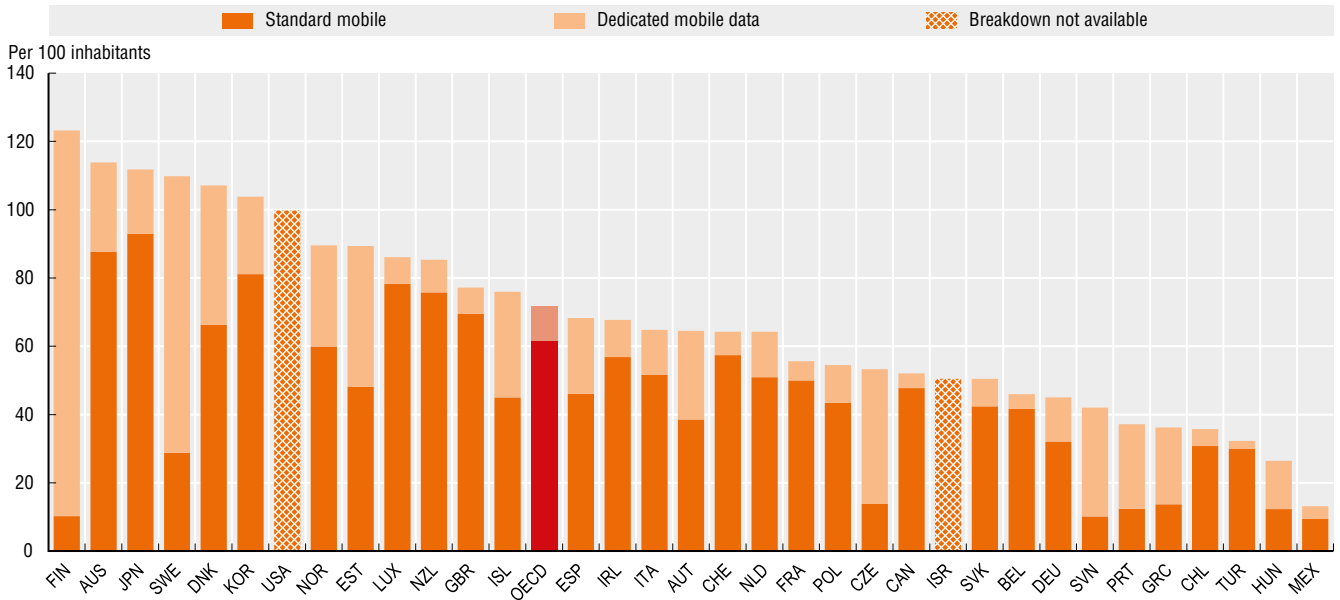
Note: The figure refers to the sum of standard and dedicated data mobile subscriptions.
Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm, July 2014.

StatLink ⟲ http://dx.doi.org/10.1787/888933147993

The penetration of M2M SIM cards, 2012

Source: OECD computations based on data from communications regulatory bodies and ministries, May 2014. See chapter notes.

StatLink ⟲ http://dx.doi.org/10.1787/888933148000

Key findings

In May 2014, registered domains reached 241 million, up from 233 million in mid-2012. This increase represented a marked slowdown in comparison with earlier years, reflecting possible saturation of the domain name market. About 150 million domains are registered under generic top-level domains (gTLD) (i.e. "com", "org", "net", etc.), with .com (commercial) accounting for three-quarters of registrations. The recent availability of new addresses (e.g. ".hotel") might provide new impetus to gTLD registration. Registrations under OECD-related country code top-level domains (ccTLDs) stood at almost 65 million at the end of the first quarter of 2014.

Statistics on domain name registration offer a partial but valuable perspective on the development of the World Wide Web. These indicators can inform discussions in areas such as domain name pricing policies, and help to ensure transparency in registration management for service providers, business users and consumers.

Cross-country differences are wide and reflect diversity in the presence of websites combined with country specificities in terms of ease and cost of registration and maintenance. Denmark, the Netherlands and Switzerland have 200 or more ccTLDs registered per 1 000 inhabitants, while other OECD countries have 50 per 1 000 users or less. This latter group includes countries where use of ccTLDs is historically lower, for example, Korea, where users rely on second-level domains, and the United States, where some gTLDs are "domestic" (e.g.: .gov for government, or .edu for educational institutions) and gTLDs have consistently been used more widely than the .us domain. For other countries in this range, such as Mexico and Turkey, the rate generally reflects lower Internet penetration.

The number of Internet hosts has historically provided a complementary perspective on the size of the Internet and its growth. However, this indicator is gradually losing ground, as the one-to-one relationship between a host and an IP address is blurred, not least due to the depletion of IPv4 addresses. As of January 2014, hosts worldwide reached 1.01 billion, up 6% annually from 888 million in 2012, but representing a slowdown from 10% in the previous biennium and a 26% compound annual growth rate from 2000 to 2010.

The number of routed autonomous systems (AS) that a country has may be a proxy for the amount of competition in a market. It indicates the ease with which a company may take control over routing its traffic and exchange with other networks. Most countries saw an increase in the number of AS per capita between 2010 and 2012.

Definitions

The Domain Name System (DNS) translates user-friendly host names (e.g. www.oecd.org) into IP addresses. The hierarchical syntax of a domain name is supported by the "dot" in the name and is read by the DNS server from right to left (.org is the top level domain and .oecd is the sub-domain of this TLD.) *Generic top level domains* (gTLDs) include ".com" or ".org", *country code-top level domains* (ccTLDs) consist of two-letter codes generally reserved for a country or a dependent territory (e.g. ".au" for Australia). Registry operators, known as Network Information Centres (NICs), distribute two-letter codes.

An *Internet host* is a machine or application connected to the Internet and uniquely identified with an IP address.

An *autonomous system* (AS) can be defined by the aggregate of IP blocks for which the network is responsible. Such networks are termed autonomous because they can determine the routing of their traffic independently from any other network. Every AS is assigned a unique number (ASN) by a regional Internet registry (RIR).

Measurability

The measure of domain names works by asking the network a question such as "where is OECD.org located?" The DNS answers using resolvers that query the data stored in a hierarchical and widely distributed sets of machines known as DNS servers that are essential for the smooth functioning of the Internet. The number of Internet hosts is measured by the Internet Systems Consortium (ISC) survey, which queries the domain system for the name assigned to every possible IP address. Hosts used to proxy for IP addresses; the one-to-one relationship between a host and an IP address is now being blurred by the use of Network address translation (NAT), which allows many computers to share a single IP address, to mitigate the depletion of IP(v4) addresses.

Autonomous systems vary significantly and differ considerably in size. The majority of measurement forms available calculate the extent of the Internet the network can reach directly. Another approach examines the number of IP addresses behind an AS. These data only show information from routing tables, not on number of customers, revenues or geographic size.

Country code top-level domain registration (ccTLD) density 2014 Q1 and growth (2013 Q1-2014 Q1)
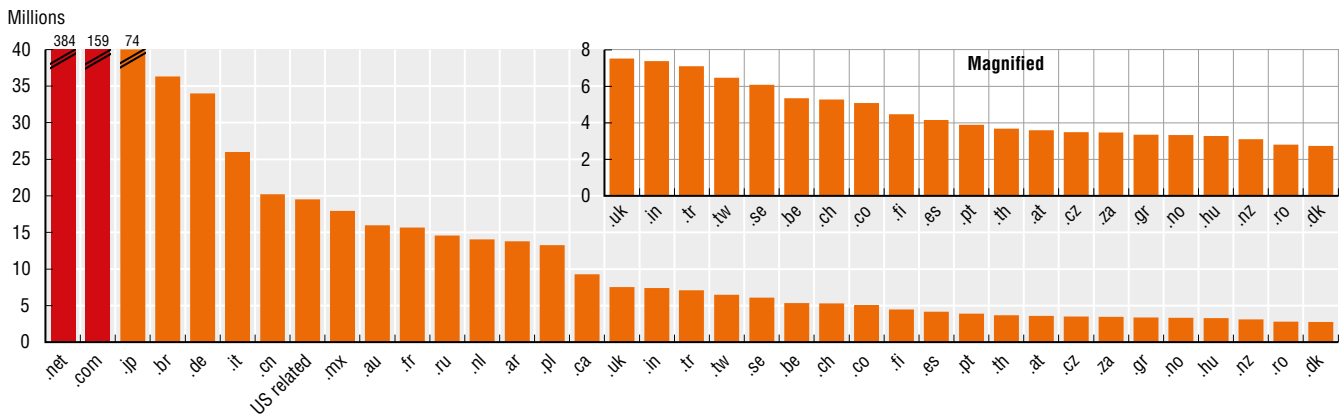
Per thousand inhabitants and Internet users, annual growth rate (right-hand scale)
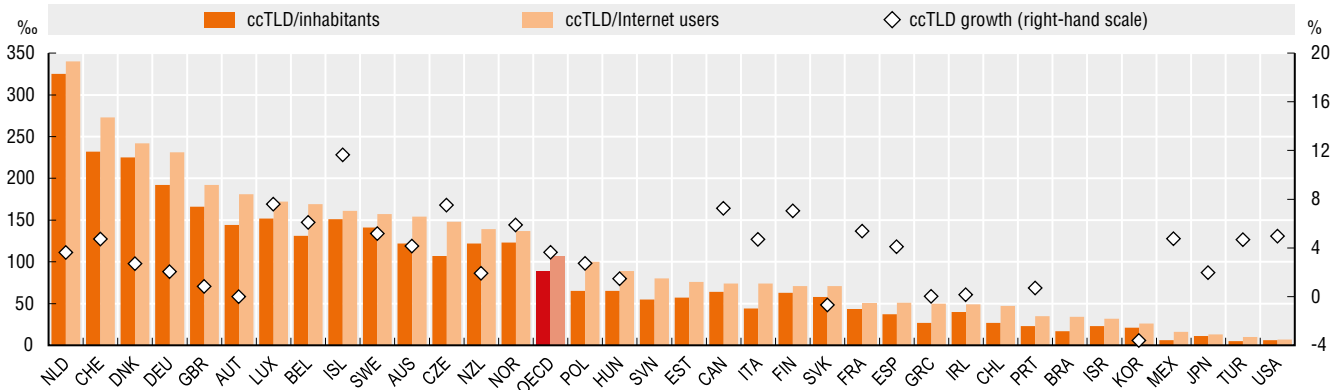
Source: OECD computations based on countries' Network Information Centres (NICs) and KISA, May 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148012

Hosts by type of domain, January 2014

Note: US-related domains include .us, .edu, .mil and .gov.
Source: Internet Systems Consortium (ISC), ftp.isc.org/www/survey/reports/current/bynum.txt, June 2014.

StatLink http://dx.doi.org/10.1787/888933148021

Routed autonomous systems, 2013
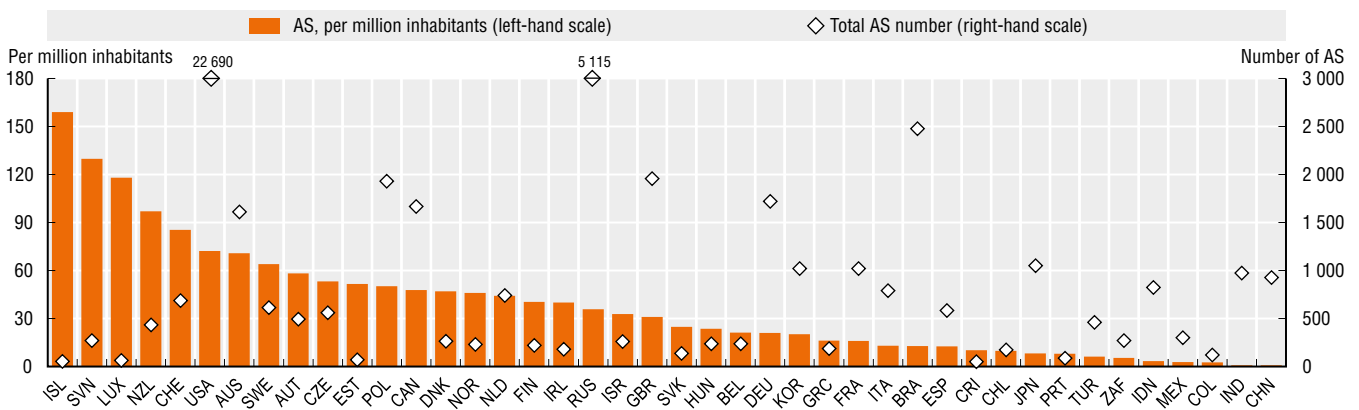
Source: OECD computations based on Potaroo, April 2014.

StatLink http://dx.doi.org/10.1787/888933148033

Key findings

Adequate network access speed is essential to fully exploit existing services over the Internet and to foster the diffusion of new ones.

In December 2013, fixed (wired) broadband subscriptions rates in the OECD area reached 27%, up from 23% at the end of 2009. In Denmark, the Netherlands and Switzerland, subscription rates are 40% or above, but remain below 20% in six other OECD countries.

Distribution of fixed broadband subscriptions across speed tiers varies significantly across countries, due to a variety of factors (e.g. level of competition, population density in the market addressed, availability of back-haul, type of technology most widespread, etc.).

In December 2013, Korea was the OECD country with the highest share of fixed broadband subscribers with a download speed above 10 Mbit/s (71%), followed by Japan (47%), the Netherlands (45%) and Switzerland (42%). The share of subscribers with a download speed below 4 Mbit/s was largest in Chile (74%) followed by Mexico (65%) and Turkey (56%).

Users in Korea and Japan are recorded as having the highest speed levels, as a result of extensive deployment of fibre to the home. Countries with competing DSL and cable television networks also perform well with cable networks overcoming some distance barriers, particularly in places with lower population densities. It is notable that the countries with the three lowest penetration rates also offer the lowest actual speeds.

Differences in speed levels are important for customers. For example, high-speed broadband subscribers (above 10 Mbit/s) can download a high-quality movie (1.5 GB) in less than 22 minutes, while the same process takes at least 52 minutes for low-speed subscribers (below 4 Mbit/s).

In most OECD economies, mobile connectivity is undergoing major advancements through the deployment of *Long Term Evolution* (LTE) networks. Mobile broadband providers are advertising download speeds at levels increasingly closer to those of some fixed broadband offers. The two networks are complementary as wireless networks are effective only to the extent that traffic can be quickly offloaded to fixed networks (a consequence of spectrum limitations).

DID YOU KNOW?

In 2013, the share of fixed high-speed broadband subscribers (above 10 Mbit/s) ranged between over 70% and less than 2% across OECD countries.

Definitions

Fixed (wired) broadband penetration is computed as the number of subscriptions to fixed (wired) broadband services, divided by the number of residents in each country.

Fixed (wired) broadband includes DSL, cable, fibre to the home (FTTH) and other fixed wired technologies.

All components include only connections with advertised data speeds of 256kbit/s or more.

Measurability

Measurement of broadband performance is affected by the potential gap between advertised and "actual" speeds delivered to consumers. Several tools are available to measure actual download and upload speeds, together with other quality-of-service parameters.

Among the major providers of broadband speed data, M-Lab and Ookla compile results from Internet access speed tests conducted by users. The willingness to perform the test, the overall broadband adoption rate, the extent to which ISPs promote the tool and the languages spoken, are all factors that may affect the number of tests and the comparability of the results among countries.

By way of contrast, Akamai runs tests on the speed at which content is delivered to users through its server network located around the world.

Despite significant differences in methodologies, the results from Akamai, M-Lab and Ookla are strongly correlated, except in the case of Japan, where Akamai reports lower broadband speed. It can also be observed that Ookla delivers systematically higher download speed measurement than the other two tools.

The breakdown of fixed broadband penetration by speed tiers presented here is based on Akamai.

Fixed (wired) broadband penetration rates, December 2009 and 2013
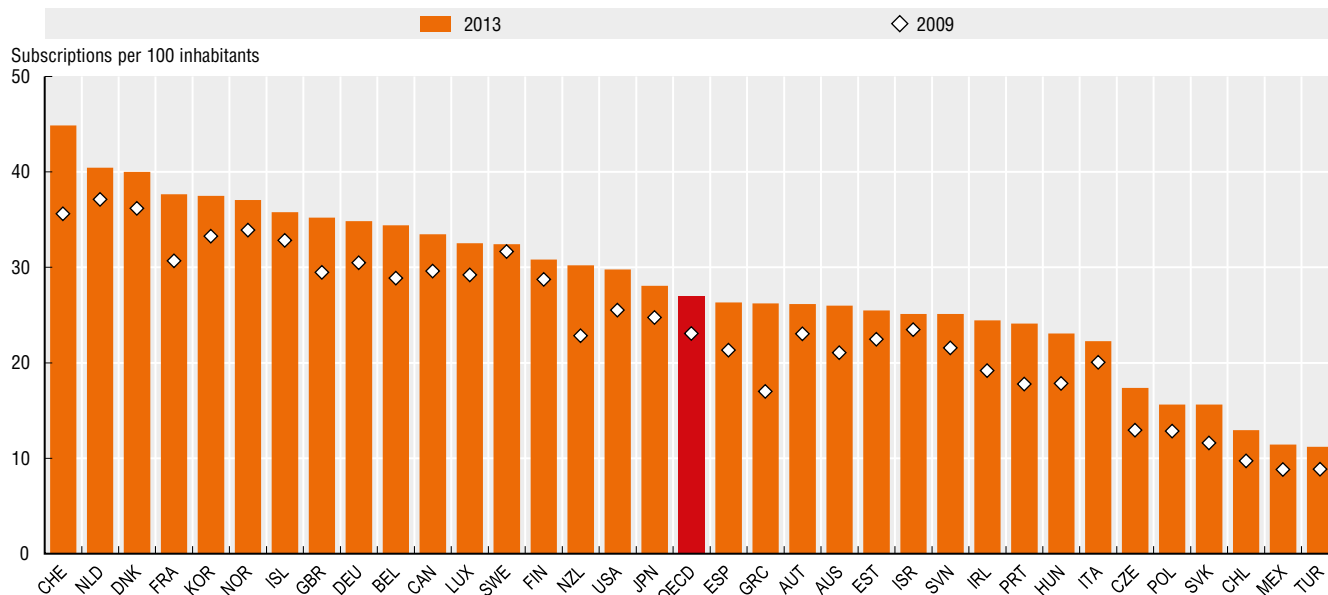
Subscriptions per 100 inhabitants

Source: OECD, Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm, July 2014.

StatLink ᐅ *http://dx.doi.org/10.1787/888933148044*

Fixed (wired) broadband penetration rates by speed tiers, December 2013

Subscriptions per 100 inhabitants
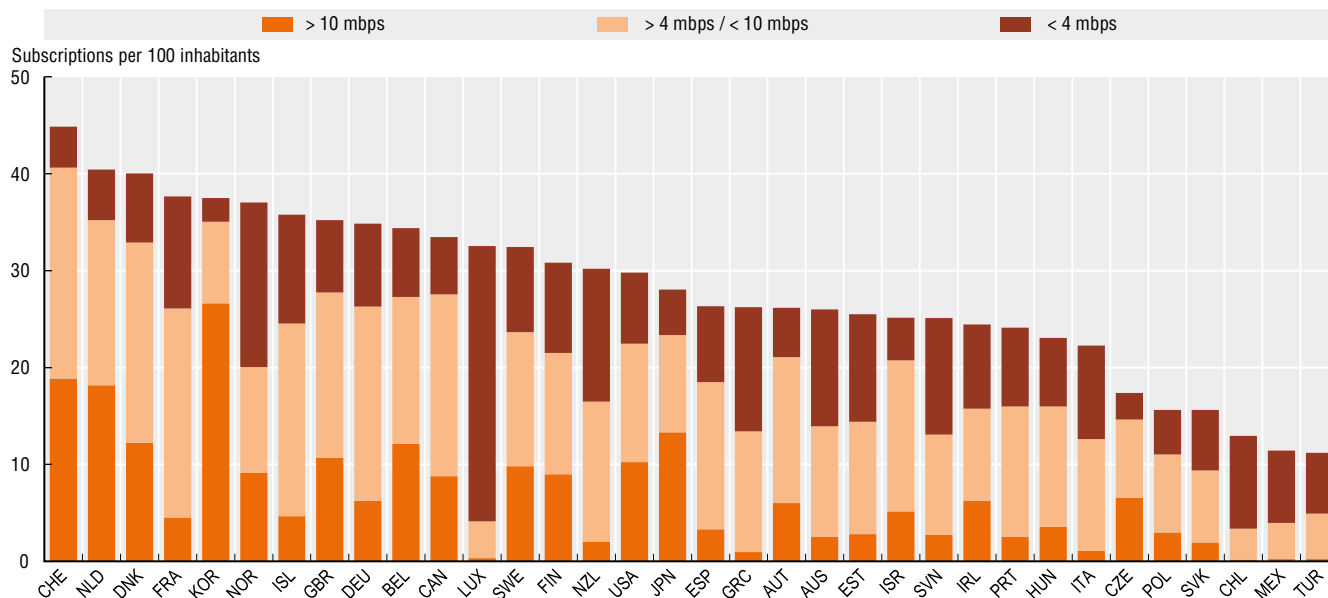
Source: OECD computations based on Akamai, July 2014. See chapter notes.

StatLink ᐅ *http://dx.doi.org/10.1787/888933148053*

Key findings

Prices for connectivity provide useful insights into competition and efficiency levels in communication markets. Benchmarking these prices allows stake-holders, including telecommunication operators, policy makers and consumers, to evaluate progress towards their objectives.

The OECD uses a set of telecommunication prices based on a basket approach. It selects the least costly options among surveyed offers, thereby providing a tool to compare prices available to consumers and businesses with a range of differed usage patterns.

Assessment of any market requires consideration of prices from a range of baskets, including for users that have widely varying requirements and significant differences in their ability to pay. Here, one basket is shown by way of example, but a full range is available in the *OECD Communications Outlook 2013*.

In 2014, a fixed-line broadband subscription basket with 33 GB usage and at least 15 Mbit/s download speed costs from USD 58 to less than USD 17 per month, expressed in purchasing power parity (PPP).

Country performance for any single basket can vary widely, hence the need to examine a range of baskets. In this case, the average price for the same basket across the OECD decreased from USD 38.1 to USD 34.5 PPP in the 18 months from September 2012 (with the largest decreases observed in Iceland, Mexico and Turkey).

Broadband mobile services are rapidly gaining a larger share of the wireless and overall market for communication services. Nonetheless, wireless and fixed services are viewed as being complimentary, even though they may be substitutable for some services such as telephony.

Operators in all countries offer voice and data packages that include a specified volume of traffic or unlimited offers, with mobile data traffic nearly always more costly than fixed-line services. This is one reason why smartphone users predominantly access data services when connected to Wi-Fi in locations such as offices and at home.

One of several mobile baskets tracked by the OECD includes 100 calls, 140 SMS and 500 MB of data. In February 2014, this basket was priced between USD 19 and USD 36 PPP a month in half of OECD countries. Monthly subscription prices were lowest in the United Kingdom (USD 10.4 PPP), Estonia (11.9) and Austria (13.6) and highest in Japan (77.0), Chile (58.6) and Hungary (54.5).

DID YOU KNOW?

Depending on the country of residence, smartphone users in the OECD can pay up to seven times more for a comparable basket of mobile services.

Definitions

Broadband services are frequently sold as mixed bundles including Internet access, telephony and (for fixed networks) television. As broadband bundles are sometimes sold at a lower price than stand-alone services, connectivity prices are not always directly comparable among offers and across countries.

The OECD methodology for measuring *prices of communication services* is based on "baskets" of fixed broadband and mobile communication services, collected from several operators with the largest market shares in each country. USD PPP is used to facilitate international comparisons, with data also being available in USD using exchange rates.

The OECD has developed a new set of baskets for broadband services, both for fixed broadband (adopted in 2009) and wireless broadband (2012).

Measurability

To collect broadband price data, 1 950 stand-alone fixed broadband offers from 102 operators and 1 300 mobile voice plus data offers from 74 operators in the 34 OECD countries were surveyed for the OECD/Teligen baskets. Where stand-alone broadband was not available from a given operator, the least expensive bundled package was selected and included in the comparison.

For fixed broadband, a set of three operators per country was chosen (with an average of 19 offers per operator). These included the incumbent telecommunications operator, the largest cable provider (if cable exists) and one alternative provider, if available, over DSL, cable or fibre.

The surveyed offers had to be advertised clearly on the operator's website. In the case of DSL, cable and fibre offers, these were recorded but not used in calculations when speeds were below 256 Kbit/s. The considered offers were for month-to-month service and had to be available in the country's largest city or in the largest regional city for firms with only regional coverage.

Mobile baskets were based on consumer profiles and offers available from the largest operators in each country.

Prices of fixed broadband basket, 33 GB, 15 Mbit/s and above, September 2012 and March 2014

USD PPP per month
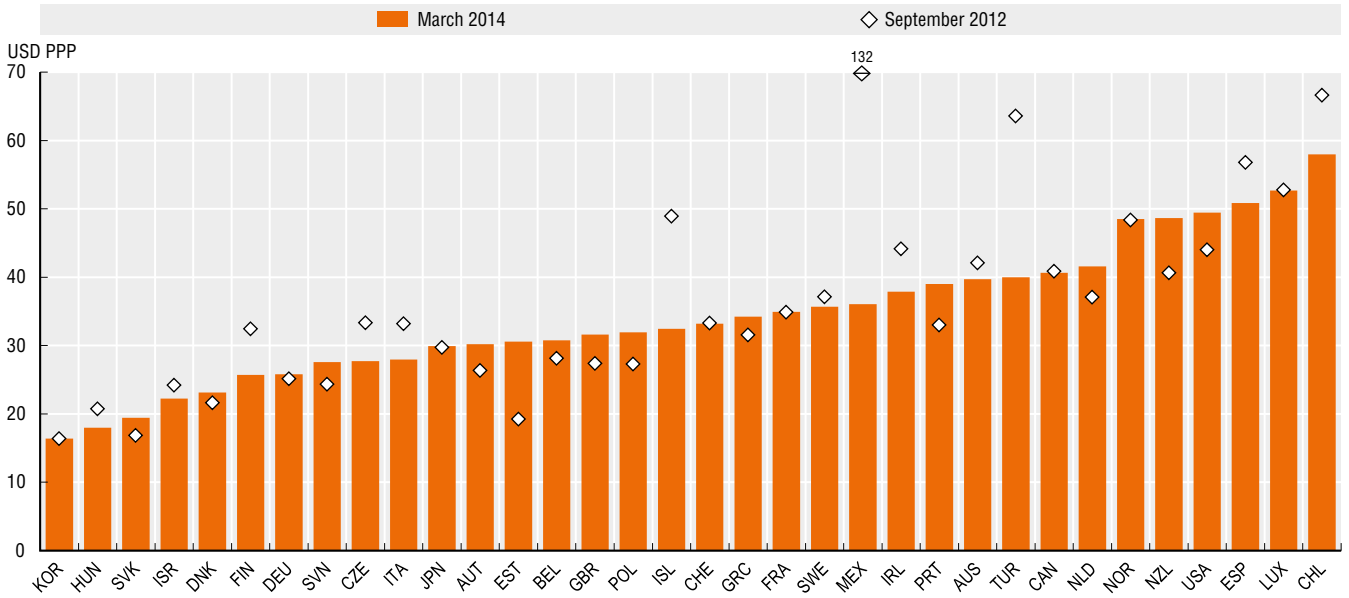
Source: OECD and Teligen, April 2014. See chapter notes.

StatLink ⫘ http://dx.doi.org/10.1787/888933148062

Prices of mobile voice calls plus data traffic reference baskets, February 2014

USD PPP per month

Source: OECD and Teligen, April 2014. See chapter notes.

StatLink ⫘ http://dx.doi.org/10.1787/888933148078
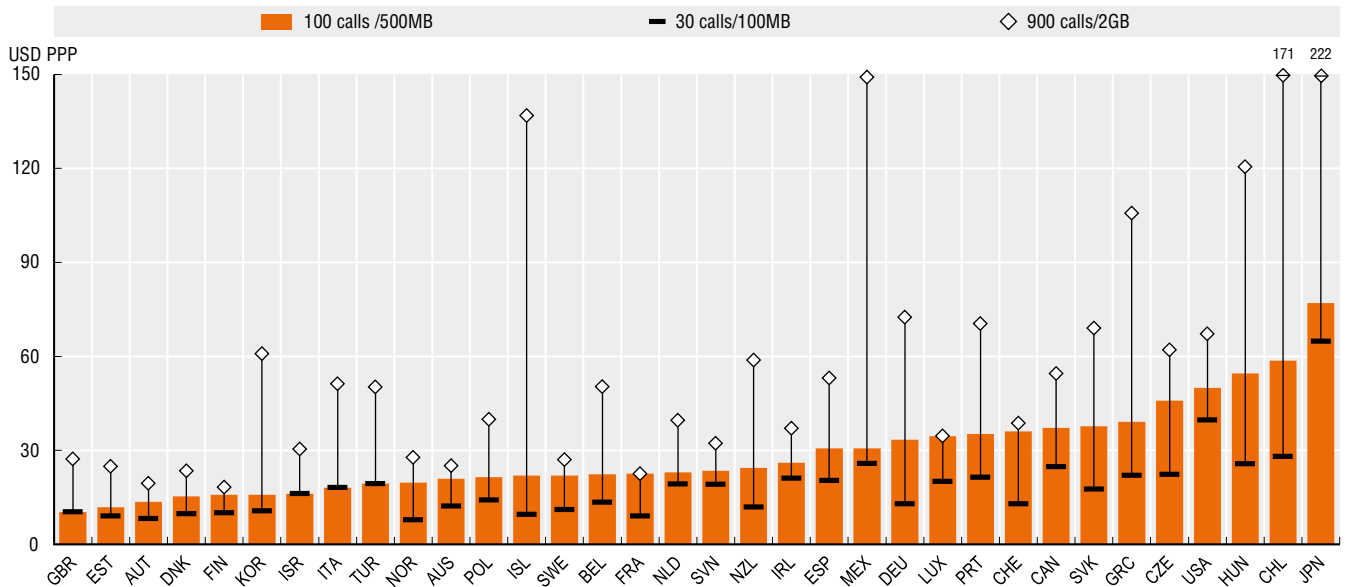
Key findings

Most ICT devices today are Wi-Fi enabled, allowing users to connect to the Internet anywhere and anytime.

More than 60% of Internet users in the OECD area employ a laptop computer and almost as many use a desktop. Meanwhile, 37% of users now connect to the Internet via smartphones and 13% via tablets. In some OECD countries, well above 10% of users report connecting through other devices as well, such as game consoles or TVs.

Overall, the number of devices per user is associated with rates of Internet usage and other factors, including per capita income and age. These factors affect, in particular, the diffusion of tablets and smartphones, which show the highest variability across countries and, together, influence to a large extent their position with respect to the average number of devices per user.

The diffusion of smartphones and tablets is accompanied by the multiplication of dedicated software applications, otherwise known as "apps".

Apps extend the rich communication potential of the Internet beyond the traditional desktop computer and enable users to benefit from a myriad of services, including many related to mobility, such as location-based services and a growing array of sensors available with handheld devices. They also represent an increasingly important channel for governments and companies to deliver content, information and services to users.

The average smartphone user in the OECD has on average 28 applications installed, but uses only about 11. In general, the number of apps installed is closely correlated with the number of apps in use.

Familiarity is an important factor in explaining sophistication of usage. Other things being equal, in countries where the diffusion of smartphones is comparatively high, a higher share of individuals are likely to install and use a broader array of applications.

There are exceptions, however. On average, users in Japan are among those with the highest number of apps installed (37), but also among those with lowest number of apps in use (less than 8).

DID YOU KNOW?

The average user in Korea connects to the Internet using 2.5 different devices, against 1.2 in Hungary. The average OECD smartphone user has about 28 apps available, but uses only 11.

Definitions

The *average number of devices used* is an approximation based on the sum of the items surveyed in ICT usage surveys.

Apps are computer software (applications) meant to execute specific tasks, as opposed to the system software. Here, they are considered with respect to mobile devices only. Statistics on apps are based on a survey commissioned by Google to specialised enterprises in different countries. The reference period for the number of apps in use was the previous 30 days.

Measurability

The design and breadth of surveys on ICT usage by individuals is quite diverse across countries (see 3.1). Data on the variety of devices in use, in particular, ought to be considered as indicative only.

Devices are surveyed in different ways and are sometimes bundled together (e.g. laptops combined with personal computers). As such it is not possible to achieve fully comparable indicators. In particular, the average number of devices per user might be underestimated for Canada and Japan, due to the lack of specific figures for tablets and laptops, respectively.

Apps-related information from the Google multi-country survey can be considered sufficiently reliable, but is based on relatively small country-level samples (about 1000 individuals) limiting its use. A specific module on apps has been included in the 2014 revision of the OECD Model Survey on ICT Access and Usage by Households and Individuals. In the future it will be possible to collect data for applications on mobile phones with official statistics, using much larger samples and capturing a richer set of policy relevant metrics. These include the diffusion of specific types of apps (e.g. health or education related) or aspects related to security, distinguished by different groups of individuals.

Devices used to access the Internet, 2013

Variety of devices per user linked to the percentage of Internet users (left-hand panel)
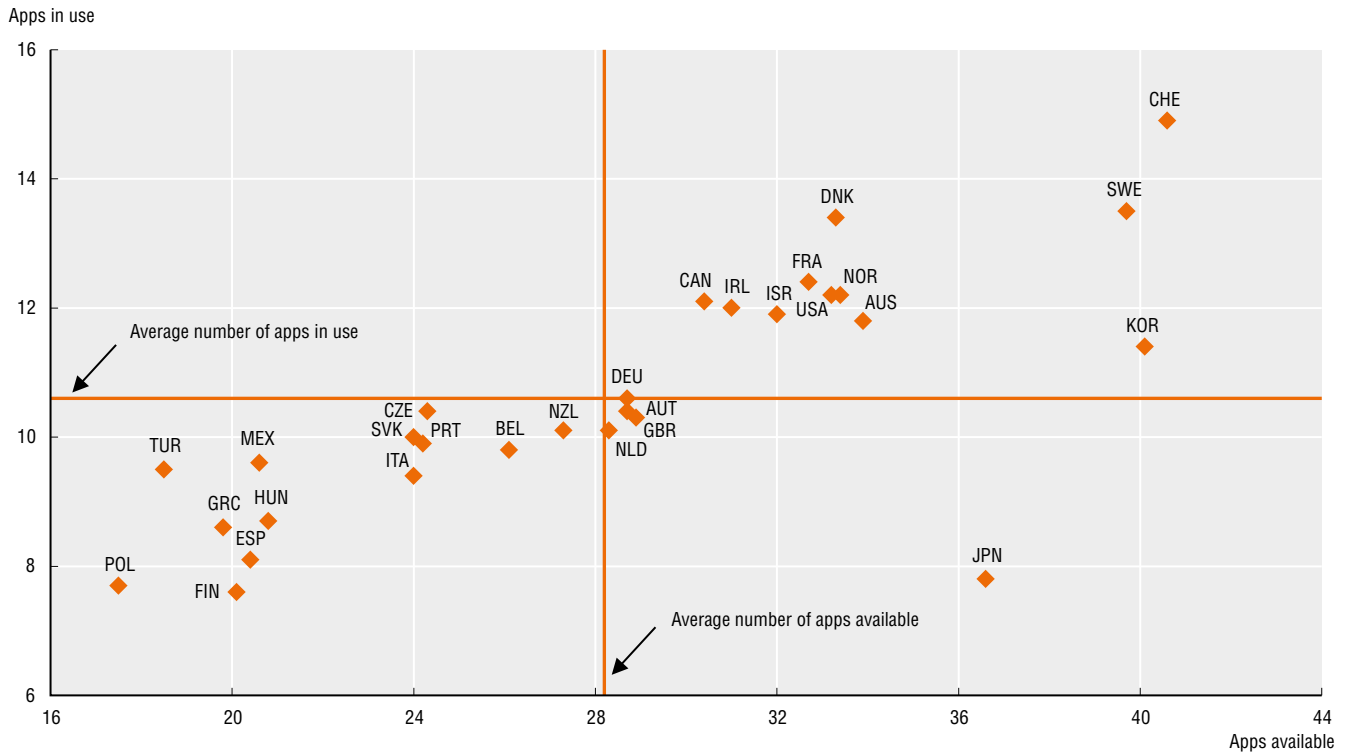*and Users by device as a percentage of Internet users (right-hand panel)*
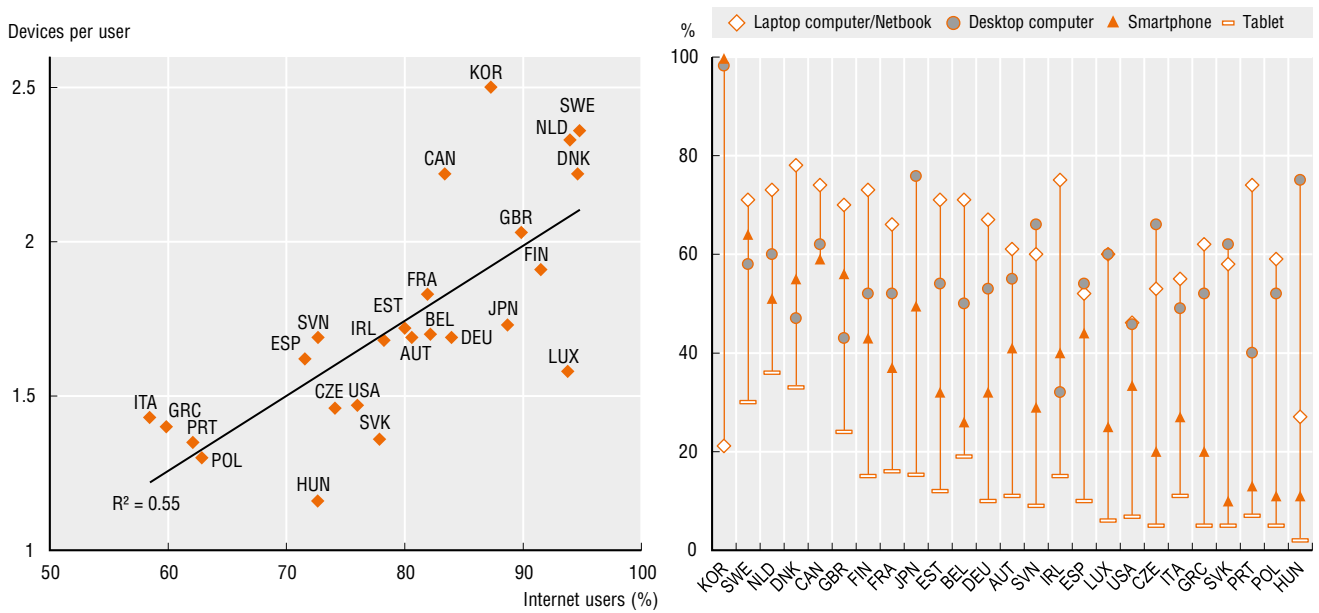
Source: OECD, ICT Database, May 2014; European Commission (2013), *Cyber security*, Special Eurobarometer, No. 404, Brussels and national sources. See chapter notes.

StatLink ⧉ *http://dx.doi.org/10.1787/888933148083*

Smartphone apps availability and usage, 2013

Average number per user

Source: Google, Our Mobile Planet, Smartphone research 2013, think.withgoogle.com/mobileplanet/en/downloads. See chapter notes.

StatLink ⧉ *http://dx.doi.org/10.1787/888933148094*

Key findings

The Internet opens up new opportunities on global markets for consumers and businesses. IT infrastructure, regulatory framework and economic integration of countries are among key factors that impact cross-border e-commerce uptake by individuals and enterprises.

Despite recent initiatives both at the national and international level to foster cross-border online transactions, e-commerce activities mostly remain within national borders. In 2012, in a majority of countries for which data are available, the percentage of enterprises that engaged in electronic sales (e-sales) in their own country was much higher than those who carried out cross-border e-sales. Exceptions were Ireland and Luxembourg, where multinational enterprises (MNEs) play a larger role.

In Finland and Norway, the share of enterprises that conducted cross-border online sales within the EU was less than 30%, as opposed to Austria and Italy, where this share was 62% and 56% respectively.

In general, European countries prefer EU partners both for online sales and purchases, while consumers in Canada mostly order from the United States as regards cross-border online purchases. In 2013, 26% of individuals who ordered goods or services over the Internet in the EU28 chose sellers located in other EU countries, against 14% from those located in the rest of the world. In Canada, 63% of e-consumers reported ordering from sellers in the United States.

Most OECD countries are placing greater emphasis today on policies and programmes that promote market transparency and provide information and guidance to empower citizens by strengthening their ability and confidence to buy goods and services across borders, in particular online.

In 2012, at the EU level, consumer trust in purchasing goods or services via the Internet from retailers located in another EU country was highest in Iceland, Ireland and Luxembourg, and lowest in Germany.

Language appears to be one of the enabling factors related to consumer trust. Available data from the EU28 show that trust in cross-border online purchases in non-English speaking European countries increases with willingness to place orders in another EU language.

DID YOU KNOW?

In 2013, 63% of e-consumers in Canada ordered goods or services from the United States, and 26% of e-consumers in the EU28 ordered products from other EU countries.

Definitions

An e-commerce transaction is the sale or purchase of goods or services, conducted over computer networks by methods specifically designed for the purpose of receiving or placing of orders *(OECD Guide to Measuring the Information Society 2011)*. For individuals, whether sellers or purchasers, such transactions typically occur over the Internet. For enterprises, *e-commerce sales* figures presented here include all transactions carried out over webpages, extranet or Electronic Data Interchange (EDI) systems.

MNEs are treated as *national sellers* once their website declares them to be registered as a company with an address in the surveyed country. National sellers include the trade business or sales offices established in the country by foreign owners.

Partner countries refer to the EU members for countries in the European Statistical System and to the United States for Canada.

Shares of *Internet users who trust in EU cross-border sellers* and of those who are *willing to use another EU language for purchases over the Internet* are computed as a percentage of those who expressed an opinion about the statements (agree or disagree).
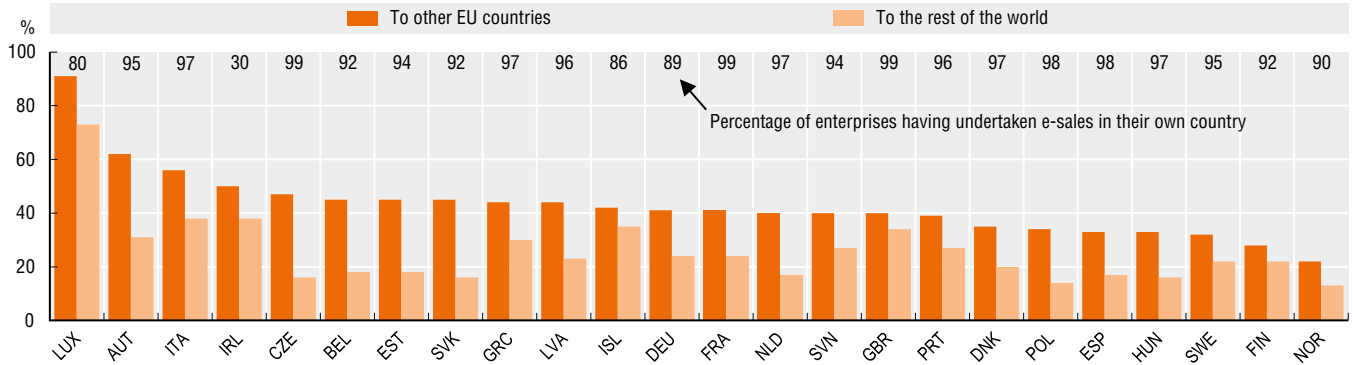
Measurability

Flash Eurobarometers are thematic public opinion surveys conducted at the request of the European Commission to obtain relatively rapid results by focusing on a specific target group. The survey on consumer attitudes towards cross-border trade and consumer protection was carried out in the 28 EU countries, Iceland and Norway in September 2012 across a sample of 25 543 individuals aged 15 years and more. Different social and demographic groups were interviewed via telephone in their mother tongue on behalf of the European Commission Directorate-General for Health and Consumers (DG SANCO).

As is the case for all public opinion surveys, interpretation of the results is subject to caution. As the samples used are relatively small, marginal differences observed across countries might be the result of sampling errors and not necessarily represent differences in the underlying population.

Cross-border e-commerce sales by enterprises, 2012

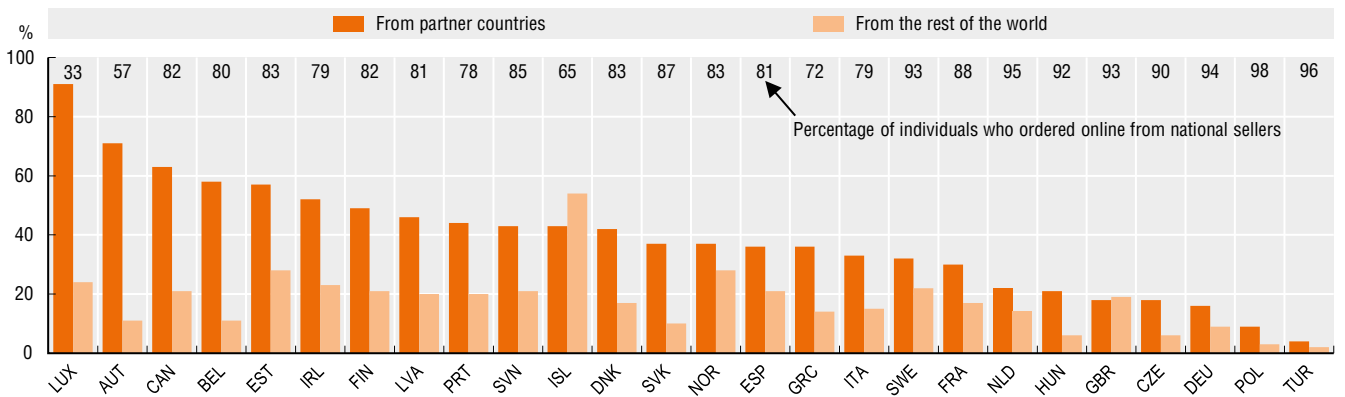*As a percentage of all enterprises having undertaken sales via e-commerce*

■ To other EU countries   ■ To the rest of the world

Percentage of enterprises having undertaken e-sales in their own country

Source: OECD based on Eurostat, Information Society Statistics, June 2014. See chapter notes.

StatLink ⌗ http://dx.doi.org/10.1787/888933148101

Cross-border online purchases by individuals, 2013

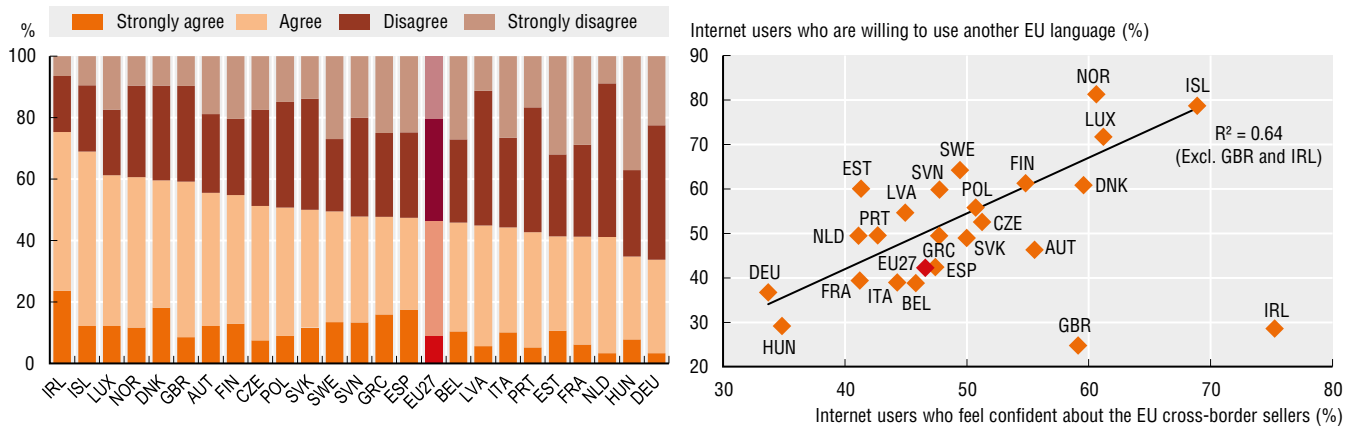*As a percentage of individuals who ordered goods or services over the Internet in the last 12 months*

■ From partner countries   ■ From the rest of the world

Percentage of individuals who ordered online from national sellers

Source: OECD based on Eurostat, Information Society Statistics and national sources, June 2014. See chapter notes.

StatLink ⌗ http://dx.doi.org/10.1787/888933148115

Consumer trust in cross-border online purchases, 2012

"I feel confident purchasing goods or services via the Internet from retailers/providers in another EU country" (left-hand panel)
linked to the willingness to use another EU language for purchases over the Internet (right-hand panel)

■ Strongly agree   ■ Agree   ■ Disagree   ■ Strongly disagree

Internet users who are willing to use another EU language (%)

R² = 0.64
(Excl. GBR and IRL)

Internet users who feel confident about the EU cross-border sellers (%)

Source: OECD based on European Commission (2012), *Consumer attitudes towards cross-border trade and consumer protection*, Flash Eurobarometer, No. 358, Brussels.

StatLink ⌗ http://dx.doi.org/10.1787/888933148121

Key findings

The digitisation of information and network connectivity create new challenges for the protection of sensitive data and network communications.

Most businesses adopt security measures to protect their digitised information and networks. The extent to which they undertake these measures depends on their awareness and capabilities and the digital security risks they face. This in turn relates to factors such as their size and the industry in which they operate.

In 2010, the most widespread security measures adopted by enterprises included offsite backup of archives and strong-password authentication. A minority of firms adopted intrusion detection systems (IDS) and authentication and identification tools such as hardware tokens and biometric methods. Offsite backup was used by 75% or more of enterprises in Denmark and Norway, against less than 20% in Hungary, the Slovak Republic and Turkey. In 2012, this rate was also low in Korea, possibly due to the substitution of offline with online backup over the cloud. The use of strong passwords is still the easiest way to protect access to information, in particular for SMEs, and in 2010 was used by most firms, especially in Ireland, Italy and Spain where the business sector is dominated by small enterprises.

Major security issues include denial-of-service (DoS) and distributed denial-of-service (DDoS) attacks, the latter employing several machines. Such attacks often target access to the networks of individual organisations (e.g. banks) and can result in partial or complete disruption of Internet access in whole areas when a major service provider is affected. Taking into account the number of active hosts, data on (D)DoS attacks provide an indication of threat levels and show that certain areas are particularly attractive to this type of security threat.

In general, large enterprises are more prone to DoS attacks. Differences across economies are significant, but are difficult to explain. The share of enterprises suffering from DoS attacks in 2010-12 was 1% or below in Hungary, Japan and New Zealand, but above 10% in the Slovak Republic.

At the global level and in absolute terms, China, the Russian Federation and the United States lead both in terms of DDos attacks originating from or targeting each geographical area. These two measures are highly correlated, suggesting to some extent the local nature of many attacks. Exceptions include Chinese Taipei, the Netherlands, Panama and Romania, which are at the origin of many more attacks than they receive, while the opposite is the case in Canada, Estonia, Italy, Norway, Poland, Spain and Sweden.

DID YOU KNOW?

In 2010-12, between 2% and 6% of businesses in most economies experienced an IT security problem resulting in denial-of-service. Large firms are targeted proportionally more frequently than SMEs.

Definitions

Security methods considered here include two information protection systems: *offsite data backup* and the *use of digital intrusion detection systems* (devices or software applications monitoring for malicious activities or policy violations). Three identification and authentication tools are also considered: *strong passwords* (where the concept of strength encompasses length, the use of different types of characters and limited duration), *hardware tokens* (including smartcards) and *biometric methods*. Tools within each group are not mutually exclusive (i.e. are not additive) and the two groups are complementary. The information is collected by national surveys on ICT usage in businesses.

Denial-of-service (DoS) attacks aim to make machines or network resources unavailable by interrupting or suspending the services of a host connected to the Internet (websites, Internet services or whole network). Attacks can take several forms; a *distributed denial-of-service (DDoS)* attack occurs when the bandwidth or the computing resources of the targeted systems is flooded using multiple machines, which are often controlled remotely by the attacker by means of malware. The indicator on businesses experiencing DoS problems highlights the diffusion of attacks on enterprises by employment size and is based on user survey information drawn from official statistics. The indicators on numbers of DDoS attacks by origin and target geographical area are based on monitoring of websites undertaken by a not-for-profit organisation, Shadowserver (shadowserver.org).
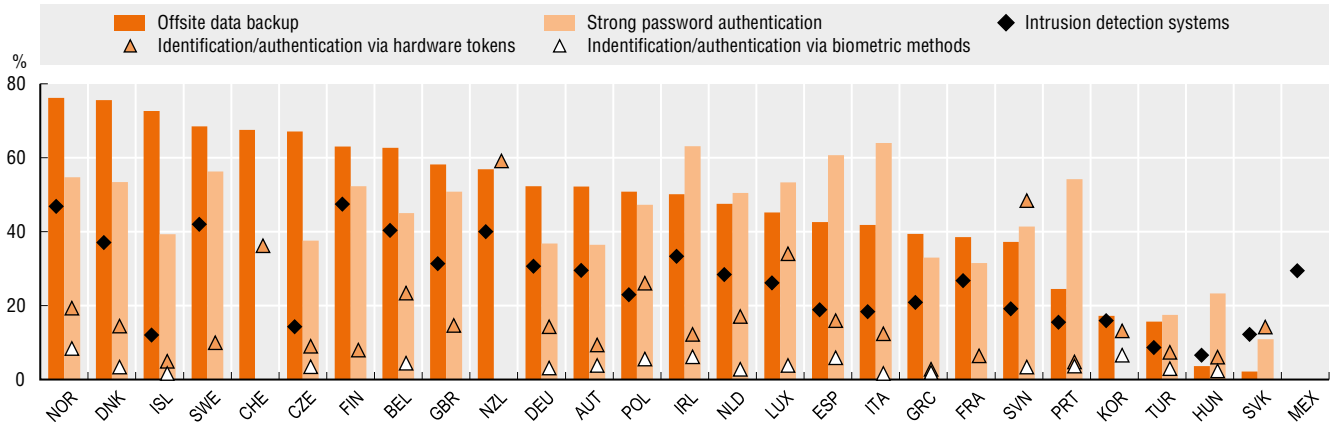
Measurability

Data availability and comparability on security topics still pose challenges. Security tools and issues evolve rapidly, and the latest collection of data by Eurostat dates from 2010. Information on incidence of security issues also requires the validation of methodologies used to gather data from the Internet, and should be complemented by an appreciation of the gravity of security incidents.

The OECD is working with National Computer Security Incident Response Teams to develop a common set of metrics on incidents (see 2.10), and proposed a dedicated module on security and privacy in its 2014 revision of the OECD Model Survey on ICT Usage by Businesses.

Use of security methods for authentication/identification and the protection of data by enterprises, 2010
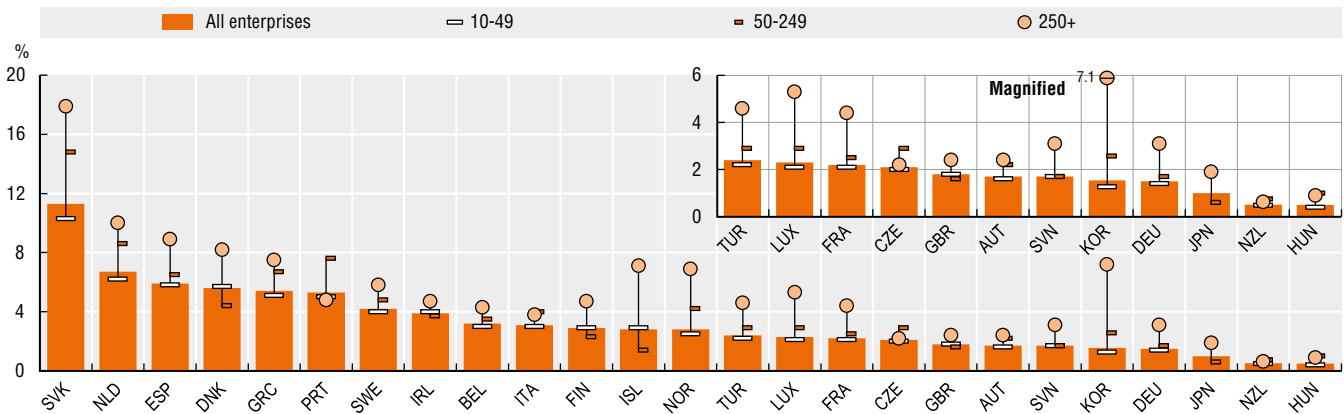*As a percentage of all enterprises*

Legend:
- Offsite data backup
- Strong password authentication
- Intrusion detection systems
- △ Identification/authentication via hardware tokens
- △ Indentification/authentication via biometric methods

Countries (x-axis): NOR, DNK, ISL, SWE, CHE, CZE, FIN, BEL, GBR, NZL, DEU, AUT, POL, IRL, NLD, LUX, ESP, ITA, GRC, FRA, SVN, PRT, KOR, TUR, HUN, SVK, MEX

Source: OECD, ICT Database and Eurostat, Information Society Statistics, June 2014. See chapter notes.

StatLink ⟐ http://dx.doi.org/10.1787/888933148133

Businesses having encountered IT security problems, attacks resulting in denial-of-service, by size, 2010
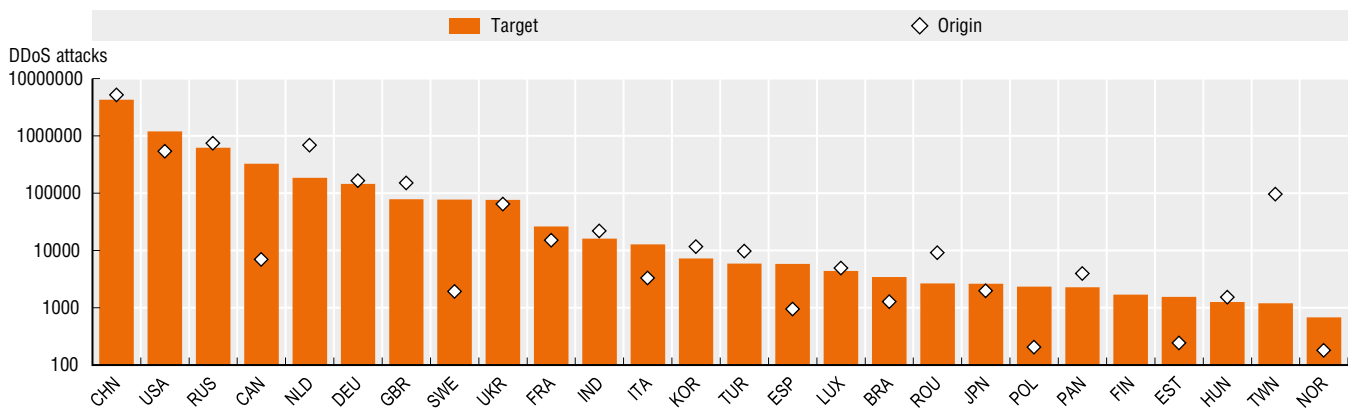*As a percentage of all businesses in each employment size class*

Legend:
- All enterprises
- 10-49
- 50-249
- 250+

Magnified (inset): TUR, LUX, FRA, CZE, GBR, AUT, SVN, KOR, DEU, JPN, NZL, HUN — with value 7.1 marked

Countries (main, x-axis): SVK, NLD, ESP, DNK, GRC, PRT, SWE, IRL, BEL, ITA, FIN, ISL, NOR, TUR, LUX, FRA, CZE, GBR, AUT, SVN, KOR, DEU, JPN, NZL, HUN

Source: OECD, ICT Database and Eurostat, Information Society Statistics, June 2014. See chapter notes.

StatLink ⟐ http://dx.doi.org/10.1787/888933148142

Distributed denial-of-service attacks originating from or targeting each geographical area, April 2014
Numbers based on the location of command and control points, logarithmic scale

Legend:
- Target
- ◇ Origin

DDoS attacks (y-axis): 100 – 10000000

Countries (x-axis): CHN, USA, RUS, CAN, NLD, DEU, GBR, SWE, UKR, FRA, IND, ITA, KOR, TUR, ESP, LUX, BRA, ROU, JPN, POL, PAN, FIN, EST, HUN, TWN, NOR

Source: Shadowserver, www.shadowserver.org/wiki/pmwiki.php/Stats/GeoLocations, May 2014.

StatLink ⟐ http://dx.doi.org/10.1787/888933148153

Key findings

Security and privacy are among the most challenging issues facing online services and the development of e-commerce. Both concern consumer trust that personal information will not be viewed, stored or manipulated during transit and storage by third parties without their consent or for fraudulent purposes.

Trust is a central factor in all economic transactions, both offline or online. However, the importance of trust increases with online shopping, as this is more prone to uncertainty and risk than traditional shopping.

In 2009, security was cited as the main reason for not buying online for over one-third of Internet users in the European Union who had not made any purchases online. Privacy concerns accounted for a slightly smaller share (about 30%). The strong variation in perceptions of security and privacy risks across countries with comparable degrees of law enforcement and technological know-how suggests that cultural attitudes towards online transactions play a significant role.

Online security and privacy concerns show a positive relationship in most countries. In 2009, security concerns among Internet users not buying online were the highest in France, the Slovak Republic and Switzerland and the weakest in the Czech Republic, Ireland and Poland. Privacy concerns were the highest in Switzerland, followed by the Slovak Republic and Finland, and the weakest in Australia, Canada and the Czech Republic.

Traditionally, security issues in e-commerce have been considered in relation to the abilities of e-merchants to protect their online transaction systems. However, e-consumers are becoming increasingly aware that security depends crucially on their behaviour.

In recent years, Internet users have changed their behaviour in a number of ways because of security concerns. They are now less likely to give personal information on websites or in response to open emails from people they know. However, in 2013 only about one-third of Internet users in the European Union had ever changed the security settings of their browsers, ranging from above 50% in Austria to 15% in the Czech Republic.

Definitions

Security concerns for regarding online payments include misgivings about giving credit card details over the Internet and related anxiety about financial loss.

Privacy concerns refer to reluctance to provide personal details over the Internet, including names and addresses, but also private photos or private financial information.

Modifying the *security settings of Internet browsers* refers to any action to improve browser settings to ensure higher protection against viruses and other attacks or attempts at intrusion (normally accessible under "Tools", "Internet options" in the web browser menu).

Measurability

Information on perceived security and privacy is collected through the e-commerce module of the ICT usage surveys in households and by individuals. Information on whether Internet users have ever changed their browser's security setting is collected through a module on e-skills.
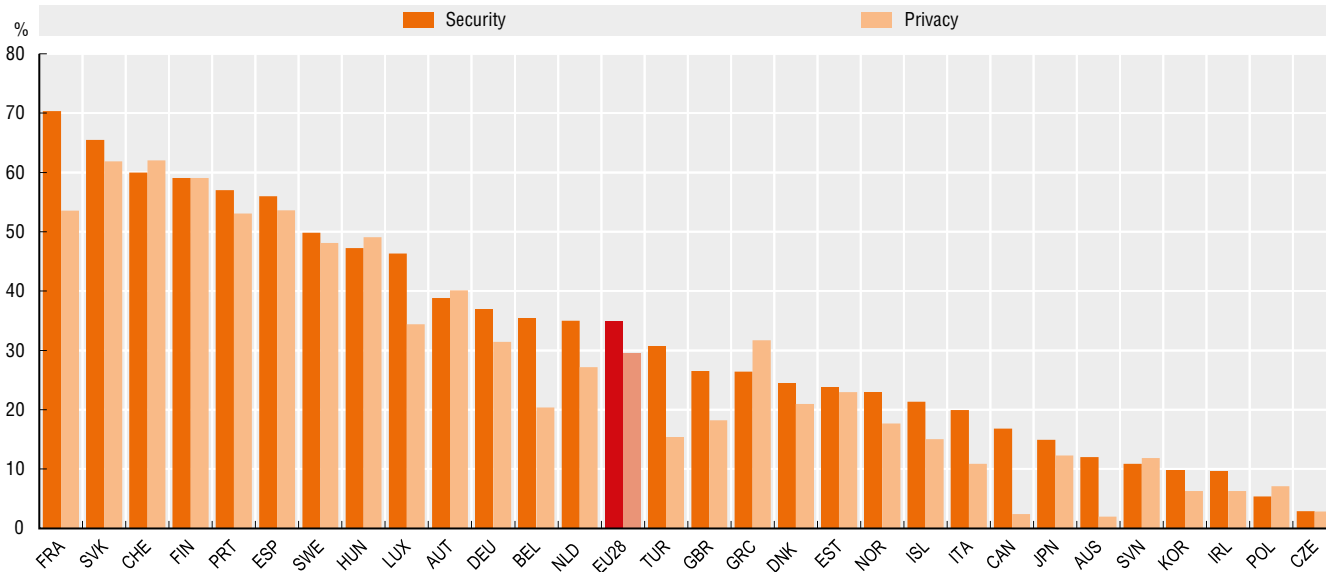
Both the European and OECD model surveys on ICT usage ask direct questions about security and privacy, including on the use of protection from IT threats, the frequency of security updates and security incidents.

The 2014 revision of the OECD Model Survey on ICT Access and Usage by Households and Individuals includes a specific module on security and privacy, based on policy-relevant indications from the OECD Working Party on Security and Privacy in the Digital Economy.

It is a matter of debate among statisticians whether respondents are able to answer technical questions about IT security. To minimise this problem, coverage of the OECD security module is limited to home use, as this is the ICT environment about which users are more likely to have information, as opposed to ICT use at work or school.

Main reasons for not buying online because of privacy and security concerns, 2009 or more recent year available

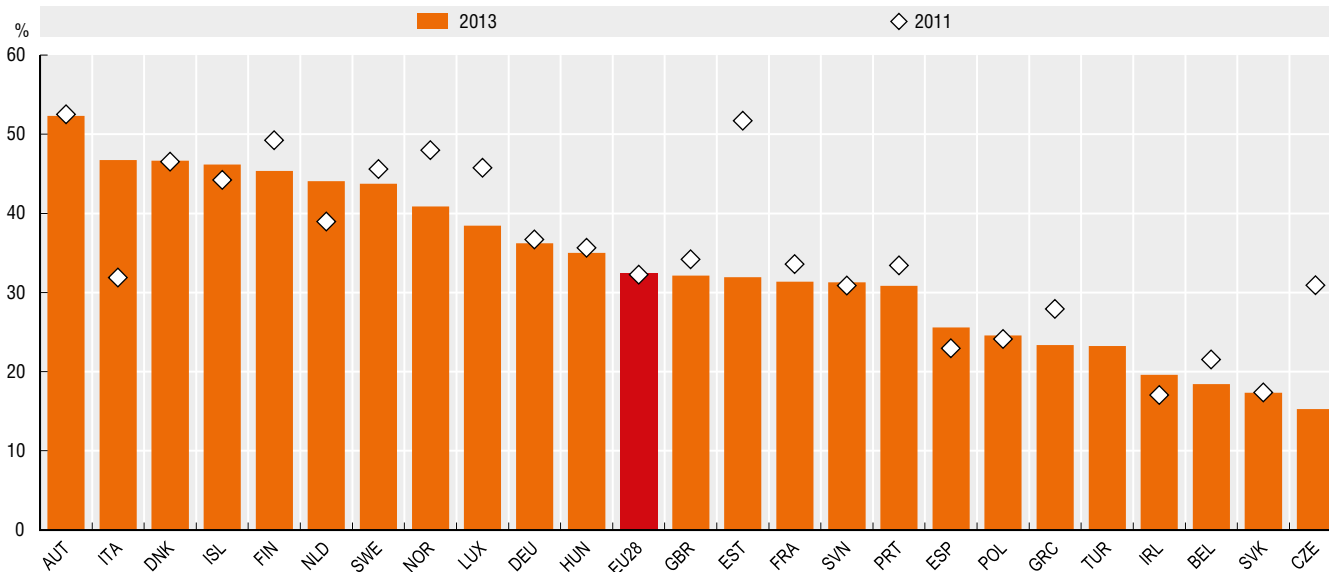*Percentage of Internet users who did not make online purchases*

Legend: ■ Security ■ Privacy

X-axis: FRA, SVK, CHE, FIN, PRT, ESP, SWE, HUN, LUX, AUT, DEU, BEL, NLD, EU28, TUR, GBR, GRC, DNK, EST, NOR, ISL, ITA, CAN, JPN, AUS, SVN, KOR, IRL, POL, CZE

Source: OECD computations based on Eurostat, Information Society Statistics and national sources, May 2014. See chapter notes.

StatLink ⫶⫶⫶ http://dx.doi.org/10.1787/888933148160

Acknowledging the issue of Internet security: users changing browser security settings, 2011 and 2013

As a percentage of Internet users

Legend: ■ 2013 ◇ 2011

X-axis: AUT, ITA, DNK, ISL, FIN, NLD, SWE, NOR, LUX, DEU, HUN, EU28, GBR, EST, FRA, SVN, PRT, ESP, POL, GRC, TUR, IRL, BEL, SVK, CZE

Source: OECD computations based on Eurostat, Information Society Statistics, May 2014.

StatLink ⫶⫶⫶ http://dx.doi.org/10.1787/888933148178

Why do we need indicators?

The protection of security and privacy online has become a key policy issue as individuals, businesses and governments shift large parts of their daily activities to the Internet. Malware are reported to be spreading at high rates, increasing the risks of compromising information infrastructures (van Eeten *et al.*, 2010). Advances in trans-border flows of personal data, as well as big data storage and analytics, amplify the risk of misuse of personal data and challenge the application of privacy protection regulation (OECD, 2011).

These issues have reached a tipping point where policy makers can no longer neglect their implications on innovation, economic growth and prosperity. A recent OECD work on the economics of personal data, for example, highlights the value of personal data and its contribution to innovation as a "New Source of Growth" in sectors as diverse as healthcare, finance, energy and marketing. Likewise, the OECD report *National Cybersecurity Strategies* reveals that OECD governments now recognise that the Internet has evolved from a useful platform for e-commerce and e-government to an essential infrastructure for the functioning of society, making online security a "national security" concern (OECD, 2012).

These evolving challenges and opportunities call for improvement in the evidence base for security and privacy policies, for at least three reasons – first, to assess whether policy interventions on online privacy and security are warranted, second, to design more effective measures for online security and privacy and, finally, to better assess the benefits and costs of online security and privacy policies currently in place.

What are the challenges?

Statistical information on online security and privacy are typically drawn from three major sources: user surveys, activity reports and the Internet.

Surveys among individuals and business have a number of major advantages. These include comparable data based on international standards that can be associated to characteristics of respondents, the possibility to collect subjective information and the flexibility to adjust to new policy needs. They also have several drawbacks when it comes to the measurement of online security and privacy. Respondents may not answer the surveys correctly, either because they do not have the necessary information or knowledge to understand or to answer the questions correctly (e.g. about security threats), or because they do not wish to answer questions on sensitive matters (e.g. illegal downloading).

Activity reports are intended to give stakeholders information about an organisation's routine work, for example, firms' financial statements and reports by privacy enforcement authorities. One of the biggest advantages of activity reports as a source of data is their periodic release, which allows the building of time series from the reported data. However, international differences in reporting requirements and changes in national reporting rules may make the collected information non-comparable across countries and over time.

The *Internet* is itself a rich source of data. When it comes to measuring Internet-related activities, Internet traffic can provide big data sets for analysis. The main strength of Internet-based data is that it is automatically generated and can be collected and distributed in real-time via the Internet. For example, data collected on malware, whether through antivirus or firewall solutions, can be transmitted directly to providers of these tools, thus circumventing sensitivity and information issues raised by household and business surveys. The most severe drawback of Internet-based data, however, is statistical: it is very hard to define an Internet sample and to generalise the results from particular users, service providers or websites to the whole Internet population. Therefore, Internet-based data should be linked to more traditional sources, such as surveys and reports. However, this data linking is not without problems. In order to protect the privacy of users, Internet identifiers (e.g. IP addresses) are usually anonymised or aggregated, making the link to individual or firm-level data unfeasible.

Besides the issues specific to each data source, there is a more fundamental challenge to the measurement of security and privacy, whether online or offline. Because of the illegal nature of privacy and security violations, not all incidents are identified or reported. Only incidents that have been identified as such can be measured, and such incidents represent an unknown share of the total number of incidents. This has some serious implications concerning how to interpret numbers of privacy and security incidents. For example, a decrease in the number of reported malware infections may reflect an actual decrease in malware or a reduced ability to detect it.

Options for international action

A number of internationally coordinated actions have been undertaken or are currently ongoing to improve the measurement of online security and privacy. The OECD Working Party on Security and Privacy in the Digital Economy issued a series of suggestions for improving ICT use surveys for policy makers in the areas of cybersecurity and privacy, notably the economics of personal data and security, prevention measures and incident response. These recommendations were implemented in the 2014 revision of the OECD Model Surveys on ICT usage by households/individuals and by businesses.

The OECD is also undertaking a project to improve the use of data generated by Computer Security Incidents Response Teams with national responsibilities ("national CSIRTs"), as a source of internationally comparable statistics. Many national CSIRTs already produce and report statistics based on data about their activities and the incidents they handle. However, these statistics are often difficult to compare for reasons including differences in CSIRT constituencies, lack of common reporting rules and divergent taxonomies of key aspects of CSIRT operations, such as the notion of "incident". These current statistics are thus not ideal to inform policy-making decisions.

The following figure shows this point by comparing the number of alerts/warnings and vulnerability reports issued by five national CSIRTs in 2010-13. In general, these CSIRTs use a different basis for publishing alerts/warnings and vulnerability reports. For example, some CSIRTs separate publications of alerts/warning from that of vulnerabilities while others bring them together. In addition, some provide a single publication for multiple vulnerabilities while others do the opposite. This explains why cross-country differences in the number of alerts/warnings and vulnerability reports are not correlated to the size of the country, either in terms of population or number of Internet users.

Number of alerts/warnings and vulnerability reports issued by five national CSIRTs, 2010-13
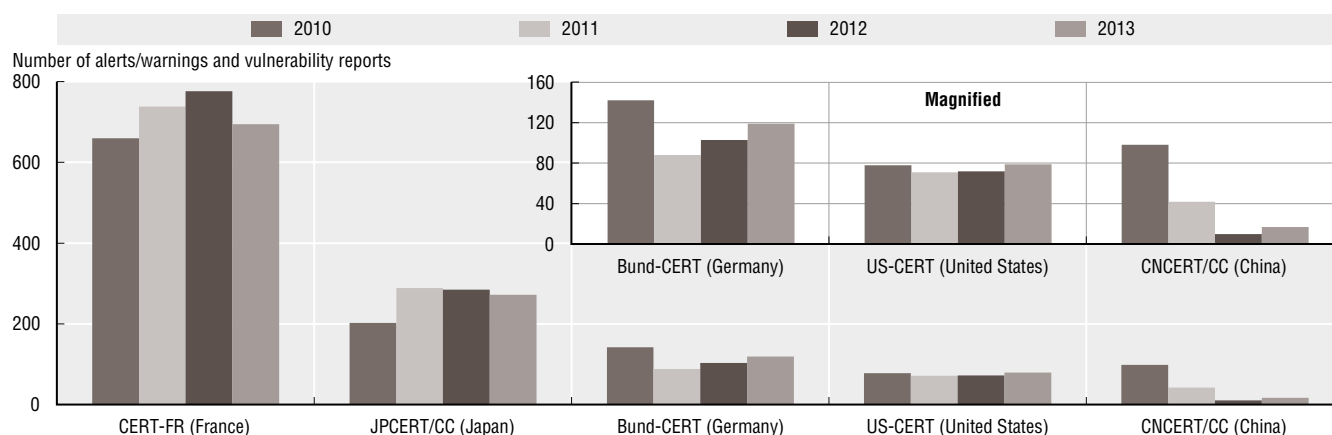
Source: OECD computations based on CSIRTs reports, July 2014.

StatLink ⟨⟩ *http://dx.doi.org/10.1787/888933148183*

The OECD is engaging with CSIRTs from member countries as well as non-members to improve this situation. The overall objective of the work is to develop guidance for CSIRTs to produce and report internationally comparable statistics. This guidance would provide statistical definitions for a set of indicators (e.g. budget, personnel, skills and co-operation, along with specific kinds of incidents) that national CSIRTs could report on a voluntary basis, in addition to suggestions for CSIRTs to better leverage existing data, such as from third-party institutions, for statistical purposes.

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Van Eeten, M., J.M. Bauer, H. Asghari and S. Tabatabaie (2010), "The role of Internet service providers in botnet mitigation: An empirical analysis based on spam data", *OECD Science, Technology and Industry Working Papers*, No. 2010/5, OECD Publishing. Doi: http://dx.doi.org/10.1787/5km4k7m9n3vj-en.

Notes

Israel
"The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities or third party. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

2.2 Mobile data communication

The penetration of M2M SIM cards, 2012

Data originate from the following national sources: Austria (RTR), Belgium (BIPT), Czech Republic (CTU), Denmark (ERST), Estonia (MKM), Finland (FICORA), France (ARCEP), Germany (Bundesnetzagentur), Ireland (Ofcom), Italy (AGCOM), the Netherlands (ACM), Poland (Ministry of Administration and Digitization), Portugal (ANACOM), the Slovak Republic (Ministry of Transport, Construction and Regional Development), Slovenia (AKOS), Spain (CMT), Sweden (PTS) and the United Kingdom (Ofcom).

For France, Ireland and Portugal, data refer to 2013.

2.3 The growth of the Internet

Country code top-level domain registration (ccTLD) density 2014 Q1 and growth (2013 Q1-2014 Q1)

For Brazil, Chile, Estonia and Slovenia, data refer to end-May 2014.

2.4 Toward higher speed

Fixed (wired) broadband penetration rates by speed tiers, December 2013

This figure is based on OECD subscription data (December 2013) merged with Akamai's actual speed data (1st quarter, 2014).

For Luxembourg, there is a technical issue in the Akamai data related to the use of Network Address Translators and IPv6. It is estimated that if modified, to account for both these factors, the ratio of connections above 10 Mbit/s would climb from 1% to more than 30%.

2.5 Prices for connectivity

Prices of fixed broadband basket, 33 GB, 15 Mbit/s and above, September 2012 and March 2014

The OECD basket of fixed broadband services includes total charges for a subscription with a minimum speed of 15 Mbit/s and 33 GB for 60 hours of usage per month. USD purchasing power parities (PPP) are used to facilitate international comparisons.

Prices of mobile voice calls plus data traffic reference baskets, February 2014

Price benchmarking results for mobile broadband services presented here cover services provided over a handset or smartphone.

The 30 calls/100 MB, 100 calls/500 MB and 900 calls/2 GB OECD baskets of mobile telephone charges include fixed and usage charges for respectively 30, 100 and 900 voice calls, and a volume of 100 MB, 500 MB and 2 GB of data traffic per month. These baskets portray approximately small, average and large users of voice and mobile data. USD purchasing power parities (PPP) are used to facilitate international comparisons. Additional information on the computation methodology can be found in the *OECD Communications Outlook 2013*.

Mobile tariff plans in some OECD countries (e.g. Japan) may focus on a different balance of usage between data and voice (e.g. larger volume of data and fewer minutes of calls), and mobile users may benefit from an extra monthly subsidy for a handset purchase provided by the operator. These points should be taken into consideration when interpreting indicators of mobile prices.

2.6 ICT devices and applications

Devices used to access the Internet, 2013

For Canada, data refer to 2012. Devices per user data originate from the Internet Use Survey 2012 as published in *The Daily* on 28 October 2013 and relate to the percentage of households with Internet access by Internet access device. Data include laptops only instead of laptop computers/netbooks, and all wireless handheld devices instead of smartphones only. Data on tablets are not available.

For countries in the European Statistical System, data originate from the Special Eurobarometer No. 404 on cyber security.

For Japan, devices per user data are based on the Internet Usage Trend Survey 2012 and relate to individuals aged 6 or more. Data refer to PC use at home instead of desktop computers. Data on laptop computers/netbooks are not available.

For Korea, data originate from the Survey on the Internet Usage 2012. Devices per user data relate to the percentage of households with Internet access by Internet access device. The smartphone category includes all mobile phones. Data on tablets are not available.

For the United States, data originate from the US Bureau of the Census, relate to individuals aged 15 and more, and refer to 2011. The category laptop computers/netbooks includes laptops only. The category Smartphones includes all cellular phones and tablets includes e-books.

Devices per user data are computed using an additional "Other" category, which typically includes game consoles and televisions with Internet access.

Smartphone apps availability and usage, 2013

For the number of apps installed, data refer to the question: "And of the apps you currently have installed on your smartphone, how many have you used actively in the last 30 days? Please type in a number. If you don't know the exact number please provide your best estimate."

For the number of apps actively used, data refer to the question: "And of the apps you currently have installed on your smartphone, how many have you purchased for a certain amount in an app distribution platform such as Apple App Store and Google Play? Please type in a number. If you don't know the exact number please provide your best estimate."

The average excludes zero values.

2.7 E-commerce across borders

Cross-border e-commerce sales by enterprises, 2012

For Germany, data refer to 2010.

Cross-border online purchases by individuals, 2013

Partner countries refer to other EU countries for those in the European Statistical System and to the United States for Canada.

For Canada, data refer to 2012.

2.8 Security

Use of security methods for authentication/identification and the protection of data by enterprises, 2010

For Korea, data refer to 2012.

For Mexico, data refer to 2008.

Businesses having encountered IT security problems, attacks resulting in denial-of-service, by size, 2010

For Japan, data refer to 2011.

For New Zealand, data refer to 2012.

2.9 Perceiving security and privacy threats

Main reasons for not buying online because of privacy and security concerns, 2009 or more recent year available

For Australia, data originate from the Multipurpose Household Survey as published in the *Household Use of Information Technology 2012-13* and refer to 2012/2013 (fiscal year ending in June 2013) instead of 2013. "Payment security concern" relates to "concerned about providing personal details online".

For Canada, data originate from the Internet Use Survey 2012.

For Japan, data originate from the Internet Usage Trend Survey 2011. "Security concern" relates to "concerned about security when giving out credit card information" and "Privacy concern" relates to "protection of personal information". Data cover Internet users aged 15 and more, instead of 16-74 year-olds.

For Korea, data originate from the Survey on the Internet Usage 2009 and relate to "Privacy concern" and "Security concern" as reasons for not using Internet shopping.

For Switzerland, data originate from the Omnibus TIC 2010 survey.

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Chapter 3
EMPOWERING SOCIETY

Key findings

Internet usage varies widely across OECD countries and among social groups. In 2013, 90% and more of the adult population were accessing the Internet in Luxembourg, the Netherlands, the Nordic countries and Switzerland, but less than 60% in Greece, Italy, Mexico and Turkey.

Usage rates across the OECD reached almost 80% in 2013, an 18-percentage point increase on 2006. Many lagging countries caught up thanks to recent advances in mobile broadband availability and uptake.

Developments in mobile technology have also enabled people to conduct daily personal computing and communications activities "on the go". As a result, society is increasingly made up of "nomadic" computer and Internet users: in 2013, more than 40% of adults used a mobile or smartphone to connect to the Internet in the OECD.

For most people, the Internet is now part of everyday life. On average, over three quarters of users connect to the Internet on a daily basis. In Iceland and Italy the share of daily users is very similar to that of total users; in Chile, Japan and Mexico, however, many users do not access the Internet daily.

Differences in Internet uptake are linked primarily to age and educational factors, often intertwined with income levels. In most countries, uptake by young people is nearly universal, but there are wide differences for older generations (notably seniors). More than 75% of 55-74 year-olds in Denmark, Iceland, Luxembourg, the Netherlands and Sweden reported using the Internet in 2013 against less than 10% in Mexico and Turkey.

Education appears to be a much more relevant factor for older people than for younger people. Usage rates for 55-74 year-olds with tertiary education are generally in line with those of the overall population, and in leading countries approach that of 16-24 year-olds. Older people, in particular those with a lower education, are thus a potential focus of strategies to foster digital inclusion. In 2013, the differential between the Internet usage rates of 55-74 year-olds with high and low educational attainment was particularly significant in Hungary, Poland and Spain.

Definitions

Users include individuals who accessed the Internet within the last three months prior to surveying. Different recall periods have been used for some countries (see chapter notes). Daily users consist of individuals accessing the Internet approximately every day on a typical week (i.e. excluding holidays, etc.).

Figures on individuals using the Internet via mobile or smartphones also include Wi-Fi networks for countries in the European Statistical System; for other countries see chapter notes.

The *education gap* corresponds to the percentage difference between the shares of Internet users with tertiary education (ISCED level 5 or 6) and those with at most lower secondary education (ISCED levels 0, 1 and 2). The focus is on 55 to 74 year-olds.
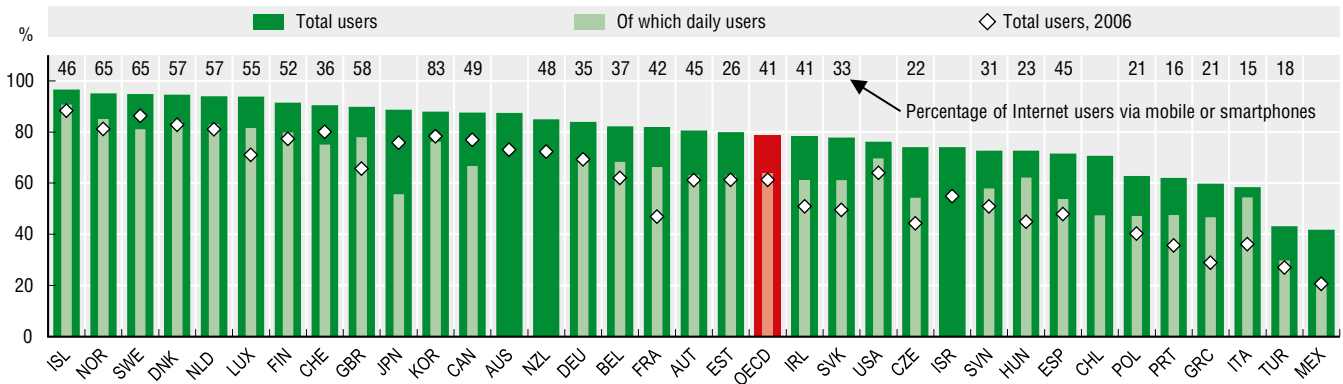
Measurability

Not all OECD countries survey ICT usage by households and individuals. Data availability for specific indicators also varies. Surveys in Australia, Canada, Chile, Israel and New Zealand are undertaken on a multi-year or occasional basis, but take place annually in other countries. Even among European countries, where indicators are fully harmonised, data collection practices differ; for example, ICT usage is not always monitored by means of a dedicated survey. In Austria, Belgium, Czech Republic, Estonia and Ireland, data are collected through the Labour Force Survey, while in Italy and the United Kingdom data are gathered through a general survey on living conditions.

Other potential sources of difference include the compulsory or voluntary nature of responses and recall periods (in the European Union the survey is compulsory in only eight countries). Breakdown of indicators by age or educational attainment groups may also raise issues concerning the robustness of information, especially for smaller countries, owing to sample size and survey design.

Total, daily and mobile Internet users, 2006 and 2013
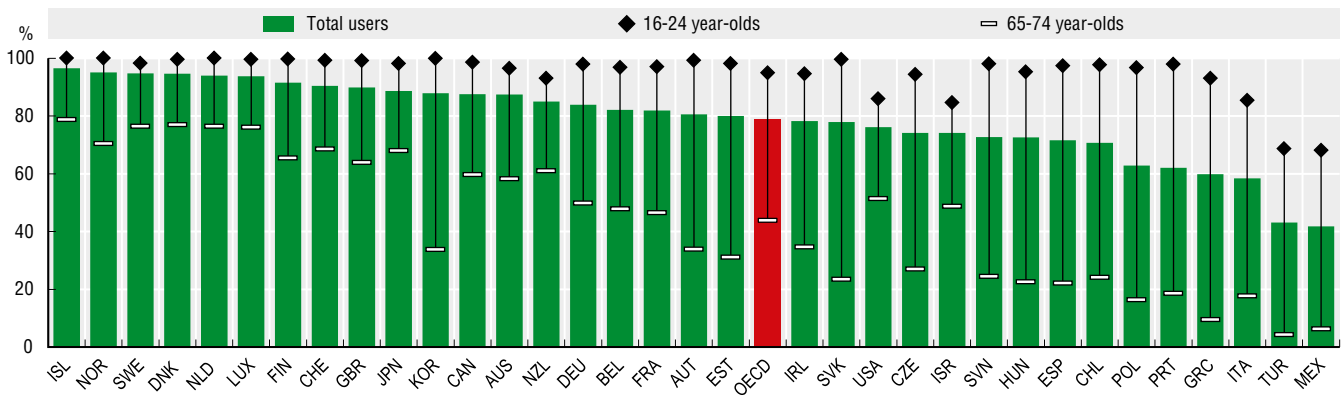
As a percentage of 16-74 year-olds

Legend: ■ Total users ■ Of which daily users ◇ Total users, 2006

Values above bars (Percentage of Internet users via mobile or smartphones):

ISL	NOR	SWE	DNK	NLD	LUX	FIN	CHE	GBR	JPN	KOR	CAN	AUS	NZL	DEU	BEL	FRA	AUT	EST	OECD	IRL	SVK	USA	CZE	ISR	SVN	HUN	ESP	CHL	POL	PRT	GRC	ITA	TUR	MEX
46	65	65	57	57	55	52	36	58		83	49		48	35	37	42	45	26	41	41	33		22		31	23	45		21	16	21	15	18	

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, May 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148196

Internet users by age, 16-24 and 65-74 year-olds, 2013

As a percentage of population in each age group

Legend: ■ Total users ◆ 16-24 year-olds ▭ 65-74 year-olds

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, May 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148208

Internet users among 55-74 year-olds by educational attainment level, 2013

As a percentage of 55-74 year-olds in each educational attainment group
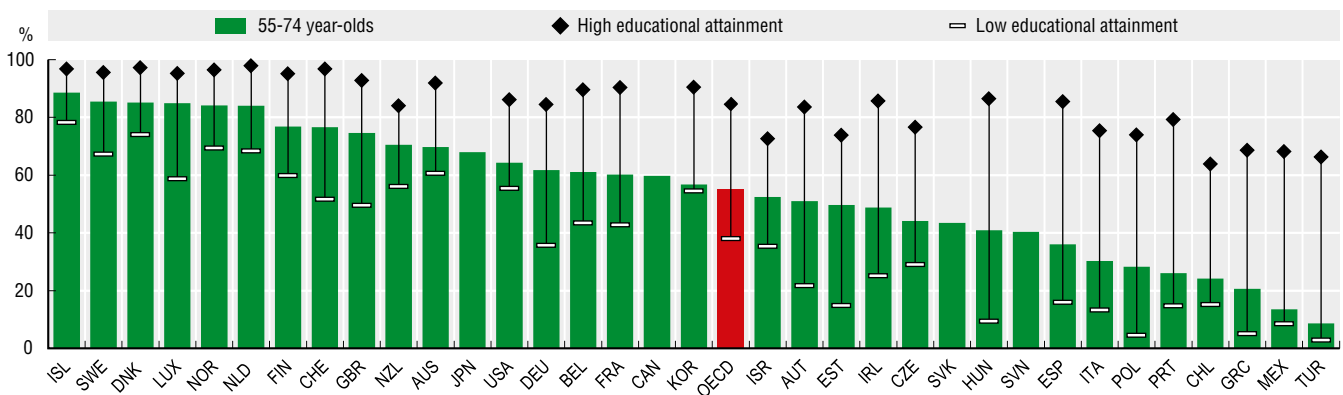
Legend: ■ 55-74 year-olds ◆ High educational attainment ▭ Low educational attainment

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, May 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148219

Key findings

Internet usage to perform specific activities varies widely both according to the type of activity and across countries, as a result of institutional, cultural or economic factors. Comparing diffusion of different online activities among individuals can help to shed light on factors that encourage and discourage their diffusion.

Over 2012-13, on average almost 90% of Internet users reported sending emails, about 80% reported using the Internet to obtain information on goods and products, and 70% reported reading online news. The share of Internet users ordering products online was 57% while only 22% sold products over the Internet.

Activities such as sending emails, searching product information or social networking show little variation across all countries. However, the shares of Internet users performing activities usually associated with a higher level of education, with cultural elements or more sophisticated service infrastructures, tend to present higher inter-country variability. This is the case, for example, for the majority of indicators related to e-government, e-commerce and online banking.

In 2013, the use of online banking varied significantly from over 90% in Estonia, Finland and Norway to less than 20% in Chile and Greece. Overall income and wealth levels contribute to these differences, but are not the sole factors. For example, in Estonia the share of individuals who carried out online banking activities was rather high compared to the relatively low per capita income.

Income-related differentials within countries were also uneven, the highest gap in 2013 being observed in Spain. The gap between the highest and the lowest quartiles was also high for Belgium and Luxembourg, but much lower in countries with comparable online banking rates, such as Austria or France.

Country uptake patterns for sophisticated activities tend to be similar. For example, online banking is positively correlated with the use of e-government services (also requiring trust, familiarity and infra-structural development), software downloading and, to a lesser extent, e-purchases, audio-video streaming and online gaming. Hence, other elements are likely to come into play, including familiarity with online services, trust and skills, together with country-specific elements not considered here (see Measurability).

Definitions

Diffusion indicators by activity are computed as the simple average (i.e. not weighted by population) of country percentage shares, as well as extreme (minimum and maximum) and quartile values of each distribution. This approach shows the variability in uptake of each activity among Internet users across countries, with the lines between the 1st and the 3rd quartile including the central 50% of country values for each indicator.

In the case of *online banking*, the poorest and richest 25% of households are compared.

Measurability

Collection of data on ICT usage by individuals is uneven across OECD countries, due to differences in the frequency and nature of surveys (see 3.1).

Collection of data varies as well over time, as surveys commonly shift their focus on a regular basis to ensure that the response burden remains acceptable.

Data might also reflect a variety of country-specific elements, including the diffusion and ease of use of alternative channels to perform certain activities (e.g. local terminals of government offices or ATMs in the case of banking services, as in Portugal and Turkey), as well as institutional aspects. For example, in Korea the amount of money individuals are allowed to transfer via the Internet is subject to limitations on grounds of security.

Finally, indicators are not always fully harmonised across countries.

The OECD is actively engaged in work to facilitate the collection of comparable information in this field through its Model Survey on ICT Access and Usage by Households and Individuals, and by encouraging the co-ordinated collection of statistics on usage, in particular, on emerging topics. It is also currently exploring alternative ways to collect information, including the use of Internet-based statistics (see 3.9).

The diffusion of selected online activities among Internet users, 2012-13
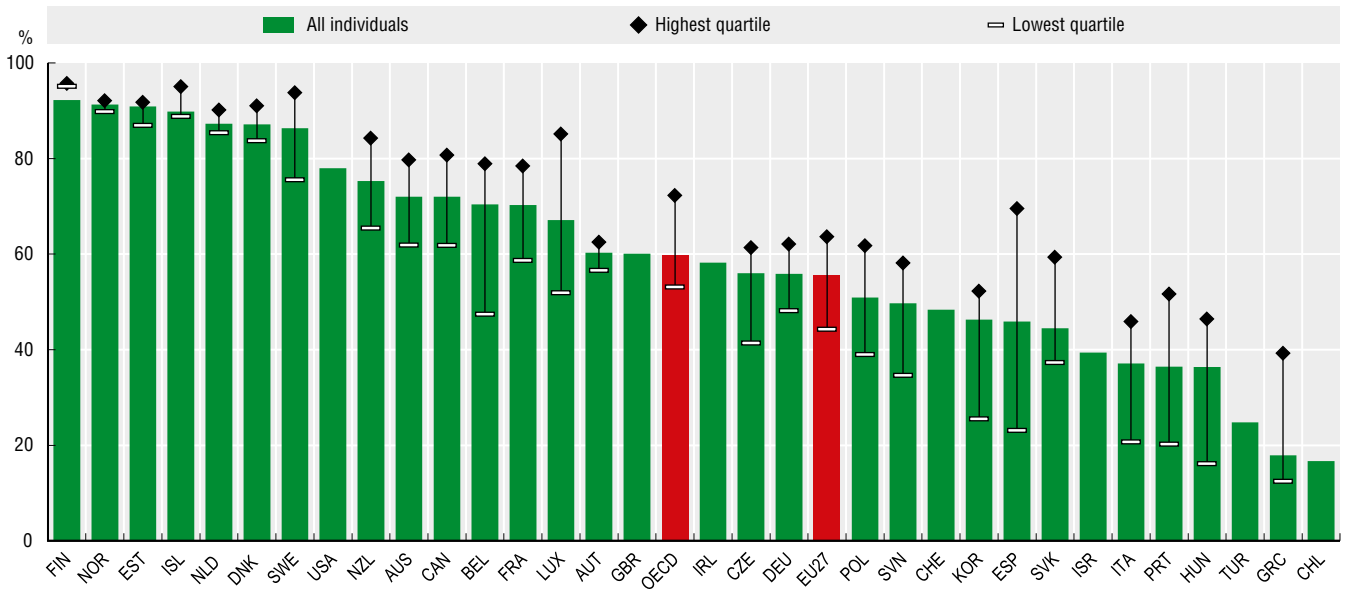
Percentage of Internet users performing each activity
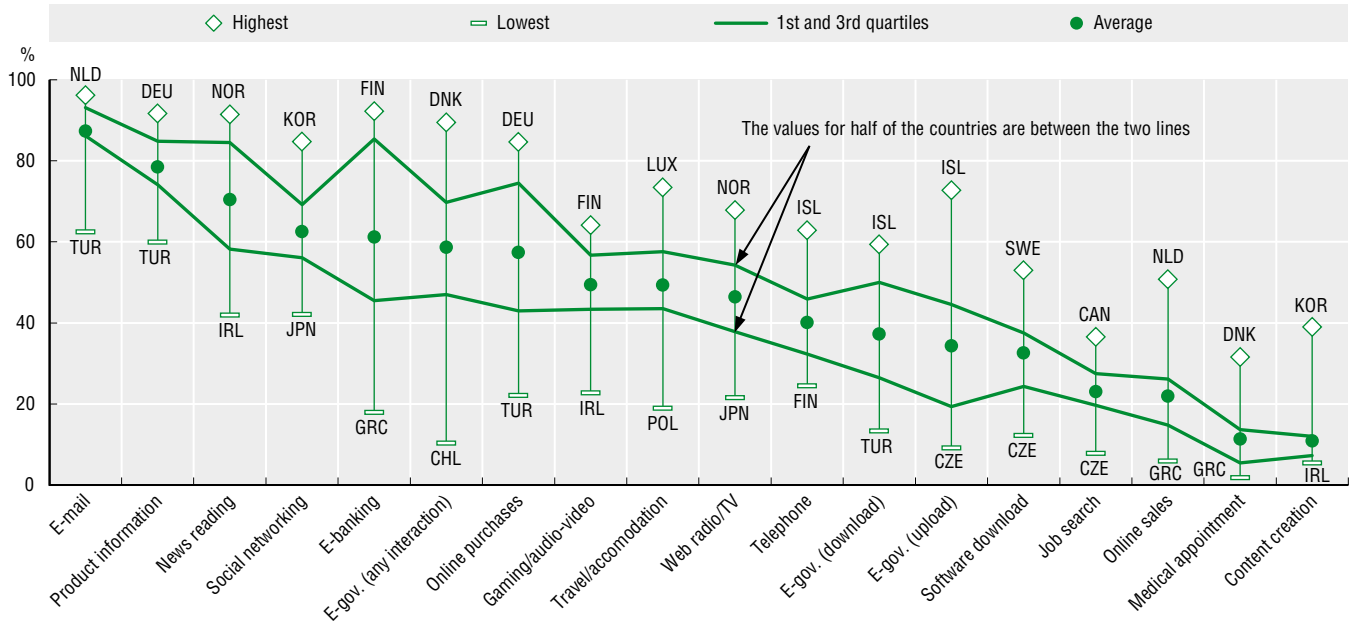
Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, July 2014. See chapter notes.

StatLink ⌨ http://dx.doi.org/10.1787/888933148228

The diffusion of Internet banking, 2013

Percentage of Internet users by income quartile of the household

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, May 2014. See chapter notes.

StatLink ⌨ http://dx.doi.org/10.1787/888933148231

Key findings

The breadth of activities performed by each Internet user can be analysed to develop an indicator of user sophistication.

The average number of activities performed by users, for all available countries combined, shows that in 2013 Internet users performed on average 6.3 out of the 12 activities selected, up from 5.4 in 2009 (i.e. from 45% to 51.6% of the listed activities), mirroring a growing maturity of usage.

By country, the averages range from 7.5 to 8 activities per user in the Nordic countries and the Netherlands, to about 5 activities or less in Greece, Italy, Korea, Poland and Turkey. The growth rates between 2009 and 2013 ranged from 6.2% in Spain to 22.9% in Iceland.

The breadth of activities performed by country is, on average, closely related to differences in the level of Internet uptake. This suggests that "experience matters", as countries leading in uptake also have a proportionally larger share of individuals using the Internet over a longer period of time.

Regardless of the reason, this pattern demonstrates that countries with low levels of uptake benefit less from the Internet than the rate of usage implies, as their users on average are performing fewer activities (i.e. are less "sophisticated" users).

Not controlling for other factors, the education gap is among the most important explanatory factors of the breadth of activities performed on the Internet. While users with tertiary education perform on average 7.3 different activities, those with at most lower secondary education perform only 4.6.

This is not surprising, as some of the activities in the list are either more complex or otherwise indirectly connected to education (e.g. through age or income). Differences by level of education are particularly high for Belgium, Hungary, Ireland, Korea and Turkey. Furthermore, users with low levels of education in countries experiencing a wide education gap perform fewer activities than senior users (defined as individuals between 55 and 74 years old).

DID YOU KNOW?

The breadth of activities performed online is related to rates of Internet usage and education levels. Educated users in Italy are engaged in less sophisticated online activities than average users in Northern Europe.

Definitions

The average number of *online activities per user* is based on information on the share of users for each activity. The following 12 activities were considered: using e-mail, telephoning or video calling over the Internet, participating in social networks, finding information about goods or services, reading online news, online banking, using services related to travel and accommodation, interacting online with public authorities, selling goods or services, buying physical goods, buying digital content and buying services.

These indicators are derived from individual micro-data made available by Eurostat for countries in the European Statistical System (ESS). For Korea, a special tabulation has been produced by the Korean Internet and Security Agency (KISA).

To portray the (gross) relation with Internet uptake, the number of activities per user by country is plotted jointly with the shares of Internet users, showing for convenience a simple (non-linear) regression line and the corresponding variance explained. The average number of activities has also been computed for individuals with tertiary and low or no formal education, and for the subpopulation of individuals aged 55 and above.

Measurability

Collection of information on ICT usage by individuals is uneven across OECD countries, due to differences in frequency and the nature of surveys (see 3.1). In particular, data on the type of activities performed – potentially wide and increasing – are often restricted to basic information. For this reason, the comparison is limited to countries participating in the ESS (OECD EU member countries, Iceland, Norway and Turkey). Data for Korea are also presented, although activities do not fully correspond to those listed for the ESS countries, resulting in a possible underestimation of the number of activities performed.

The variety of activities performed online by Internet users, 2009 and 2013

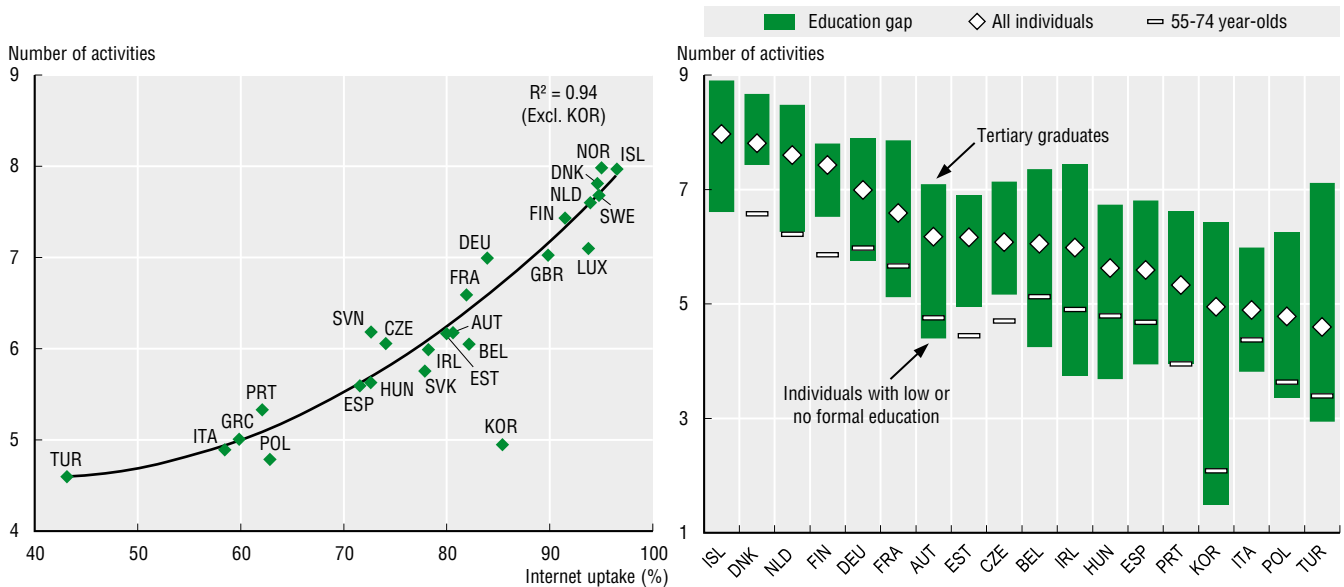*Average number of activities per user*
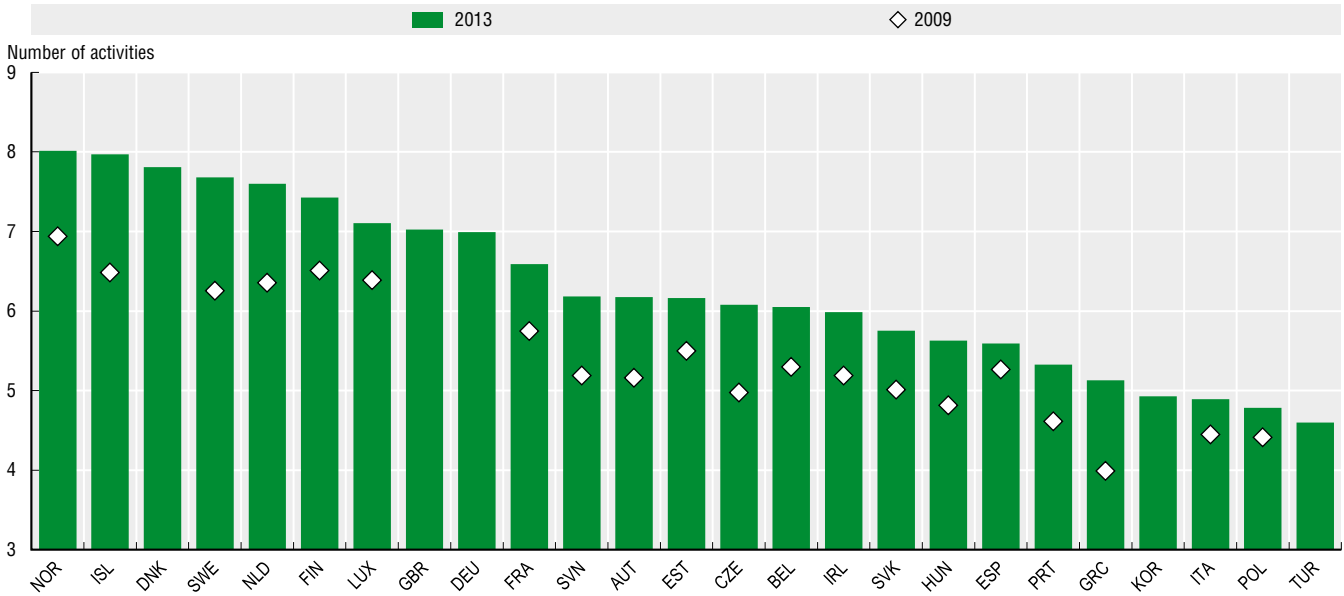
Source: OECD computations based on Eurostat, Information Society Statistics and ad-hoc data tabulation by KISA, May 2014. See chapter notes.

StatLink ᵃᵍ⁵ᵖ http://dx.doi.org/10.1787/888933148245

Factors influencing the variety of activities per user: Internet uptake, education and age, 2013

Number of activities linked to the percentage of users (left-hand panel) and by education level and age (right-hand panel)

Source: OECD computations based on Eurostat, Information Society Statistics and ad-hoc data tabulation by KISA, May 2014. See chapter notes.

StatLink ᵃᵍ⁵ᵖ http://dx.doi.org/10.1787/888933148252

Key findings

The Internet permeates every aspect of the economy and society, and is also becoming an essential element of children's lives.

According to the results of the 2012 OECD Programme for International Student Assessment (PISA), 90% of students in the OECD first access the Internet before the age of 13. On average, for countries where data are available, less than 0.5% of 15 year-olds reported never having accessed the Internet.

Age of first access to the Internet varies largely across countries. More than one third of students started using the Internet aged 6 or younger in Denmark and the Netherlands. About 80% of students accessed the Internet before age 10 in the Nordic countries, the Netherlands and Estonia, as opposed to 30% in Greece and the Slovak Republic.

Early use of the Internet appears to be correlated with time spent online by 15 year-olds, across countries. In Australia, Denmark and Sweden, the average student spends about 4 hours on the Internet on a typical weekday, whereas students in Korea spend less than 1.5 hours. Students use the Internet mostly outside of school. Time spent online at school is slightly more than half an hour per day in the OECD, with little variation among countries.

While access to information via the Internet may bring considerable benefits for children's education, it also exposes them to online risks such as access to inappropriate content, harmful interactions with other children or adults, and exposure to aggressive marketing practices. Children online may also put at risk the computers they use and inadvertently disseminate their own personal data.

Parental control software is the most common technological solution for enhancing child safety online. There are notable differences across countries in terms of individual use of such tools. In 2010, the share of individuals using parental control or web-filtering software varied from 22.5% in Slovenia to 2% in the Slovak Republic. Recent data from Japan show an increase in usage from about 20% in 2010 to 26% in 2012.

Protection of children online is an important public policy concern in many countries. The 2012 OECD *Recommendation of the Council on the Protection of Children Online* offers guidelines for all stakeholders (businesses, civil society and the online technical community) involved in making the Internet a safer environment for children.

DID YOU KNOW?

On average, 15-year-olds in the OECD spend about 3 hours a day on the Internet on a typical weekday.

Definitions

Students assessed by PISA are between the ages of 15 years 3 months and 16 years 2 months. They must be enrolled in school and have completed at least 6 years of formal schooling, regardless of the type of institution, the programme followed, or whether the education is full-time or part-time.

The average number of *hours* spent online is computed by taking the midpoint of each category available in the questionnaire, except for the first category (no time), which is recoded as zero minutes, and the last category (more than six hours per day), which is recoded as six hours.

All PISA shares are reported as a percentage of respondents.

A *parental control or a web filtering software* is designed to control the content viewed and restrict the material delivered over the Internet. Parents may use this software to limit the sites that children may view on computers at home.
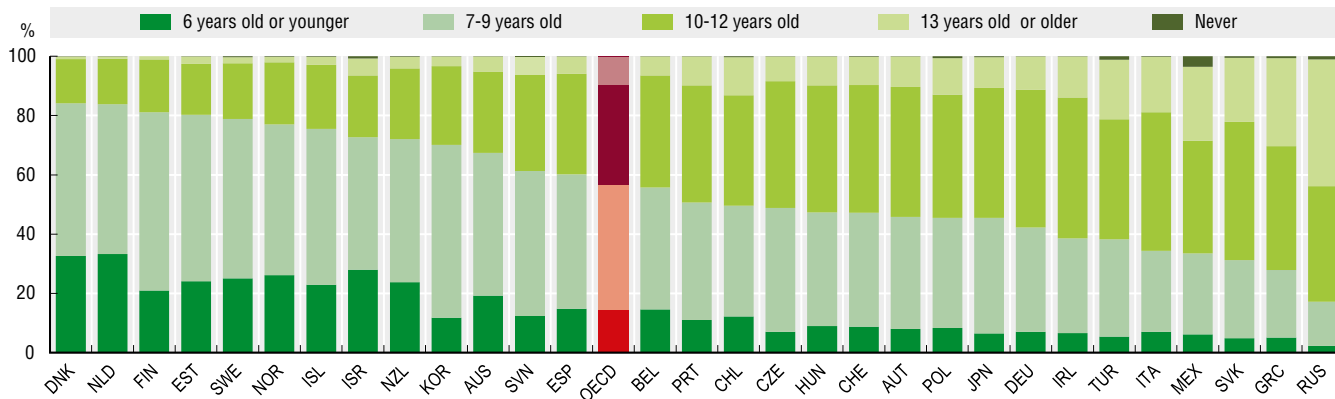
Measurability

PISA 2012 assessed the skills of 15 year-olds in 65 economies. Around 510 000 students between the ages of 15 years 3 months and 16 years 2 months participated, representing 28 million 15 year-olds globally.

The ICT familiarity questionnaire is an optional module and consists of questions on the availability of ICTs at home and school, the frequency of use of different devices and technologies, and student's attitudes towards computers. In 2012, 43 out of 65 economies participating in PISA ran this specific module on an overall student population of 310 000. Despite the valuable information gained as a result of implementation, the ICT questionnaire is not administered in several countries, including Canada, France, the United Kingdom and the United States, due to the high costs generated by the inclusion of these additional questions in the survey.

The information on use of parental control and web-filtering software for all countries, excluding Japan, originates from the special module on Internet security of the 2010 Community Survey on ICT Usage in Households and by Individuals. This type of data has not been collected subsequently.

Age of first access to the Internet, 2012

As a percentage of all students

Legend: 6 years old or younger | 7-9 years old | 10-12 years old | 13 years old or older | Never

Source: OECD, PISA 2012 Database, May 2014.

StatLink ᎒ᏆᏋ *http://dx.doi.org/10.1787/888933148262*

Internet use of 15 year-old students at school and outside school, 2012

Average number of hours spent on the Internet during a typical weekday

Legend: Internet use outside school | Internet use at school

Source: OECD, PISA 2012 Database, May 2014.

StatLink ᎒ᏆᏋ *http://dx.doi.org/10.1787/888933148275*
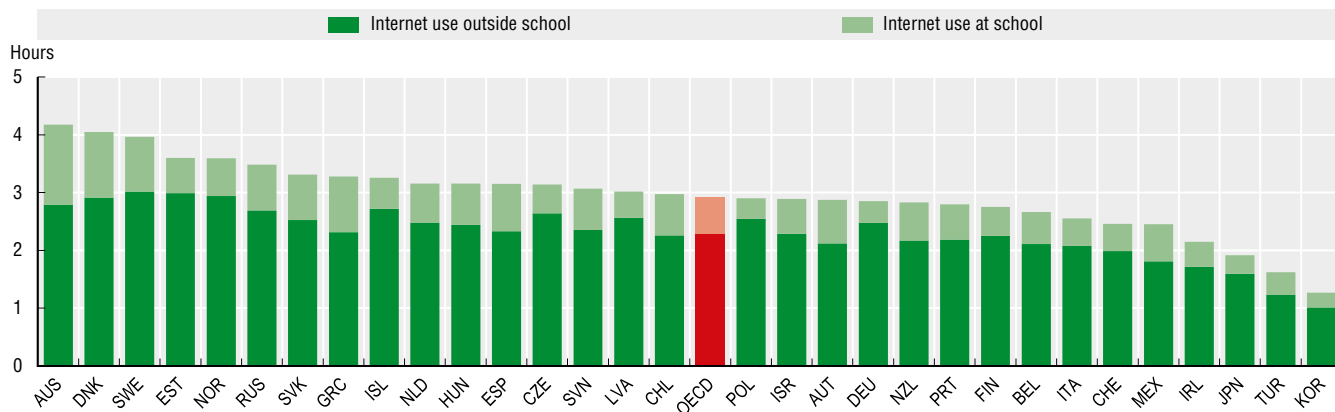
Individuals using a parental control or web-filtering software, 2010

As a percentage of all individuals having used the Internet in the last 12 months
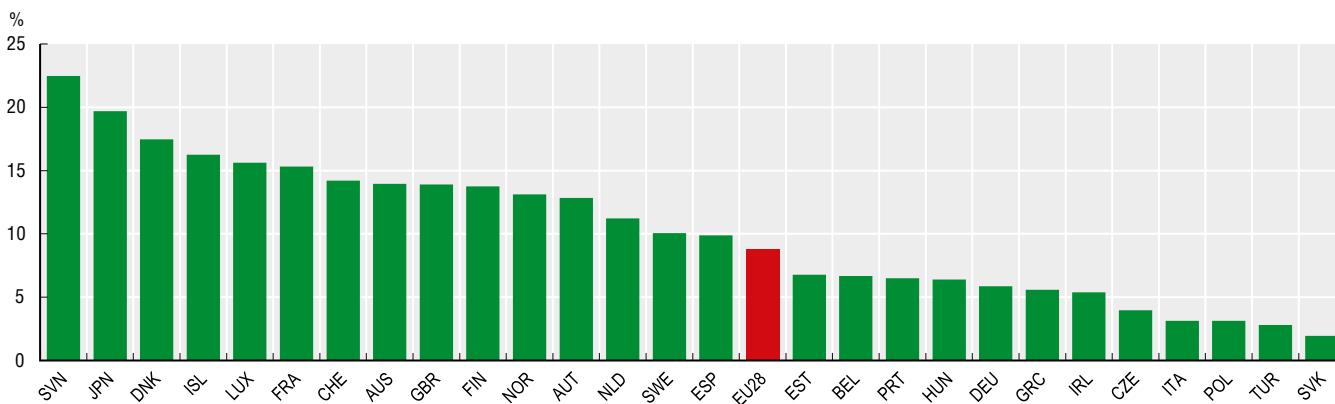
Source: OECD, ICT Database and Eurostat, Information Society Statistics, May 2014.

StatLink ᎒ᏆᏋ *http://dx.doi.org/10.1787/888933148282*

Why do we need indicators?

In 2012, about 55% of 15 year-olds in the OECD reported having accessed the Internet for the first time before the age of 10, and spending on average 3 hours per day online (see 3.4). The Internet is becoming an essential component of children's lives, but carries a spectrum of risks to which children are more vulnerable than adults. Addressing risks faced by children online is becoming a policy priority for an increasing number of governments. However, a number of measurement gaps need to be filled to improve comparable assessments across countries of the contexts in which children make use of different ICT tools, and the broader impacts of their activities online.

Indicators of children's online activity can be derived from official statistics, if the age range in the population scope of the ICT usage surveys permits, as in the case for Japan and Korea. Alternatively, countries may choose to add a specific module (e.g. Poland) to the main ICT survey or run separate surveys (e.g. Australia, Brazil, Egypt, the United Kingdom) to collect additional information on usage patterns and issues related to child protection online.

The lack of harmonisation in the coverage, concepts and definitions used in different ICT surveys often hinders sound international assessments (see 3.1) and does not allow information on children online to be fully captured in an internationally comparable fashion. For example, age coverage in surveys varies considerably with some countries assessing from age 5 upwards as in the Ofcom surveys on Children's Media Literacy (United Kingdom) or in the specific module of the 2013 survey on ICT usage by households in Poland. Some others (e.g. ICT Kids Online survey, Brazil) cover children from age 9 upwards. A broader age range in the population scope, such as found in Korea, would permit better understanding of the determinants of online activities and the role played by early childhood institutions in framing the use of different online technologies.

Data needs remain important in the field of child protection online, especially with regard to children's exposure to online incidents, their behaviour while facing different risks, and the roles played by parents, teachers and different IT protection tools in terms of risk prevention. Finally, too little is known about how children reap the benefits of online activity and the impacts of this activity on school performance, personal development, and health and well-being in the short and long term.

What are the challenges?

There are a number of challenges to better assessment of children's online activities and protection, the most significant of which relates to the administrative burden on national statistical offices. Some countries introduce specific questions on children's ICT use into ICT usage surveys, thereby obtaining valuable information, however many others are discouraged by the high costs involved.

In parallel, more targeted surveys allow a deeper investigation of the opportunities and risks associated with Internet use by children. However, the collection of such data often remains ad-hoc and does not allow for timely international comparisons in a context characterised by rapid change.

In the case of household surveys, it should be noted that questions related to children online are sometimes addressed both to parents and children with responses not necessarily being identical. Therefore, the identification of the respondent has an impact on the reliability of the information collected.
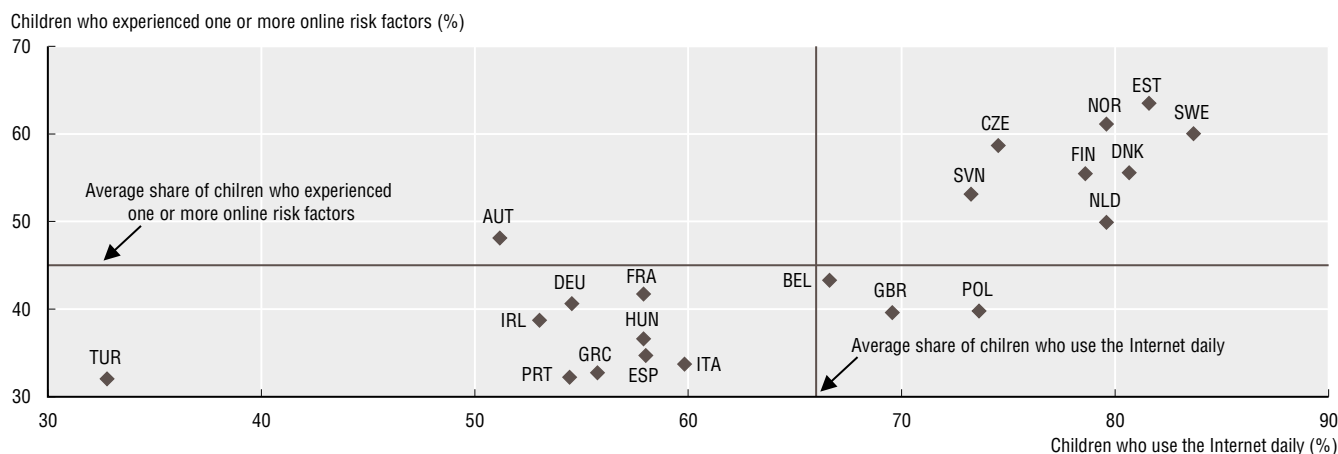
Finally, as in the case of all subjective assessments, robust data collection – on awareness and knowledge of online threats, concerns and attitudes towards online risks, preventive measures and the perception of harm – remains difficult from both an national and international perspective.

Options for international action

An attempt in 2010 by the EU Kids Online research network to collect internationally comparable data on children's online activity surveyed 1 000 individuals aged between 9-16 years old across 25 countries (Livingstone *et al.*, 2011). The results showed that the percentage of children who reported experiencing one or more risks online increased with daily use of Internet.

Internet use and online risk experience of 9-16 year-olds, 2010

Percentage of children who use the Internet daily linked to those who experienced one or more online risk factors

Children who experienced one or more online risk factors (%)

Average share of chilren who experienced one or more online risk factors

AUT

DEU   FRA   BEL

IRL   HUN

TUR   PRT GRC ITA
ESP

Average share of chilren who use the Internet daily

CZE   NOR EST SWE

SVN   FIN DNK

NLD

GBR   POL

Children who use the Internet daily (%)

Source: Livingstone *et al.* (2011).

StatLink http://dx.doi.org/10.1787/888933148299

Despite the relatively small size of the sample, the EU Kids Online survey sheds light on children's online experiences from Internet use (length, devices, location), their online activities (opportunities, skills, risky practices), the risks encountered online and the experienced outcomes (whether harmful or not, how children cope).

ITU (2010) provides a statistical framework for the measurement of child online protection within the Global Cybersecurity Agenda framework with the specific aim of establishing measures suitable for international comparisons. The report also recommends a list of main indicators related to measuring child online protection along with their definitions and suggestions for data collection.

The 2014 revision of the OECD Model Survey on ICT Access and Usage by Households and Individuals also contains a specific module on children online. It aims to better identify and assess different incidents faced by children online such as cyber bullying, child solicitation, grooming or exposure to a medium that might foster harmful behaviour on the part of children.

Protection of children online remains today an important public policy concern in many countries. The 2012 OECD *Recommendation of the Council on the Protection of Children Online* offers guidelines for all stakeholders (businesses, civil society and the online technical community) involved in making the Internet a safer environment for children. In particular, it underlines the need for governments to share information about national policy approaches to protect children online and develop the empirical foundations for quantitative and qualitative international comparative policy analysis. The Internet Literacy Assessment indicator for Students (ILAS) developed by Japan is an insightful example of follow-up to the Recommendation. The results of the project were presented at the OECD Working Party on Information Security and Privacy in 2013 and illustrate specific policy issues, including the role played by parents and the negative impact of excessive restriction on the use of the Internet.

References

ITU (2010), *Child Online Protection: Statistical Framework and Indicators*, Geneva, ITU.

Livingstone, S., L. Haddon, A. Görzig, and K. Ólafsson (2011), *Risks and Safety on the Internet: The Perspective of European Children. Full Findings and Policy Implications from the EU Kids Online Survey of 9-16 Year-olds and Their Parents in 25 Countries*, EU Kids Online Deliverable D4, EU Kids Online Network, London, eprints.lse.ac.uk/33731.

OECD (2012), *Recommendation of the Council on the Protection of Children Online*, acts.oecd.org/Instruments/ShowInstrumentView.aspx?InstrumentID=272.

Key findings

Students are at the forefront of ICT uptake across all OECD countries. Differences in the use of ICTs persist, however, even among young people; and schools play a crucial role in reducing this digital gap.

The results of the 2012 OECD Programme for International Student Assessment (PISA) show that about 70% of students in the OECD use the Internet at school. This share ranges from 97% in Denmark to about 40% in Turkey. More than 40% of 15-year-olds in Korea reported that Internet access was available at school, but that they did not use it. About 30% of students in Japan and Mexico stated that Internet access was unavailable in school compared with an OECD average of 10%.

ICTs are used at school for various purposes such as communication, playing games, homework assignments, searching for information, and practising and drilling, including for foreign language learning or mathematics. According to the 2012 PISA results, there are significant differences across countries in terms of activities carried out on computers at school. In Norway, about 70% of 15-year-olds reported using a computer for practising and drilling, a percentage that dropped to 27% in Ireland and less than 10% in Korea and Japan.

In some countries such as Israel, Italy, Mexico and Turkey, the use of computers at school for practising and drilling appears to be rather diffused compared to the relatively low level of Internet connection availability at school. This variation across countries is related to differences in the education systems, policy priorities and school policies in terms of student access to and use of ICTs.

Regarding frequency of use, in most countries the majority of students use computers for practising and drilling only once or twice a month. The percentage of students using computers for this purpose on a daily basis remains low, standing at 12% in Denmark, 10% in Norway and around 2% in Finland and Germany.

Over the last few years, ICTs have contributed increasingly to a wider array of learning opportunities and education programmes through the development of online courses, in particular, the massive open online courses (MOOCs).

In 2013, 7.8% of Internet users in the EU followed an online course against 4.7% in 2007. This increase was generalised across countries, and shares more than doubled in some of them. On average, for the 30 OECD countries for which data are available, 9.4% of Internet users followed an online course in 2013. This percentage varied from 40% in Korea and 33% in Canada, to less than 4% in Austria, the Czech Republic, Japan and Poland.

DID YOU KNOW?

More than 70% of 15-year-olds across the OECD use the Internet at school.

Definitions

Students assessed by PISA are between the ages of 15 years 3 months and 16 years 2 months. They must be enrolled in school and have completed at least 6 years of formal schooling, regardless of the type of institution, the programme followed, or whether the education is full-time or part-time.

All PISA shares are reported as a percentage of respondents.

The Internet is considered as *available* even if student access is limited to certain times or to certain activities.

An *online course* reflects learning courses distant from the location of education and training organisations or employer where courses can be attended in person (often, but not necessarily done at home). Interaction with teachers, trainers and/or learning material is effected via the Internet. Often, individuals use e-learning software programmes. Data also include individuals who take a course only partially delivered online.

Measurability

PISA 2012 assessed the skills of 15 year-olds in 65 economies. Around 510 000 students between the ages of 15 years 3 months and 16 years 2 months participated, representing 28 million 15 year-olds globally.

The ICT familiarity questionnaire is an optional module administered to an overall student population of 310 000 across 43 countries and economies. It provides information on the availability of ICTs at home and school, the frequency of use of different devices and technologies, and student's attitudes towards computers.
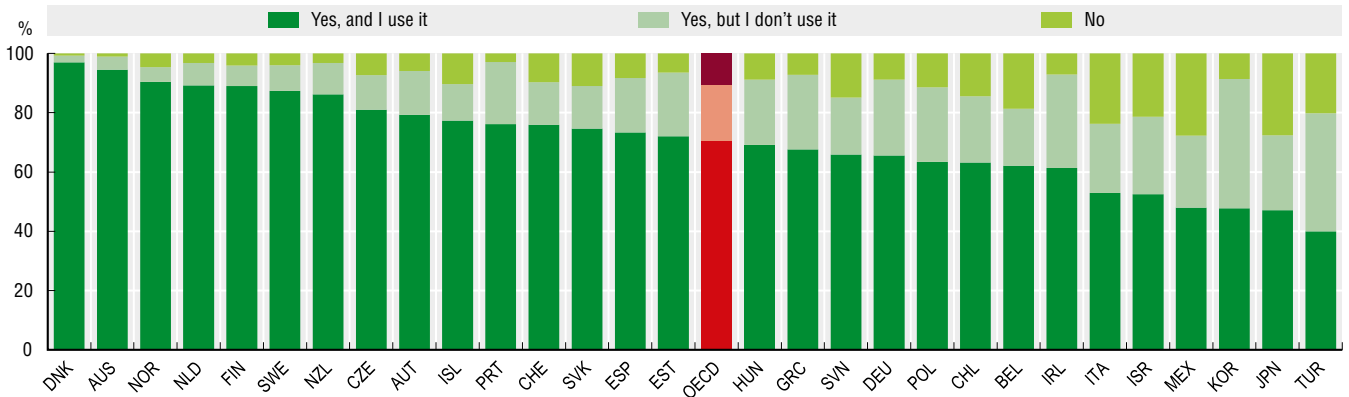
There is still an important lack of internationally comparable data over time in terms of ICT uptake, use and impact, especially at the higher education level and in vocational education. For example, as regards online courses, more detailed cross-country information on the type of courses offered, attendance frequency and participants' characteristics would allow for a better understanding of ICT use in education today.

The OECD's Innovation Strategy for Education and Training is leading to a measurement agenda in line with the increasingly important role played by ICTs for education as enablers of pedagogical innovation.

Internet connection availability at school, 2012
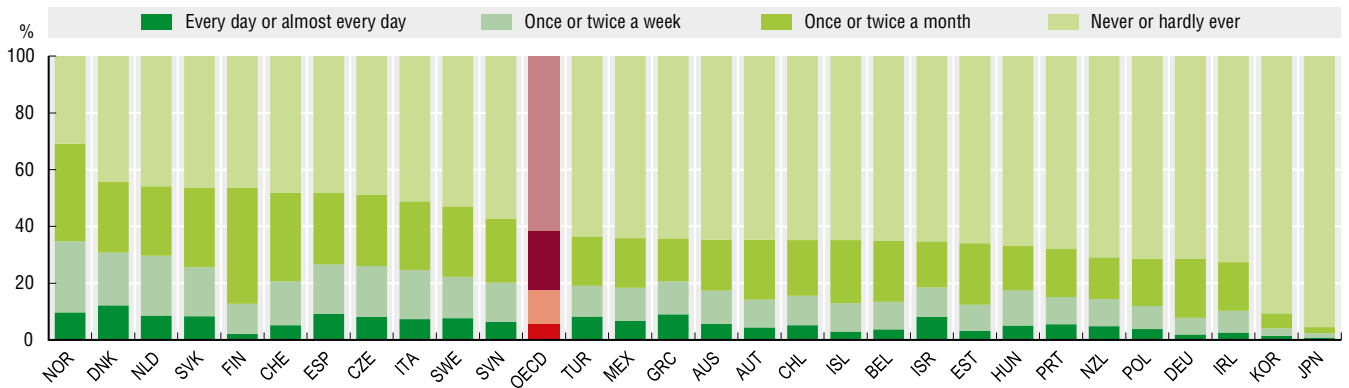*Percentage breakdown of all students*

Yes, and I use it   Yes, but I don't use it   No

DNK AUS NOR NLD FIN SWE NZL CZE AUT ISL PRT CHE SVK ESP EST OECD HUN GRC SVN DEU POL CHL BEL IRL ITA ISR MEX KOR JPN TUR

Source: OECD, PISA 2012 Database, May 2014.

StatLink ⌨ http://dx.doi.org/10.1787/888933148307

Computer use at school for practising and drilling, such as for foreign language learning or mathematics, 2012
Percentage breakdown of all students

Every day or almost every day   Once or twice a week   Once or twice a month   Never or hardly ever

NOR DNK NLD SVK FIN CHE ESP CZE ITA SWE SVN OECD TUR MEX GRC AUS AUT CHL ISL BEL ISR EST HUN PRT NZL POL DEU IRL KOR JPN

Source: OECD, PISA 2012 Database, May 2014.

StatLink ⌨ http://dx.doi.org/10.1787/888933148314

Individuals who attended an online course, 2007 and 2013
As a percentage of individuals who used the Internet in the last three months
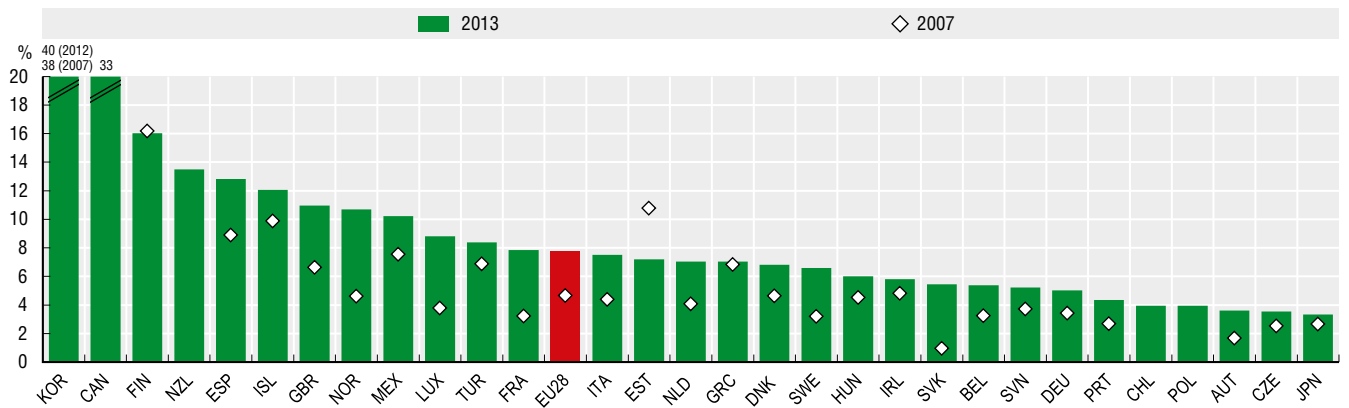
2013   ◇ 2007

40 (2012) 33
38 (2007)

KOR CAN FIN NZL ESP ISL GBR NOR MEX LUX TUR FRA EU28 ITA EST NLD GRC DNK SWE HUN IRL SVK BEL SVN DEU PRT CHL POL AUT CZE JPN

Source: OECD, ICT Database and Eurostat, Information Society Statistics, May 2014. See chapter notes.

StatLink ⌨ http://dx.doi.org/10.1787/888933148328

Key findings

Intensification of ICT use in the home and the workplace has strongly affected the set of skills needed to participate fully in and benefit from connected societies and increasingly knowledge-based economies.

The results from the first OECD Programme for the International Assessment of Adult Competencies (PIAAC) show important differences across countries in terms of computer use at work. In 2012, about 80% of individuals at work reported having experience with a computer in the Nordic countries, as opposed to about 50% in Italy and 45% in the Russian Federation. However, a significant majority of individuals in all countries reported their computer use in the workplace as being straightforward or moderate. The share of individuals experiencing complex computer use varied between 8% of all individuals at work in Denmark and 3% in the Russian Federation.

In 2012, on average, 54% of workers reported using word processors, while 46% used spreadsheets and about 10% carried out programming tasks. Despite the relatively generalised use of word processors and spreadsheets across countries, the share of individuals with programming skills remains low varying between 17% in Korea and 6% in Italy.

While such cross-country variation in the type of ICT skills used at work may reflect differences in the labour market structure, it also provides an indication of the skill base and its characteristics. For instance, workers in countries that report relatively high ICT skills use at work, such as the Netherlands and Norway, also cite higher confidence in their computer skills should they change jobs.

Job mobility is an important driver of knowledge transfer and spillovers, which in turn foster innovation and growth in the digital economy. However, in 2013 only 39% of individuals in the EU labour force judged their computer skills to be sufficient to look for a job or change job within a year. Among the European countries, this percentage varied between 60% in the Netherlands and 25% in Greece. In all countries, individuals with a higher level of formal education report higher confidence in their computer skills, as compared to those with no or low formal education. The gap between these two groups exceeds 60 percentage points in Poland and Turkey.

Education and labour policies play a crucial role in the acquisition of ICT skills, their use at work and also their obsolescence if they remain unused. Governments need to craft policies that sustain a skilled labour force, are able to meet current labour market needs and easily adapt to changing skills demands over time.

DID YOU KNOW?

In 2013, more than 60% of the EU labour force reported their computer skills as being insufficient to apply for a new job.

Definitions

Straightforward computer use includes basic routines such as data entry or sending and receiving e-mails. *Moderate* computer use refers to word-processing, use of spreadsheets or database management. *Complex* computer use encompasses developing software or modifying computer games, programming using languages like Java, SQL, PHP or Perl, or maintaining a computer network.

All PIAAC shares are reported as a percentage of respondents.

Potential *job change* does not necessarily mean a change of employer and can concern change of functions within the same organisation. This variable provides general information on perceived skills sufficiency or gaps in relation to labour market requirements. The data refer to skills sufficient for performing a job that requires computer or Internet skills or professional ICT skills for individuals employed in ICT occupations.

Measurability

PIAAC surveyed around 166 000 adults aged 16-65 in 24 countries and sub-national regions. These included 22 OECD countries (Australia, Austria, Belgium (Flanders), Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, the Slovak Republic, Spain, Sweden, the United Kingdom (England and Northern Ireland), and the United States; and two partner countries (Cyprus and the Russian Federation).

PIAAC provides information on how skills are used at home, in the workplace and in the community; how these skills are developed, maintained and lost over a lifetime; and how they are linked to labour market participation, income, health, and social and political engagement. With this information, the Survey of Adult Skills helps policy makers to: (i) examine the impact of reading, numeracy and problem-solving skills on a range of economic and social outcomes; (ii) assess the performance of education and training systems, workplace practices and social policies in developing the skills required by the labour market and by society in general; and (iii) identify policy levers to reduce deficiencies in key competencies.
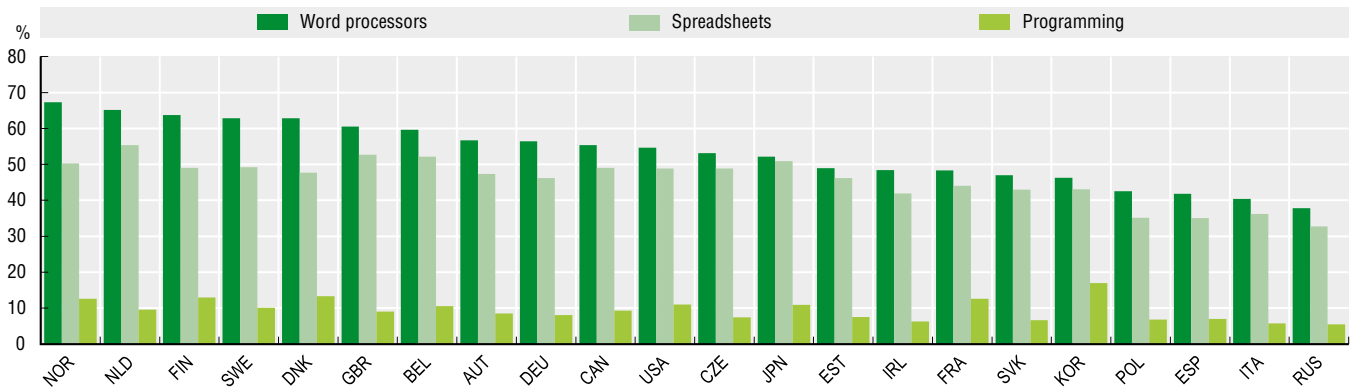
Computer use at work, 2012
Percentage shares of all workers
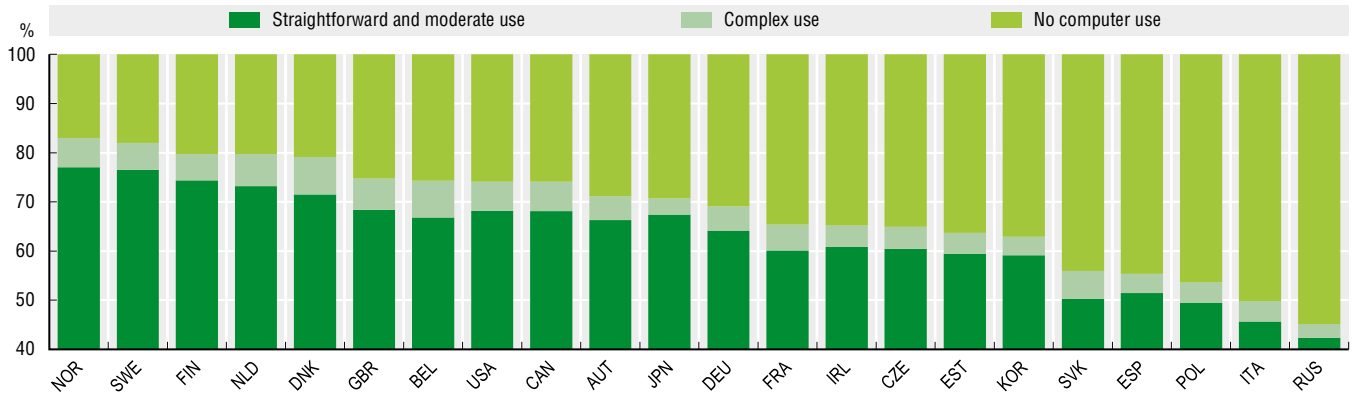
Straightforward and moderate use   Complex use   No computer use

NOR SWE FIN NLD DNK GBR BEL USA CAN AUT JPN DEU FRA IRL CZE EST KOR SVK ESP POL ITA RUS

Source: OECD, PIAAC Database, May 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148332

ICT skills use at work, 2012
Percentage shares of all workers

Word processors   Spreadsheets   Programming

NOR NLD FIN SWE DNK GBR BEL AUT DEU CAN USA CZE JPN EST IRL FRA SVK KOR POL ESP ITA RUS

Source: OECD, PIAAC Database, May 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148347

Individuals who judge their computer skills to be sufficient if they were to apply for a new job within a year, 2013
As a percentage of all individuals
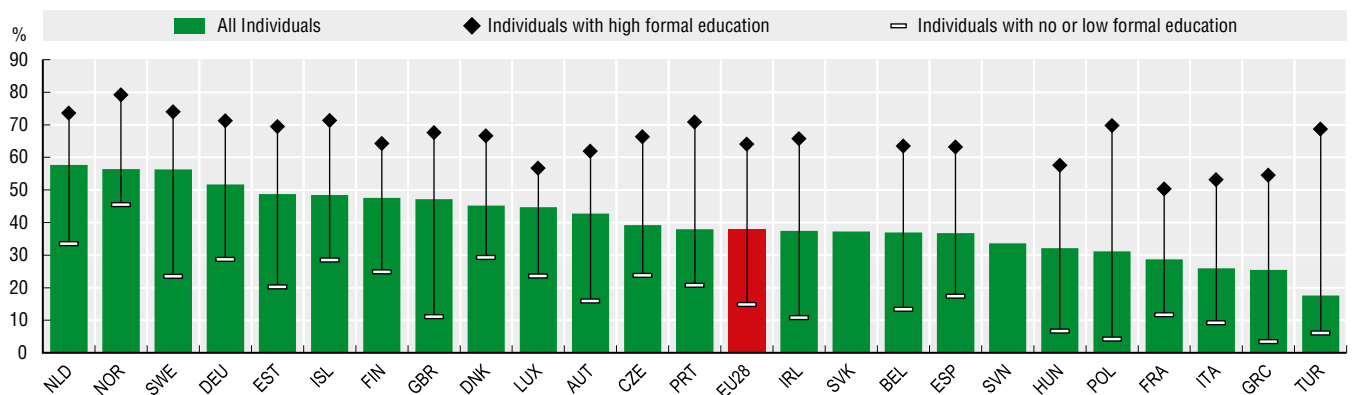
All Individuals   ◆ Individuals with high formal education   ⊟ Individuals with no or low formal education

NLD NOR SWE DEU EST ISL FIN GBR DNK LUX AUT CZE PRT EU28 IRL SVK BEL ESP SVN HUN POL FRA ITA GRC TUR

Source: OECD computations based on Eurostat, Information Society Statistics, May 2014.

StatLink http://dx.doi.org/10.1787/888933148354

Key findings

E-commerce can substantially widen choices and convenience for consumers.

On average, 47% of individuals in OECD countries now buy products online, up from 30% in 2007. This trend is bound to continue in the coming years and has already disrupted traditional distribution channels for some categories of products.

The rapid diffusion of smart mobile devices has resulted in a growing number of individuals who make purchases on the go. The share of mobile purchases varies widely across countries as well as across different product categories, with age, education, income and experience all playing a role in determining the uptake of e-commerce by individuals.

In Denmark and the United Kingdom, more than 75% of adults purchase online. This percentage is between 10% and 20% in Chile, Italy and Turkey and below 5% in Mexico.

When considering the population of Internet users these shares increase and differences between leading and lagging countries are overall narrower. About 80% or more of Internet users in Denmark, Germany and the United Kingdom make purchases online, against less than 30% in Chile, Estonia or Turkey and below 10% in Mexico. In addition, it is possible to discern a substantial increase in the diffusion of online purchases with respect to 2007 in most countries, particularly in Belgium, Israel, New Zealand, the Slovak Republic and Switzerland.

The influence of income on e-commerce uptake is reflected in the high shares observed for 25-44 year-olds and in the comparatively high diffusion among 65-74 year-old users in many countries (in particular, Chile, the United Kingdom and the United States), when compared to the age gap observed for Internet usage (see 3.1).

The most common items purchased online are travel and holiday services (about half of online shoppers on average), tickets for events, digital products and books. However, other categories are growing such as food and grocery products.

The diffusion of different categories of products via online purchase might depend on income as well as other factors, including consumer habits and supply-side elements, such as the availability of e-commerce channels by local providers and their associated pricing decisions.

DID YOU KNOW?

About half of individuals in OECD countries purchase goods and services online, and almost 20% in Denmark, Korea, Sweden and the United Kingdom use a mobile device to do so.

Definitions

Online purchases are a component of electronic commerce (e-commerce).

This includes transactions of goods and services "conducted over computer networks by methods specifically designed for the purpose of receiving or placing orders" (*OECD Guide to Measuring the Information Society 2011*). For individuals, whether sellers or purchasers, such transactions typically occur over the Internet.

Online purchases are measured with respect to a 12-month recall period, taking into consideration that this is not always a high-frequency activity.

The main indicator of Internet purchases (including with handheld devices) is computed with reference to the total adult population (16-74 year-olds with a few exceptions as detailed in the chapter notes).

Measurability

The collection of information on ICT usage by individuals is uneven across OECD countries, due to differences in the frequency and nature of surveys (see 3.1).

For online purchases, issues of comparability might be linked to several factors. These include differences in *age limits* (for Japan and the United States, data refer to all individuals aged 6 and over instead of 16-74 year-olds, and this might reduce overall rates); in *reference periods* (for Israel, the period is 3 months instead of 12, while no recall period is specified for the United States and Chile); in *the definition* itself (for New Zealand only e-purchases accompanied by an online payment are considered); and in *survey methodology* (techniques, time of year, etc.).

Finally, differences in the typology of items considered in the surveys run by the OECD countries participating in the European Statistical System, and by other member countries, limit the comparability of types of products purchased online.

Diffusion of online purchases, including via handheld devices, 2007 and 2013

Individuals having ordered goods or services online as a percentage of all individuals
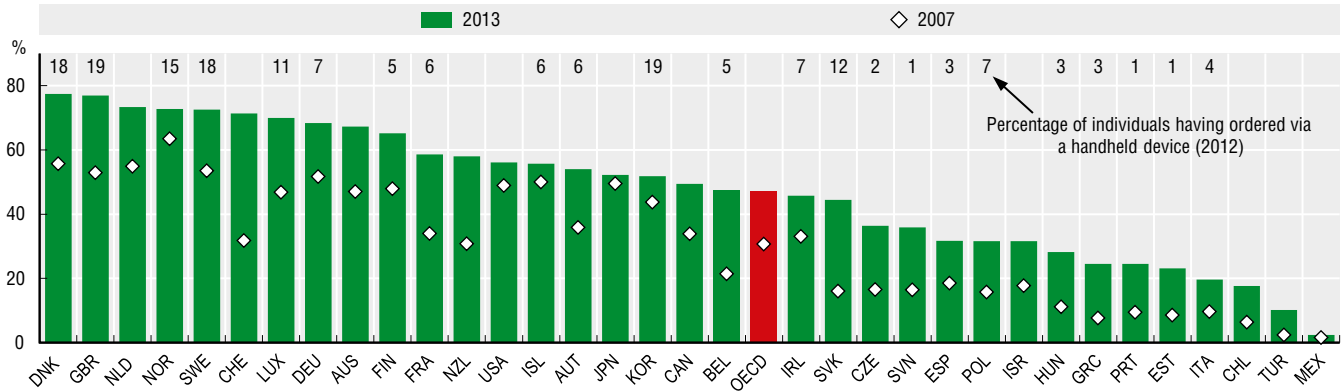
Legend: 2013 | ◇ 2007

Handheld device values (top row): 18 19 15 18 11 7 5 6 6 6 19 5 7 12 2 1 3 7 3 3 1 1 4

Percentage of individuals having ordered via a handheld device (2012)

Countries (x-axis): DNK GBR NLD NOR SWE CHE LUX DEU AUS FIN FRA NZL USA ISL AUT JPN KOR CAN BEL OECD IRL SVK CZE SVN ESP POL ISR HUN GRC PRT EST ITA CHL TUR MEX

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, May 2014. See chapter notes.

StatLink ᴐ᠊ᴦ *http://dx.doi.org/10.1787/888933148361*

Individuals who purchased online in the last 12 months, by age class, 2013

As a percentage of Internet users
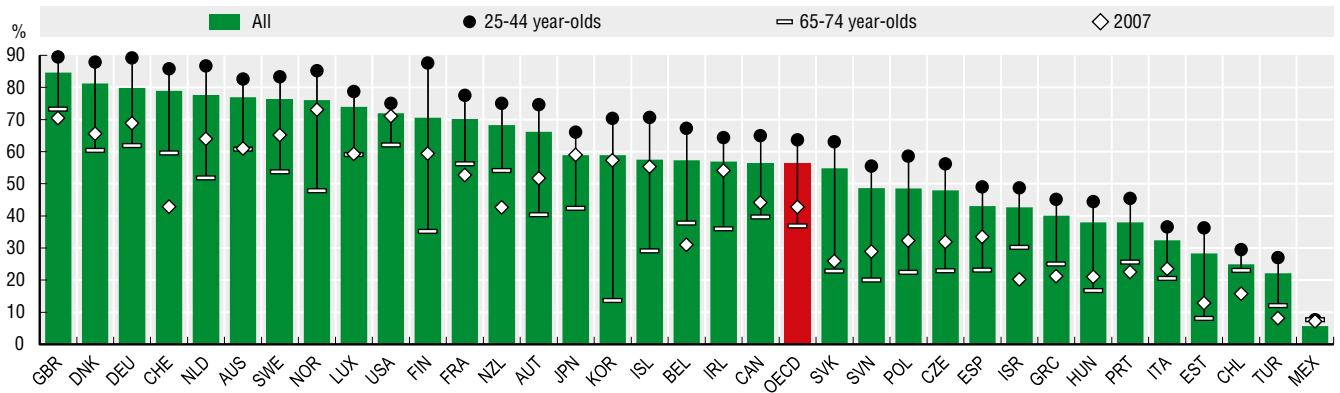
Legend: All | ● 25-44 year-olds | ▭ 65-74 year-olds | ◇ 2007

Countries (x-axis): GBR DNK DEU CHE NLD AUS SWE NOR LUX USA FIN FRA NZL AUT JPN KOR ISL BEL IRL CAN OECD SVK SVN POL CZE ESP ISR GRC HUN PRT ITA EST CHL TUR MEX

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, May 2014. See chapter notes.

StatLink ᴐ᠊ᴦ *http://dx.doi.org/10.1787/888933148373*

Online purchasers by selected types of products, 2013

As a percentage of Internet users having purchased online
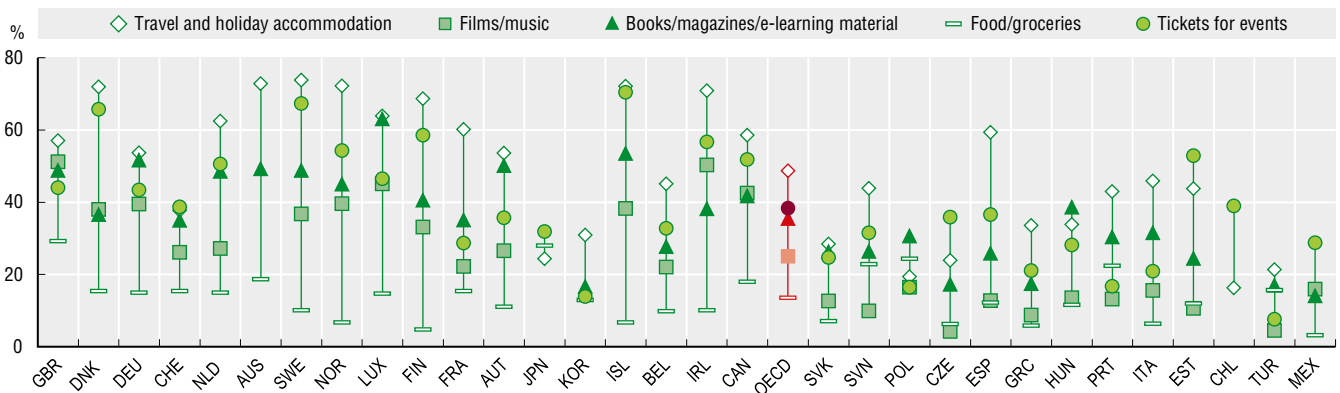
Legend: ◇ Travel and holiday accommodation | ▪ Films/music | ▲ Books/magazines/e-learning material | ▭ Food/groceries | ● Tickets for events

Countries (x-axis): GBR DNK DEU CHE NLD AUS SWE NOR LUX FIN FRA AUT JPN KOR ISL BEL IRL CAN OECD SVK SVN POL CZE ESP GRC HUN PRT ITA EST CHL TUR MEX

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, May 2014. See chapter notes.

StatLink ᴐ᠊ᴦ *http://dx.doi.org/10.1787/888933148386*

Key findings

The borderless nature of the Internet combined with recent technological developments have led to the emergence of multi-language international platforms, whose success is rooted in the similarity of needs, interests and behaviours of individuals across countries. These platforms encompass online search, social networking, information sources and entertainment, and often build on user-created content.

Wikipedia – currently the 6th or 7th most-visited website globally and the most-visited not-for-profit site – exemplifies the way in which the Internet can favour the diffusion of information and culture across countries and languages, based on the contributions of users.

Across the OECD, each Internet user visits on average more than nine Wikipedia pages (articles) per month, with about 1.6 monthly contributions (edits) per thousand Internet users. Page-views per Internet user vary from 14 or above in Estonia, Finland and Iceland, to 6 or less in Japan and Korea (depending on the existence of alternate sources of a similar nature), and in Chile, Mexico, Slovak Republic and Turkey.

In most countries about 10% to 12% of visits to Wikipedia point to a different language than that currently spoken in the country, highlighting the cross-border and cross-language nature of websites such as Wikipedia. Rates are much higher where local languages have few speakers or multiple languages coexist, and are very low for English-speaking countries. In addition, automated translation tools favour the re-production of information in less diffused languages, contributing to their survival.

The number of YouTube views reveals that, for most of OECD and partner countries, content uploaded domestically accounts for less than half of total views. Views of domestic content are more common in large, non-English speaking countries such as Brazil, Japan and Turkey, than in smaller countries, as well as those where most people speak English.

The most-visited websites across all OECD countries are the same: Google, Facebook and YouTube, with Yahoo! at some distance. These companies have developed an entire ecosystem starting from their initial business of offering a compass (and a map) to surf the Web, keeping in touch with friends or accessing self-created audio and video contents.

The development of ecosystems with an increasing number of available services creates numerous advantages for users. The high level of concentration on these digital markets, however, also raises issues of competition, privacy and security, as well as the risk of limitations in content offers.

Definitions

The indicators proposed here follow the established practice in website-related statistics. The diffusion of websites among the public is assessed in terms of the *number of unique visitors*. This means that visits from the same IP address (machine or router) are counted only once. Websites are usually automatically grouped under the first-level entry (e.g. oecd.org). A further manual aggregation is performed for websites with multiple top-level domains (such as .com and .fr).

The number of *page views* looks at how much content has been viewed, irrespective of the number of people viewing the material. The number of *edits* refers to the modifications to existing pages (articles) done by users, regardless of their breadth. For the case of Wikipedia, these data are netted for visits and edits by *bots* (machines), and have been normalised on the number of Internet users and on resident population.

Data on *YouTube views* refer to content files. The indicator targets the incidence of local content – proxied by domestic uploads – in each country's total views.

Measurability

Statistics presented on this page are drawn from selected Internet services. They are based on a full count directly provided by the owner for Wikipedia (stats.wikimedia.org/) and YouTube (courtesy of Google Inc.), while the ranking of websites can only be assessed based on specialised providers' partial counts, which differ from one another and often offer a point-in-time only estimate.

Information on individual websites is not always freely accessible. Furthermore, it is sometimes hard to disentangle the action of *bots* accessing websites from that of humans.

Finally, web-visit statistics offer a limited view on what users do: numbers often distort the real quantity they aim at portraying, let aside the quality. Indeed, visitors might visit a website because they are led there by a search engine or by direct solicitations, raising the count of visits without any underlying real activity.

Eurostat and the OECD are currently working to develop methodologies and algorithms to derive new reliable indicators directly from the Internet and other digital footprints (e.g. GPS).

Wikipedia monthly page views and edits, 2014 Q1
Per Internet user, per inhabitant

Legend: ■ Page views per Internet user   ■ Page views per inhabitant   ◇ Edits per thousand Internet users (right-hand scale)

Page views (left axis 0–16); Edits (right axis 0.0–4.0)

Countries (left to right): ISL, FIN, EST, SWE, CAN, AUT, LUX, NOR, IRL, CHE, POL, SVN, GBR, ITA, CZE, DEU, AUS, ISR, NLD, DNK, BEL, USA, NZL, GRC, FRA, RUS, HUN, PRT, ESP, JPN, MEX, SVK, CHL, TUR, BRA, IDN, IND, ZAF, KOR, CHN
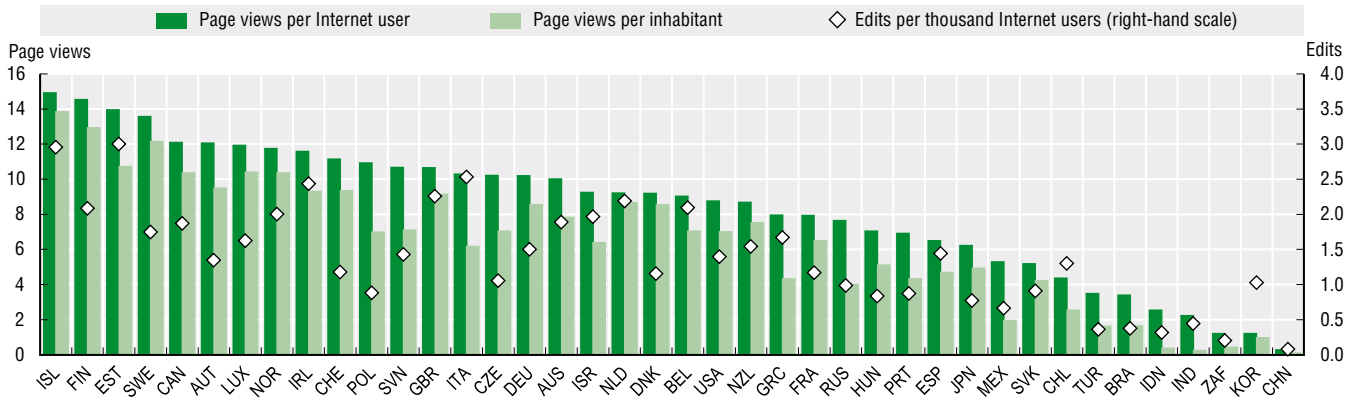
Source: OECD computations based on Wikimedia, May 2014.

StatLink http://dx.doi.org/10.1787/888933148392

YouTube views of contents uploaded domestically, 2010-11 and 2013
As a percentage of views in each country

Legend: ■ 2013   ◇ 2010-11

% (axis 0–80)

Countries (left to right): JPN, TUR, BRA, POL, IDN, ITA, RUS, HUN, GRC, MEX, KOR, CZE, FRA, IND, DEU, USA, COL, FIN, PRT, ISR, ESP, SVK, CHL, DNK, NLD, GBR, SVN, ZAF, EST, SWE, NOR, BEL, AUS, CAN, LVA, AUT, NZL, IRL, CHE, ISL, LUX
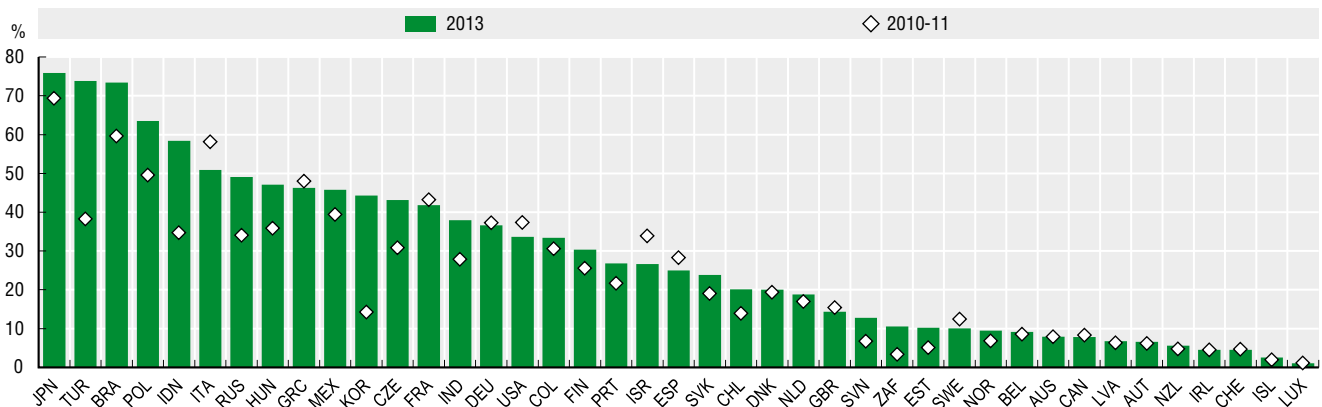
Source: OECD computations based on an ad-hoc data tabulation by Google, June 2014.

StatLink http://dx.doi.org/10.1787/888933148402

Top 10 websites by type of service, April 2014
Ranked number of unique visitors

Legend: SE Search engine · SN Social network · MC Media-Content · PT Portal · Ref. Ref.-Encyclopedia · Ns News · e$ eComm/banking · Blog Blogging

Rank	AUS	AUT	BEL	CAN	CHL	CZE	DNK	EST	FIN	FRA	DEU	GRC	HUN	ISL	IRL	ISR	ITA	JPN	KOR	LUX	MEX	NLD	NZL	NOR	POL	PRT	SVK	SVN	ESP	SWE	CHE	TUR	GBR	USA
1	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SN	SE	SE	SE	PT	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE
2	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SE	SN	SN	SN	SE	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN	SN
3	MC	MC	MC	MC	MC	PT	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	PT	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC
4	PT	MC	Ref.	PT	PT	MC	SN	PT	Ref.	PT	e$	e$	MC	MC	SN	SN	PT	e$	MC	Ref.	PT	Ref.	e$	MC	PT	PT	PT	MC	MC	Ref.	Ref.	Ns	MC	PT
5	e$	Ref.	PT	Ref.	PT	MC	Ref.	MC	Ns	Ref.	e$	PT	e$	MC	Ref.	PT	Ref.	PT	PT	PT	PT	PT	e$	e$	e$	Ns	MC	PT	Ns	MC	Ns	Ns	e$	e$
6	Ref.	e$	SN	SN	MC	MC	Ns	Ref.	Ns	e$	Ref.	Ref.	Ns	Ns	PT	Ref.	SE	MC	SN	SE	MC	SN	Ref.	Ref.	PT	Ref.	MC	PT	SN	e$	SN	MC	PT	SN
7	SN	Ns	PT	PT	Ref.	Ref.	MC	PT	MC	PT	Ns	PT	Ref.	MC	MC	PT	Ns	e$	PT	SN	Ref.	PT	Ns	Ns	Blog	PT	PT	Ref.	Ref.	PT	MC	PT	Ref.	Ref.
8	PT	e$	MC	MC	Blog	MC	PT	SN	MC	e$	PT	MC	PT	PT	PT	MC	e$	Ref.	Ref.	e$	PT	PT	MC	MC	MC	MC	e$	PT	PT	Ns	e$	e$	e$	e$
9	Ns	SE	MC	e$	SN	MC	PT	e$	e$	PT	Ns	MC	MC	MC	e$	PT	Blog	PT	PT	PT	e$	e$	SN	PT	Ref.	SN	MC	MC	Blog	SN	e$	MC	SN	MC
10	e$	PT	SE	e$	Ns	e$	e$	PT	PT	SN	PT	Blog	PT	Ref.	e$	e$	e$	PT	PT	MC	SN	MC	PT	PT	SE	PT	Ref.	e$	Ns	e$	PT	Blog	PT	SE

Source: OECD based on Alexa, www.alexa.com, visited on 20 April 2014.

StatLink http://dx.doi.org/10.1787/888933148891

Key findings

ICTs can play a considerable role in simplifying inter-actions with public authorities, while simultaneously saving taxpayer resources, thanks to the digitisation and automation of many processes. For both individuals and businesses, online interactions can include simple document browsing, downloading of forms, and the completion of administrative procedures.

The overall share of individuals using the Internet to perform administrative procedures has increased in recent years, but remains widely dispersed across countries – from 70% in Iceland to less than 10% in Chile, the Czech Republic and Turkey. This might reflect issues of data comparability, as well as differences in Internet usage rates (see 3.1) and the propensity of users to start performing administrative procedures online. The Nordic countries, Korea and the Netherlands rank high on both dimensions, while countries such as Germany and the United Kingdom, despite relatively high Internet usage rates, are characterised by a relatively low propensity to use online government services.

Explanations for these differences range from existing infrastructure and supply of e-services by the public authorities, to structural issues linked to institutional, cultural or economic factors. The perception and utility of services provided by public authority websites and their coherence with individual user needs, which are influenced by age and life cycle factors, are also key elements. Ease of access and use of a website appear to be strategic factors to foster usage and user satisfaction.

Online interactions between businesses and public authorities are more developed than for individuals, because Internet usage is generalised and enterprises are required to undertake more frequent administra-tive procedures, and also because the use of online tools in some cases is imposed by law. In 2012, more than 95% of businesses in Ireland interacted online with public authorities against 58% in Italy. This share has increased by almost 20 percentage points since 2010 in the Czech Republic and Italy, and by more than 10 percentage points in Ireland, New Zealand and Norway.

In general, differences between countries are less pronounced when simpler interactions are considered (e.g. obtaining information or downloading forms), and are performed on average by 83% of enterprises. This suggests that service availability might be a key obstacle to more complex interactions in some lagging countries.

DID YOU KNOW?

E-government services are used on average by 35% of individuals, and by more than 80% of businesses in OECD countries.

Definitions

Indicators presented here portray the *diffusion of selected types of online interaction with public authorities* among Internet users and businesses.

Interactions range from the simple collection of information from browsing government websites to interactive procedures where completed forms are sent via the Internet, excluding any interaction via e-mail (for businesses) or manually typed e-mail (for individuals). For businesses, simple interactions include here obtaining information and downloading forms; the indicator shows the highest value on the basis of data availability.

Problems encountered in using government websites are shown for countries in the European Statistical System and include technical issues, lack of clear and updated information, lack of (off and onsite) support and other unspecified problems. The variable reporting the share of users encountering at least one problem refers to the list above. This is matched with the share of users satisfied with respect to the information obtained.

Public authorities refer to both public services and admin-istration activities, for example, tax, customs, business registration, social security, public health, environment or municipal administrations. These authorities can be at local, regional or national level.

Measurability

The collection of information on e-government service usage by individuals and businesses is uneven across OECD countries, due to differences in the frequency and nature of surveys (see 3.1). The Governmental and Public Authorities delineation varies across countries, as does the variety and sophistication of services delivered to citizens and businesses.

The OECD is actively engaged in the collection of comparable and more detailed information in this field, by means of its Model Surveys on ICT usage by households/individuals and by businesses. Other complementary ways to collect information are also being explored, including the ongoing Digital Government Performance Survey carried out by the OECD Directorate for Public Governance and Territorial Development, including by means of infor-mation on public administration web-portals.

Individuals using e-government services, 2010 and 2013

Percentage of individuals obtaining information and sending completed forms on government websites in the last 12 months
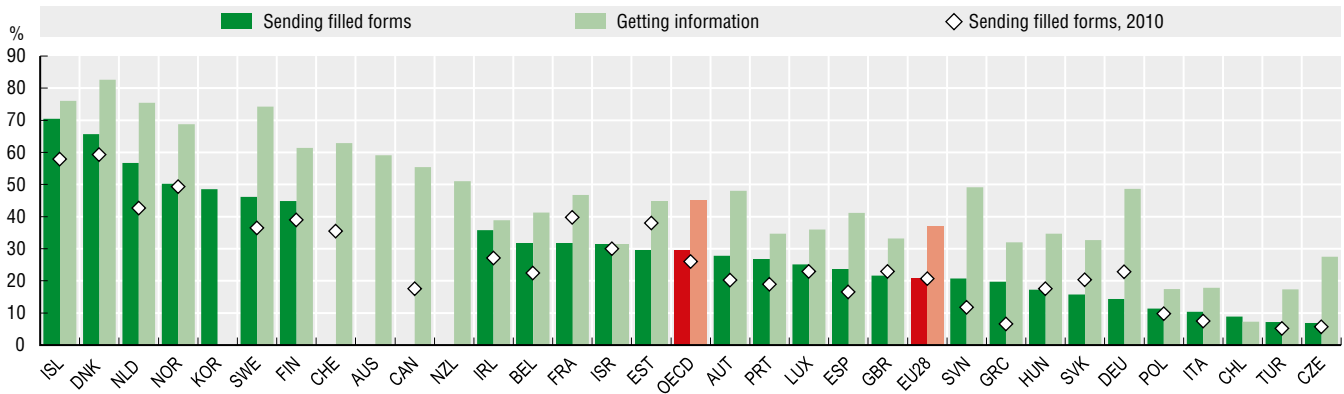
Sending filled forms ◼ Getting information ◼ Sending filled forms, 2010 ◇

Source: OECD, ICT Database and Eurostat, Information Society Statistics, May 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148419

Problems in using e-government services (left-hand panel) and satisfaction (right-hand panel), 2013

Percentage of individuals having used e-government services in the last 12 months
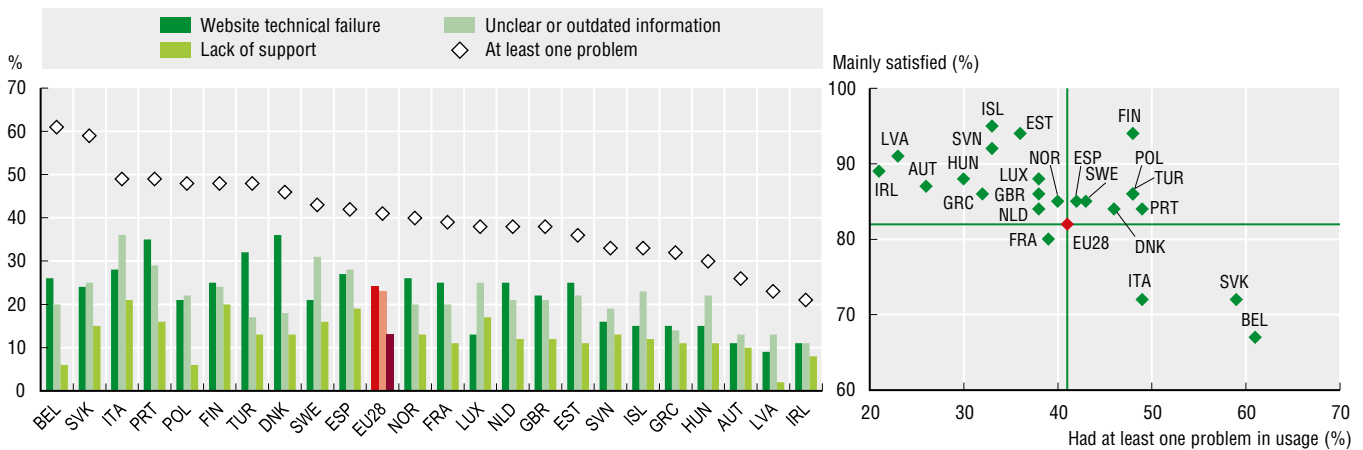
Website technical failure ◼ Unclear or outdated information ◼ Lack of support ◼ At least one problem ◇

Source: OECD based on Eurostat, Information Society Statistics, May 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148425

Businesses using e-government services, 2010 and 2012

Percentage of enterprises with ten or more persons employed
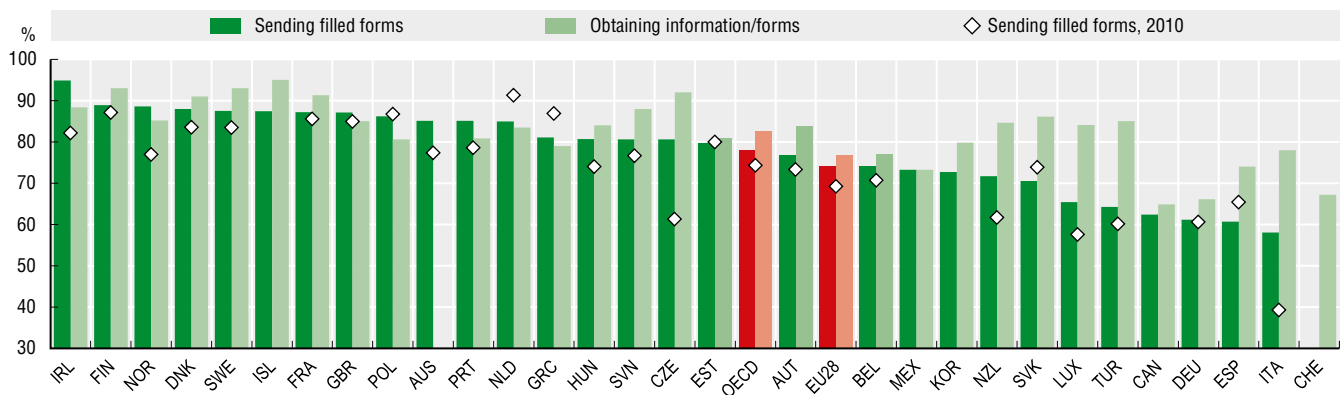
Sending filled forms ◼ Obtaining information/forms ◼ Sending filled forms, 2010 ◇

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, May 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148431

Why do we need indicators?

Governments today have recognised the large-scale changes that are made possible by health ICTs and in response they are developing approaches to leverage these technologies to pursue a range of health system reforms, such as primary care renewal and results-based financing. While the potential gains from greater use of these technologies have been apparent for years, most countries are still facing major implementation and adoption challenges. This highlights the large gap between what is possible and where we are now, with little known about how to fully leverage ICTs to improve the health and wellness of the population. Data on successful adoption and use across countries is therefore an essential learning tool for policy development in this area.

What are the challenges?

Many countries are looking to learn from others' successes and failures to inform their own policy development. This requires a shared understanding of ICT definitions in health systems as well as common approaches to measuring adoption and impact that take into account inter-country difference in their pace of ICT deployment. Over the past decade, there has been a rising interest across countries to monitor ICT adoption in health systems which led to a proliferation of surveys of varying quality and utility. These surveys were sometimes conducted by official government statistical agencies, and more often by academic entities and private-sector collection agencies funded by government health departments (OECD, 2010). Most surveys were run as standalone surveys, on an ad-hoc basis and with a main focused on the ICT adoption in the primary care sector.

National statistical offices typically limit the collection of data on the use of ICTs for health purposes to their surveys of ICT use by households and individuals. The available data show an upward trend in individuals' health-related ICT use in almost all countries over the recent period.

Individuals who searched for health-related information online, 2008 and 2013

As a percentage of individuals who used the Internet in the last three months
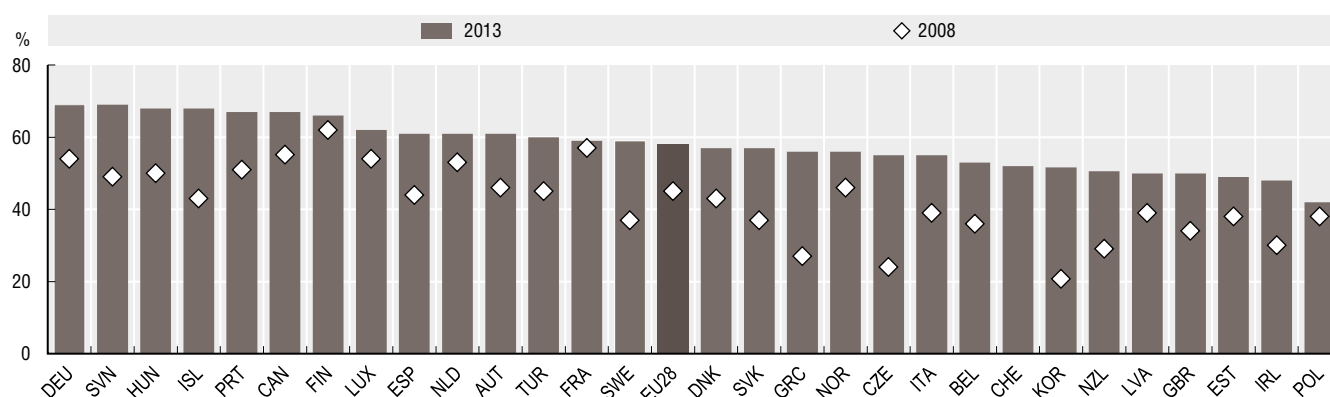
Source: OECD, ICT Database and Eurostat, Information Society Statistics. See chapter notes.

StatLink ᐧᐧᐧᐧ http://dx.doi.org/10.1787/888933148446

While the collection of such data is rather straightforward, current surveys remain limited in terms of the types of health-related online activities undertaken by individuals and on the wider adoption and use of ICTs by health systems. The OECD has undertaken two initiatives to address this limitation.

The OECD Model Survey on ICT Access and Usage by Households and Individuals has been revised in 2014 and now contains specific questions on various health-related activities carried out online (e.g. participating in social networks on health and wellness, asking medical advice, buying medicine etc.) including via apps.

Additionally, in 2008, the OECD launched a multi-stakeholder initiative to develop a robust measurement framework and comparable cross-national measures on ICT adoption and use in health systems. Three critical conclusions emerged from this work. First, one of the key challenges in achieving comparable international measures is the need to accommodate countries that are at different levels of ICT diffusion and progress towards achieving their broader e-health goals. In particular, advanced countries are unlikely to devote substantial resources to collecting data on the availability of ICTs if their policy needs are focused on effective use for better health outcomes. Organising measures along a continuum, starting from ICT availability, moving next towards effective use,

and ending with measuring outcomes and impact on population health allows all countries to participate in the benchmarking process (Adler-Milstein *et al.*, 2013; Ronchi *et al.*, 2013).

Second, OECD experience with measurement of ICT usage indicates that model surveys that comprise separate, self-contained modules are more flexible and adaptable to rapidly changing technological and policy environments. The use of core modules (as an add-on to existing national surveys or as a standalone survey) allows measurement on an internationally comparable basis. Additional modules and new measures can be added to respond to evolving or country-specific policy needs in this area.

Third, a key challenge to a model survey is to ensure that the terminology has comparable meaning across different countries, and that when individual countries make changes, they are done in ways that preserve this comparability. To this end, the OECD focused on developing indicators using a functionality-based approach (i.e. on core types of clinical and other activities that are supported by electronic systems).

Options for international action

The effort of developing a framework for comparable cross-national measures was accomplished in 2014 with the publication of the *OECD Guide to Measuring ICTs in the Health Sector* (OECD, 2014) which has two primary components. The first is a model survey in which each module shows sample questions with an accompanying glossary containing explanations of key terms. The second component is a methodological guide to aid implementation and promote validity and comparability of resulting benchmark measures. The initial set of benchmark measures included in the Guide is at present focused on four areas related to current policy demand across countries:

- Provider-centric electronic records systems: These systems are used by healthcare professionals to store and manage patient health information and data, and include functionalities that support the care delivery process. Examples include electronic medical records, EHRs and electronic patient records.
- Patient-centric electronic records systems: These systems are used mostly by patients and their families to access and manage their health information and organise their healthcare. Examples include personal health records, patient portals and other patient-centric electronic records.
- Health information exchange: This area entails the process of electronically transferring (or aggregating and enabling access to) patient health information and data across provider organisations. Examples include the e-transfer of patient data between ambulatory care providers or the transmission of prescriptions from the provider to a pharmacy.
- Telehealth: This programme encompasses the broad set of technologies that support care between patients and providers, or among providers, who are not co-located. Examples include video-mediated consultations between physicians and patients, remote home monitoring of patients and teleradiology.

Ten pilot countries (Brazil, Canada, Finland, Germany, Israel, Korea, the Netherlands, Switzerland, the United Kingdom and the United States) are currently testing the *OECD Guide to Measuring ICTs in the Health Sector* and broad implementation is expected in the near future.

In parallel, the inclusion of detailed questions on individuals' use of ICTs for health purposes in the main ICT usage surveys would shed more light on usage patterns by age, gender or educational attainment. The information collected through official sources can be augmented with the broader use of Internet-based statistics however, the collection and use of such data require the development of international statistical standards, close co-operation between different actors (businesses, Internet intermediaries and national statistical offices), and a regulatory framework to preserve user security and privacy.

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Notes

Cyprus

The following note is included at the request of Turkey:

"The information in this document with reference to 'Cyprus' relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'."

The following note is included at the request of all the European Union Member States of the OECD and the European Union:

"The Republic of Cyprus is recognized by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus."

Israel

"The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities or third party. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

3.1 Internet users

General notes:

Unless otherwise stated, a recall period of three months is used for Internet users. For Australia, Canada, Chile, Japan, Korea, Mexico and New Zealand, the recall period is 12 months. For Switzerland, the recall period is six months. For the United States, no time period is specified.

For Australia, data refer to 2012/13 (fiscal year ending in June 2013) instead of 2013, and 2006/07 (fiscal year ending in June 2007) instead of 2007.

Additional notes:

Total, daily and mobile Internet users, 2006 and 2013

Notes for data on all users:

For Canada, data refer to 2007 and 2012.

For Chile, Japan and New Zealand, data refer to 2012.

For Israel, data refer to individuals aged 20 or more instead of 16-74 year-olds.

For the United States, data originating from the Census Bureau refer to 2012 and to individuals aged 18 and above.

For Turkey, data refer to 2007 instead of 2006.

Notes for data on all daily users:

"Daily users" relates to Internet users accessing the Internet "at least once a day" for Canada and Japan, and "every day or almost every day" for Chile, Korea, Mexico and Switzerland. For the United States, data relate to the percentage of individuals answering "yes" to the question "Did you use the Internet yesterday?"

For Canada, data originate from the Internet Use Survey and refer to individuals aged 16 and above.

For Japan, data are OECD estimates based on data from the Communication Usage Trend Survey.

For the United States, data originate from the PEW Internet Project.

Notes for data on mobile users:

Unless otherwise stated, mobile Internet users relate to individuals who used a mobile phone (or a smartphone) to access the Internet away from home or away from work.

For Canada, data originate from the Internet Use Survey and relate to the percentage of individuals aged 16 or more using Internet with a wireless handheld device.

For Korea, data originate from the Survey on the Internet Usage and refer to individuals aged 3 and above. Mobile Internet users relate to individuals who have used a mobile phone, smartphone, handheld device or tablet to access the Internet away from home via a wireless broadband connection. The recall period is the last three months.

For New Zealand and Switzerland, the term "mobile Internet users" relates to individuals who have used a mobile phone, smartphone, handheld device or a tablet to access the Internet away from home via a wireless broadband connection. The recall period is the last three months for Switzerland and the last 12 months for New Zealand.

Internet users by age, 16-24 and 65-74 year-olds, 2013

For Australia, data refer to individuals aged 65 and above instead of 65-74 year-olds.

For Canada, Chile, Japan, New Zealand and the United States, data refer to 2012.

For Switzerland, data refer to individuals aged 20-29 instead of 16-24 year-olds, and to individuals aged 70 years old and more instead of 65-74 year-olds.

For Israel, data refer to individuals aged 20 and above instead of 16-74 year-olds, and to individuals aged 20-24 instead of 16-24 year-olds.

For the United States, data originate from the Census Bureau, include all individuals aged 15 and more. The category "16-24 year-olds" refers to individuals aged 18-34 and the category "65-74 year-olds" refers to individuals aged 65 and above.

Internet users among 55-74 year-olds by educational attainment level, 2013

For Australia, data refer to individuals aged 65 and above instead of 65-74 year-olds.

For Canada and Chile, data refer to individuals aged 65-74, and for Japan, to individuals aged 60-69.

For Chile, Japan and New Zealand, data refer to 2012.

For Israel and the United States, data refer to 2011.

For Australia, Israel, Korea and New Zealand, low levels of educational attainment include the middle level of educational attainment.

The breakdown by level of education is not available for Canada and Japan, and corresponds to the OECD estimate for the United States.

3.2 Online activities

General notes:

Unless otherwise stated, a recall period of three months is used for Internet users. For Australia, Canada, Chile, Japan, Korea, Mexico and New Zealand, the recall period is 12 months. For Switzerland, the recall period is six months. For the United States, no time period is specified.

Additional notes:

The diffusion of selected online activities among Internet users, 2012-13

For countries in the European Statistical System, data refer to 2012 for gaming, movies, audio, web-based radio/television, medical appointments online and content creation. For online purchases and e-government categories, the recall period is 12 months instead of three months and data relate to individuals who used the Internet in the last 12 months instead of three months.

For Australia, Canada, Chile, Japan and New Zealand, data refer to 2012.

For Australia, Chile and New Zealand, values for "Any interaction with public authorities" might be slightly underestimated, as data relate to "obtaining information from public authorities".

For Japan, data refer to individuals aged 15-69. Data for the e-purchase category correspond to a recall period of 12 months. Social networking includes constructing/updating websites and blogs, viewing/posting to forums and chat sites, and using video posting/sharing sites.

The diffusion of Internet banking, 2013

For Australia, Internet banking relates to "paying bills or banking online". Data for highest and lowest quartiles are OECD estimates based on original quintile data.

For Canada, data refer to 2012 and relate to Internet users aged 16 and over conducting electronic banking activities (paying bills, viewing statements, transferring funds between accounts).

For Chile, data refer to 2009.

For Israel, data refer to all individuals aged 20 and over (instead of 16-74 year-olds) using the Internet for paying bills.

For Korea, households in the lowest quartile have an income of less than 2 million wons and those in the highest quartile have an income of more than 4 million wons.

For New Zealand, data refer to 2012.

For Switzerland, data refer to 2010.

For the United States, data originate from the Federal Reserve Board (2013).

Quartiles data are not available for Chile, Ireland, Israel, Switzerland, Turkey, the United Kingdom and the United States.

3.3 User sophistication

General notes:

Data refer to the following activities: using e-mail, telephoning or video calling over the Internet, participating in social networks, finding information about goods or services, reading online news, online banking, using services related to travel and accommodation, interacting online with public authorities, selling goods or services, buying physical goods, buying digital content and buying services.

For Korea, data originate from special tabulations by KISA and refer to 2012. Due to lack of full correspondence with the list of activities provided in the Community Survey on ICT Usage in Households and by Individuals (Eurostat), the number of activities performed might be underestimated.

3.6 ICTs in education

Individuals who attended an online course, 2007 and 2013

For Canada, Chile, Japan and Korea, data refer to 2012.

For Canada, data refer to formal education, training or school work.

For Japan, data relate to individuals aged 15-69 (instead of 16-74 year-olds) who used the Internet in the last 12 months.

For New Zealand, data refer to 2006.

For Poland, data refer to 2008 and 2011.

3.7 ICT skills in the workplace

Computer use at work, 2012 and;

ICT skills use at work, 2012

GBR data point relates to England only.

3.8 E-consumers

General notes:

For Australia, data refer to 2012/2013 (fiscal year ending in June 2013) instead of 2013. For 2007, data refer to 2006/2007 (fiscal year ending in June 2007), and to individuals aged 15 and over instead of 16-74 year-olds.

For Canada, data refer to 2012 and relate to individuals who ordered goods or services over the Internet from any location (for personal or household use).

For Chile, data refer to 2009 and 2012.

For Japan, data refer to 2012 and to individuals aged 15-69 instead of 16-74 year-olds.

Diffusion of online purchases, including via handheld devices, 2007 and 2013

For Israel, data refer to all individuals aged 20 and over who used the Internet for purchasing all types of goods or services.

For Korea, the figure shows OECD estimates based on the Survey on the Internet Usage 2012. Data refer to the population aged 12 or more. In 2013, the share of individuals buying via handheld devices reached 35.5%.

For New Zealand, data refer to 2006 and 2012 and relate to individuals who made a purchase through the Internet for personal use, which required an online payment.

For Switzerland, data refer to 2005 instead of 2007.

For the United States, data originate from May 2011 and September 2007 PEW Internet Surveys and cover individuals aged 18 or more.

Individuals who purchased online in the last 12 months, by age class, 2013

For Chile, in 2009, no time period is specified (instead of last 12 months).

For Israel, data relate to online purchases in the last three months and refer to 2006 instead of 2007; data cover all individuals aged 20 and over instead of 16-74 year-olds.

For Japan, data refer to individuals aged 20-39 instead of 25-44 year-olds, and 60-69 instead of 65-74 year-olds.

For New Zealand, data refer to 2006 instead of 2007 and relate to e-purchases for personal use only requiring an online payment.

For Switzerland, data relate to online purchases in the last six months and to 2005 instead of 2007.

For the United States, data originate from May 2011 and August 2006 PEW Internet Surveys and refer to Internet users aged 18 and over who "ever purchased a product online". The category "16-24 year-olds" refers to individuals aged 18-24 only.

Online purchasers by selected types of products, 2013

For Australia, Chile, Japan, Korea and Mexico, data are not available for some of the selected types of products.

For Australia, data refer to the following categories: Food, groceries or alcohol; CDs, music, DVDs, videos, books or magazines; travel, accommodation, memberships and tickets of any kind.

For Canada, data relate to the following categories: Ordering food or beverages (e.g. specialty foods or wine, pizza delivery); ordering music (e.g. CDs, MP3) or videos or DVDs, tickets for entertainment events (e.g. concerts, movies, sports), books/magazines/newspapers and making travel arrangements (e.g. hotel reservations, travel tickets, rental cars). Data for the category "Books/magazines/newspapers/e-learning material" do not explicitly include e-learning material.

For Japan, Internet users buying online include individuals conducting financial transactions online.

For Switzerland, data refer to 2010.

3.10 E-government use

Individuals using e-government services, 2010 and 2013

Unless otherwise stated, "sending filled forms" relates to "sending filled forms to public authorities or public services over the Internet for private purposes in the last 12 months" for countries in the European Statistical System, and to "completing/lodging filled in forms from government organisations' websites in the last 12 months" for other countries.

For Australia, data refer to 2012/2013 (fiscal year ending in June 2013) instead of 2013, and to individuals aged 15 and over instead of 16-74 year-olds.

For Canada, data refer to 2012 for obtaining information, and to 2009 for sending filled forms. Obtaining information relates to visits or interactions with Canadian municipal, provincial or federal government websites.

For Chile, Japan, Korea and New Zealand, data refer to 2012.

For Israel, data refer to 2009, and to all individuals aged 20 and over (instead of 16-74) who used the Internet for obtaining services online from government offices, including downloading or completing official forms.

For New Zealand, data refer to individuals who have accessed a New Zealand local or central government website in the last 12 months to download or complete a form.

For Switzerland, data refer to 2010.

Problems in using e-government services (left-hand panel) and satisfaction (right-hand panel), 2013

"At least one problem" category includes website technical failure, unclear or outdated information, lack of support (online or offline), and other problems (unspecified).

Businesses using e-government services, 2010 and 2012

Unless otherwise stated, sector coverage consists of all activities in manufacturing and non-financial market services. Only enterprises with ten or more persons employed are considered.

For Australia, Korea, Mexico and New Zealand, data for sending filled forms refer to the proportion of businesses interacting online with government organisations to complete/submit forms electronically (excluding any interaction via e-mails).

For Canada, Korea, Mexico, New Zealand and Switzerland, data for obtaining information/forms refer to the proportion of businesses interacting online with government organisations for obtaining information/downloading forms (excluding any interaction via e-mails).

For Australia, data refer to the fiscal year ending 30 June 2012 (2011/12) instead of 2012, and the fiscal year ending 30 June 2010 (2009/10) instead of 2010. The total includes Agriculture, forestry and fishing.

For Canada, data for returning completed forms refer to enterprises that completed or submitted taxation forms online.

For Mexico, data refer to 2008 and to businesses with 20 or more persons employed.

For Switzerland, data refer to 2011 and to businesses with five or more persons employed.

3.11 ICT and health

Individuals who searched for health-related information online, 2008 and 2013

For Canada and New Zealand, data refer to individuals who used the Internet in the last 12 months with a recall period of 12 months instead of three months.

For Canada, data refer to 2007 and 2012 and to all individuals aged 16 and over instead of 16-74 year-olds in 2007.

For Korea, data in 2013 refer to a recall period of 12 months instead of three months.

For New Zealand, data refer to 2006 and 2012.

For Switzerland, data refer to 2010.

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Chapter 4

UNLEASHING INNOVATION

4. UNLEASHING INNOVATION

4.1 | ICT and R&D

Key findings

ICT technologies are key enablers of innovation throughout all sectors of the economy. In most OECD countries, information industries account for the largest share of the business expenditure on R&D (BERD), amounting to about 20-25% of total BERD and 0.2-0.3% of GDP in most countries.

In Finland, Israel, Japan, Korea and the United States, the sector accounts for 30% to over 50% of BERD, and ICT BERD alone represents between about 0.8% to more than 1.5% of GDP, reflecting both the high research intensity of these economies and of the sector itself.

In general, ICT R&D expenditures tend to be concentrated in manufacturing, even when ICT goods are produced offshore. Telecommunication services account for a lower share in ICT R&D in most countries except Portugal, while IT services have gained ground in Denmark and Ireland. R&D expenditure on publishing and audio-visual activities (which includes some software development) is also substantial in Ireland.

BERD intensity (business R&D/value added) in ICT manufacturing for many OECD countries ranges from 20% to about 35%, with a tendency to grow. In 2011, this share reached an exceptionally high figure in Finland as Nokia's value added fell abruptly.

The lower-than-average values in countries such as Italy and Spain reflect a specialisation in low R&D intensity segments, and in others such as the Czech Republic, Estonia or Hungary reflect their nature as production centres at the lower end of the value chain.

BERD intensity in information and communication services is also growing in many countries, but generally ranges from 2-3% to 5-6% of value added. In 2011, this share was above 6% in Denmark, followed by the United States and Portugal, as opposed to Hungary, Italy and Switzerland which ranked below 2%.

The level of BERD intensity in information and communication services, much lower than in ICT manufacturing, is partly linked to the weight of network infrastructure on value added in telecommunication services, and to the well-known difficulties in unbundling the R&D component from the activity of software development in IT services.

ICT BERD intensity is generally correlated with the relative share of ICT-related patents (see 4.5).

Definitions

Business enterprise expenditure on R&D (BERD) includes all expenditures performed by enterprises, irrespective of the sources of funding. They are generally classified by the main economic activity of the enterprise in terms of turnover.

The OECD in 2007 defined the information economy sector (see the *OECD Guide to Measuring the Information Society 2011*) as the aggregate combining ICT and digital media and content industries. Here these are all referred as *information industries*. This aggregate includes ISIC Rev.4 Division 26 (Manufacture of computer, electronic and optical products) and Section J (Information and communication services), consisting of Divisions 58-60 (Publishing and broadcasting industries), 61 (Telecommunications) and 62-63 (Computer programming and information services). ICT trade and repair activities (in Groups 465 and 951) are also included, but are not considered here due to issues of data availability.

BERD intensity figures are reported in terms of percentage points of value added for total economy (i.e. GDP) and for the corresponding industries.

Measurability

There is considerable diversity in the methods countries use to report R&D by economic activity. These include reporting on the basis of the enterprise's main activity, the product for which R&D is intended or a mixture of both. The ongoing revision of the *Frascati Manual* (OECD, 2002) attempts to promote greater uniformity of R&D data reporting, although information and communication services pose particular issues. In addition, statistics on BERD by industry are not always available at the required level of detail due to issues related to confidentiality and robustness of estimates.

The coding of enterprises by industry is another source of concern, due to changes in the main sector of activity of large R&D performers (e.g. when physical production is outsourced), and to the lack of attribution for R&D performed by specialised subsidiaries (i.e. firms whose main activity is to provide R&D services for others), which might lead to an unknown underestimation of industry-level intensities. Finally, intensity indicators suffer from variability of economic indicators (particularly value added) through the business cycle.

Business R&D performed by information industries, 2011 or more recent year available

As a percentage of GDP and of total business expenditure on R&D

ICT manufacturing ⬜ Publishing, audiovisual and broadcasting ⬛ Telecommunications ⬜ IT and other information services ⫽⫽ ICT services not allocated

BERD performed by information industries as a percentage of total BERD
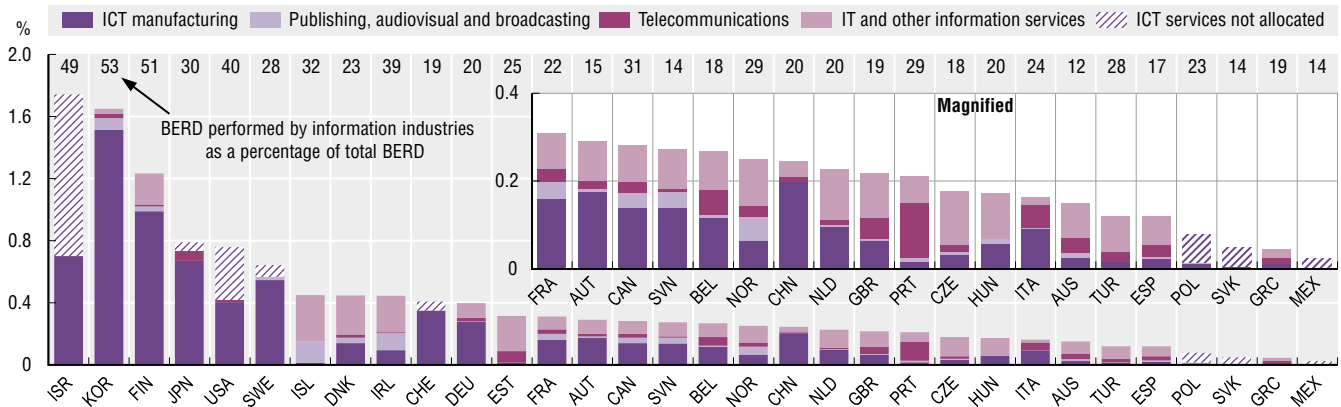
Source: OECD, ANBERD and RDS Databases, www.oecd.org/sti/anberd, www.oecd.org/sti/rds, April 2014. See chapter notes.

StatLink ⬛⬛ http://dx.doi.org/10.1787/888933148452

Business R&D intensity in ICT manufacturing industries, 2007 and 2011

R&D expenditure as a percentage of value added

■ 2011   ◇ 2007

Source: OECD computations based on OECD, ANBERD Database, www.oecd.org/sti/anberd; OECD, STAN, ISIC Rev.4 Database, www.oecd.org/sti/stan and national sources, July 2014. See chapter notes.

StatLink ⬛⬛ http://dx.doi.org/10.1787/888933148465

Business R&D intensity in information and communication service industries, 2007 and 2011

R&D expenditure as a percentage of value added

■ 2011   ◇ 2007

Source: OECD computations based on OECD, ANBERD Database, www.oecd.org/sti/anberd; OECD, STAN, ISIC Rev.4 Database, www.oecd.org/sti/stan and national sources, July 2014. See chapter notes.

StatLink ⬛⬛ http://dx.doi.org/10.1787/888933148472

Key findings

Innovation is acknowledged as an important source of competitiveness for businesses. It can do so in many ways: by reducing production costs, by enhancing existing products and leading to the creation of new ones, or by presenting and selling products more effectively.

Most OECD countries collect information, through innovation surveys, on the innovativeness of sectors by type of enterprises, on the different types of innovation and on various aspects of the development of an innovation, such as the objectives, the sources of information, the public funding, the innovation expenditures etc.

According to the 2010 Community Innovation Survey (CIS) results, the share of innovative enterprises in ICT industries is by far higher than for other industries in both ICT manufacturing and IT services, with differences of about 20 percentage points on average.

In addition, firms these sectors have a greater likelihood of combining different modes of innovation (product and/or process with organisational and/or marketing innovations).

With a few exceptions, country rankings are comparable in terms of innovation activity by ICT manufacturing and IT services firms. Austria, Belgium, Germany, Iceland, Luxembourg and Portugal lead in ICT innovating firms for both manufacturing and IT services. In Denmark, France and Sweden, about 80% ICT manufacturing enterprises are innovators, while ICT innovators in the Netherlands are mostly found in IT services.

While not all of the above countries are among innovation leaders in the broader array of manufacturing and innovation core service activities, patterns of ICT innovation activity are often similar to those of ICT specialisation.

A large proportion of innovative enterprises are also engaged in in-house R&D activities. In the ICT sector industries, across all countries for which data are available except the Slovak Republic, these shares are far higher than prevailing levels in manufacturing and services.

This is particularly evident for innovative enterprises in ICT manufacturing in Denmark, Latvia, Portugal and Spain. IT service activities are relatively R&D intensive with respect to innovation core service activities, especially in Belgium, Germany, Latvia and Portugal.

DID YOU KNOW?

About 70% of firms in ICT industries introduce innovations, against an average of 50% in the business enterprise sector.

Definitions

The *Oslo Manual* (OECD/Eurostat, 2005) defines innovation as "the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations". An innovative firm is one that has implemented an innovation during the period under review. For product and process innovation, firms with ongoing/abandoned innovation activities are also included. *Innovation activities* are "all scientific, technological, organisational, financial and commercial steps" aimed at the implementation of innovations. Some innovation activities are themselves innovative. Innovation activities also include R&D that is not directly related to the development of specific innovations.

Information technology (IT) services include Publishing, Computer programming and consultancy, and Information service activities under ISIC Rev.4 Divisions 58, 62 and 63.

Innovation core service activities include ISIC Rev.4 Divisions G46, H, J58, J61, J62, J63, K and M71.

Measurability

The most recent wave of CIS surveys (2010) offers comparable information on 22 OECD countries and Latvia. Data refer to the population of firms in manufacturing and selected business services.

Not all OECD countries survey non-R&D innovation activities and, despite ongoing harmonisation based on the Oslo Manual, national innovation surveys still present significant differences in methodology and design. In particular, some collect information on innovation as part of business R&D surveys.

Depending on survey features and cultural aspects, innovation variables are not uniformly interpreted by respondents, especially for those requiring a subjective assessment. Oslo-based surveys follow a subject-based approach (i.e. the unit of analysis is the firm, not the innovation), and therefore request information about the use of a particular knowledge sourcing strategy across one or more innovations. Innovations can also be mainly developed outside and implemented by the innovating firm.

Innovative enterprises in ICT manufacturing and total manufacturing, by type of innovation, 2010
As a percentage of enterprises with ten or more persons employed

Legend: Product or process only | Product or process and marketing or organisational innovation | Marketing or organisational only | Not specified

ICT manufacturing   Total manufacturing

Countries (left to right): ISL, LUX, DEU, AUT, BEL, PRT, NOR, SWE, FRA, DNK, IRL, ESP, NLD, EST, ITA, CZE, GBR, LVA, POL, HUN, SVK

Source: OECD computations based on Eurostat, Community Innovation Survey (2010), June 2014.

StatLink ⏍ http://dx.doi.org/10.1787/888933148482

Innovative enterprises in IT services and innovation core service activities, by type of innovation, 2010
As a percentage of enterprises with ten or more persons employed

Legend: Product or process only | Product or process and marketing or organisational innovation | Marketing or organisational only

IT services   Innovation core service activities

Countries (left to right): DEU, ISL, PRT, LUX, AUT, BEL, NLD, IRL, FRA, SWE, CZE, FIN, ITA, SVN, EST, ESP, NOR, DNK, GBR, SVK, HUN, POL, LVA

Source: OECD computations based on Eurostat, Community Innovation Survey (2010), June 2014. See chapter notes.

StatLink ⏍ http://dx.doi.org/10.1787/888933148493
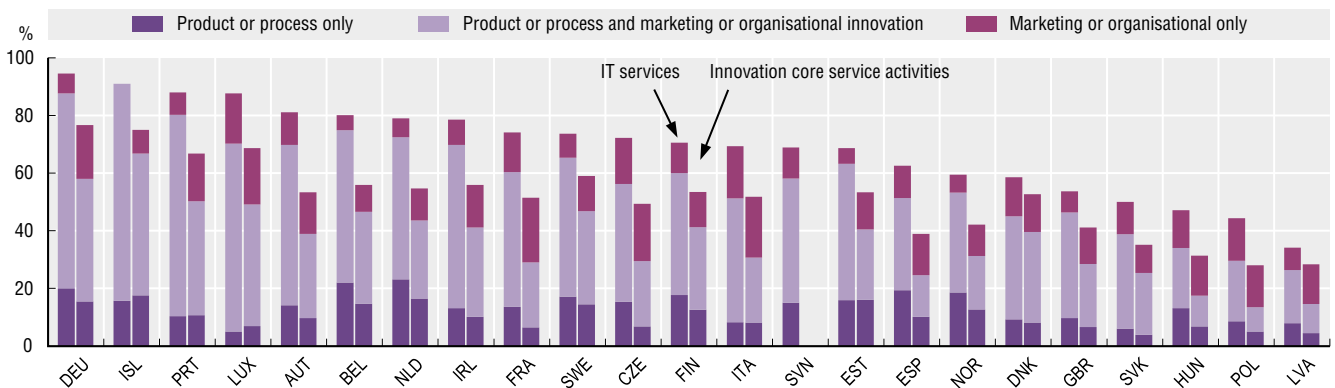
Engagement in in-house R&D activities in ICT industries, total manufacturing and innovation core services, 2010
As a percentage of enterprises in each industry
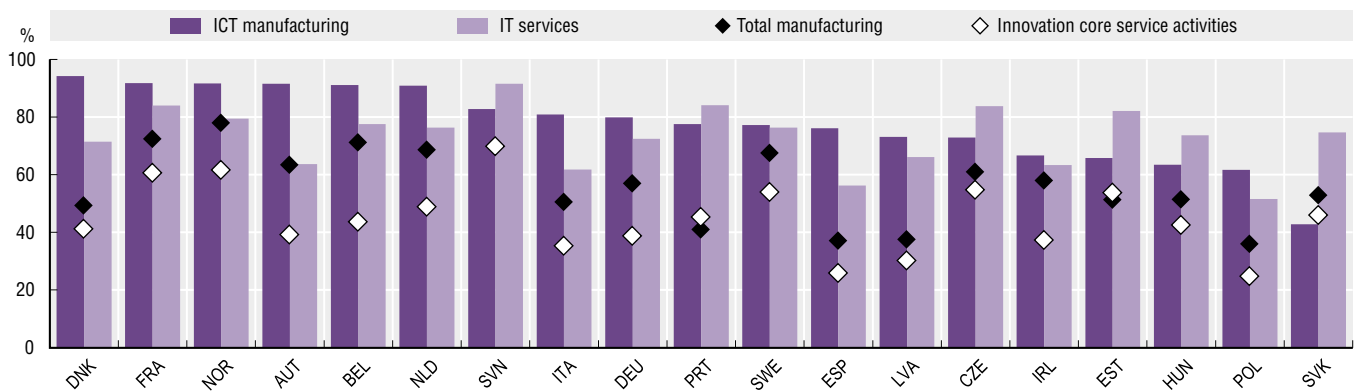
Legend: ICT manufacturing | IT services | Total manufacturing | Innovation core service activities

Countries (left to right): DNK, FRA, NOR, AUT, BEL, NLD, SVN, ITA, DEU, PRT, SWE, ESP, LVA, CZE, IRL, EST, HUN, POL, SVK

Source: OECD computations based on Eurostat, Community Innovation Survey (2010), June 2014.

StatLink ⏍ http://dx.doi.org/10.1787/888933148502

Key findings

Examination of the comparative diffusion of ICT technologies in businesses can help to explain uptake patterns and show how technologies are incorporated into company production processes.

Almost no business today is run without the help of ICTs. In 2013, 94% of enterprises had a broadband connection and more than 75% had a website but only around 20% conducted e-commerce sales (see 5.6). The use of more sophisticated ICT technologies was also less frequent. These include ICT applications used to manage information flows, where implementation requires changes in business organisation, and Radio Frequency Identification (RFID), where uptake is limited to certain types of businesses.

The speed of adoption depends in some cases on prior uptake. It took 15 to 20 years for slightly more than three quarters of enterprises to develop a website, but only a few years for around 30% of businesses to become active on social networks.

Inter-country variations are large even for nearly universal phenomena, such as broadband. Almost 100% of large enterprises have a broadband connection in all countries. However, there is still considerable variation in uptake among small enterprises across countries. In 2013, broadband uptake by small firms was almost universal in Canada, Denmark, Finland, France, Iceland, Korea and Switzerland, but below 80% in Greece and Poland. A sharp rise in uptake (especially among smaller businesses) was recorded in recent years across most countries, in particular, in Austria, Denmark, Italy, Poland, the Slovak Republic and Slovenia.

Much larger cross-country differences subsist in adoption and dynamics over time for indicators related to e-commerce (see 5.6) and to the management of information flows within companies.

The role of e-business processes in handling internal information flows can be seen in the diffusion of enterprise resource planning (ERP) software applications. In 2013, on average, such technologies were used to share information by more than 28% of enterprises, against less than 22% in 2010. ERP software was used in about 74% of larger (and more complex) enterprises, but by less than 23% of small firms, for which it is only recently becoming more affordable.

Adoption rates across countries range between 92% and 51% for larger enterprises and between 41% and 7% for smaller ones, with Belgium, Finland, Greece, Sweden and Switzerland leading, and Estonia, Hungary, Iceland and the United Kingdom lagging for enterprises of all sizes.

Definitions

Data on the *diffusion of ICT tools* and activities across countries are computed as the simple average of country percentage shares (i.e. not weighted by population) and provide extreme (minimum and maximum) and quartile values of each distribution. This approach shows the variability in uptake by enterprises across countries. The lines between the 1st and 3rd quartile include the central 50% of country values (i.e. variability for the 17 OECD countries nearer to the average, when all are represented).

Broadband includes both fixed and mobile connections with an advertised download rate of at least 256 Mbps.

Supply chain management refers to the use of automated data exchange (ADE) applications.

Enterprise resource planning (ERP) systems are software-based tools that can integrate the management of internal and external information flows, from material and human resources to finance, accounting and relations with customers. Here, only sharing of information within the firm is considered.

Measurability

Not all OECD countries undertake specific surveys on ICT usage by businesses. Aside from differences in the survey vehicle, most of the indicators portrayed correspond to generic definitions, which can only proxy ICT tools functionalities and potential uses. For example, a website may be a static and seldom updated webpage or a live tool including a shopping cart and other services (e.g. for order tracking).

For broadband, not all countries reported information for 2013. In the case of Japan, data do not include leased lines, used by about 10% of enterprises, and are limited to larger businesses only (see chapter notes).

Various software tools with different functionalities fall under the ERP heading but these are not always reported accurately. Such interpretation differences cause comparability issues (e.g. the United Kingdom ranks last in ERP adoption, but high in supply chain management software). This causes some comparability issues. The sophistication of ERP systems and their degree of implementation may lead to substantial changes in the picture of usage.

The diffusion of selected ICT tools and activities in enterprises, 2013

Percentage of enterprises with ten or more persons employed

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, July 2014. See chapter notes.

StatLink ⌨ *http://dx.doi.org/10.1787/888933148510*

Broadband connectivity, by size, 2010 and 2013

Percentage of enterprises in each employment size class

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, July 2014. See chapter notes.

StatLink ⌨ *http://dx.doi.org/10.1787/888933148520*

Use of enterprise resource planning software, by size, 2010 and 2013

Percentage of enterprises in each employment size class

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, July 2014. See chapter notes.

StatLink ⌨ *http://dx.doi.org/10.1787/888933148530*

Why do we need indicators?

Detailed enterprise information is essential to ascertain the reasons behind firms' success in the knowledge economy and, ultimately, to tailor more appropriate policies to foster this progress. Ideally, data collection should embrace the structural and economic features of enterprises, as well as their underlying intangible endowments (e.g. ICT skills) and behavioural patterns, especially with respect to innovation as enabled by ICT adoption.

Unlike sectoral or macro statistics, micro-data (e.g. firm-level data), permit to account for the rich dynamics of production and innovation activities, where firms with different levels of productivity compete through different market strategies.

Micro-data are also better suited to economic analysis, as firm output (e.g. productivity) can be directly related to inputs (e.g. R&D). This permits the factors behind the better performance of some firms to be identified, as these are typically averaged out in the aggregation of data across firms.

One shortcoming of micro-data is that they do not account for the potential impacts of firm behaviour on other firms. For example, an increase in the market share of one firm may occur at the expense of another. For these effects to be captured it is essential that micro-data be related in a statistically and economically significant way to sectoral and macro data, a process of aggregation sometimes referred to as meso data.

What are the challenges?

National Statistical Offices (NSOs) are by far the largest holder of micro-level information on enterprises and households/individuals. But although the starting point of statistical production by NSOs is always micro-level information, the main objective remains aggregated indicators. In addition, statistical surveys are designed to produce robust estimates on a given domain, not to be reused in combination with other surveys. In some cases, a negative coordination policy is undertaken, excluding firms covered by other surveys from the sample, so as to reduce the burden on respondents. In practice, joint sampling tends to be considerably smaller, skewed towards larger firms, and with time series available for only a few enterprises. Finally, until recently micro-data were usually kept dormant and even now are seldom made accessible to third parties, including other NSOs.

Things are changing fast, however. Analysts increasingly demand access to this valuable asset, and NSOs themselves are actively working to add value to their statistical production by rethinking collection practices, producing new (multi-dimensional and distribution-related) indicators and directly undertaking micro-based social and economic analysis.

For instance, in Australia and New Zealand business surveys encompass questions on innovation and ICT use. Italy implemented this practice for its 2011 enterprise census, and some countries use sampling strategies to increase longitudinal and joint coverage – for example, the Canadian Centre for Data Development and Economic Research (CDER). Furthermore, the future Euro Groups Register (EGR), which will include structural information on all relevant multinationals operating in Europe, is predicted to become the coordination framework for all European statistical authorities and will represent an important step towards sharing information at a multi-country level.

Additional challenges are mainly legal. Laws restrict access to micro-data from NSOs in all countries to protect confidentiality and secrecy. As a consequence, official micro-data from different countries cannot be pooled and, as country specific analyses generally use different models and methodologies, the results are not typically comparable across countries.

Options for international action

In recent years, several important international projects based on micro-data have examined the same aspects from different perspectives. The *OECD firm-level project on the analysis of productivity and growth* was launched as early as 2001/2, with ten participating countries (Bartelsman, Scarpetta and Schivardi, 2005). Eight countries contributed to a first round of OECD work with micro-data on ICT and economic growth, including a cross-country comparison of Japan, the United States and Denmark (OECD, 2004). More recent activity on micro-data analysis includes the OECD projects on *Innovation*, based on innovation survey data in 20 countries (OECD, 2009); *Human Capital*, based on labour force survey data (Liu, 2011), and *ICT-Enabled Innovation*, which links ICT and innovation surveys (Spiezia, 2011).

Micro-data-based work by Eurostat includes the *Feasibility study on linking data from different sources* (Eurostat, 2008), the projects *ESSLimit on Linking Microdata on ICT Usage*, which links ICT, innovation and business surveys from

15 European countries (Eurostat, 2012), and the *ESSLait on Linking of Microdata to Analyse ICT Impact* (Eurostat, 2013), which also covers other variables such as exports and ICT skills, and offers a wealth of information on ICT usage linked to other behavioural and performance variables as shows the following figure.

ICT uptake among innovators and non-innovators in 13 European countries, 2004, 2008 and 2010

Percentage shares of adopters of the selected technologies in the two groups, all countries averages
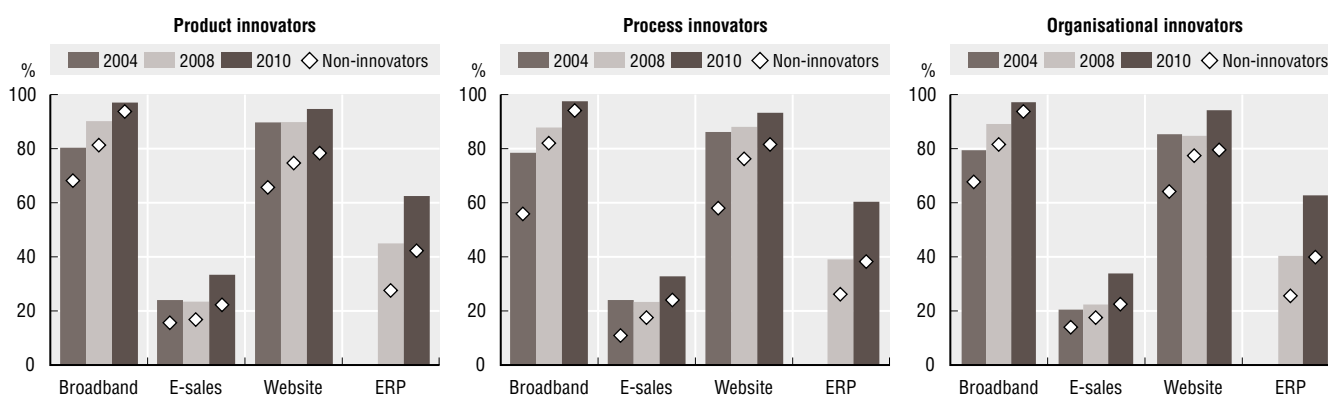
Source: OECD based on the EU ESSLait project Micro Moments Database, June 2014. See chapter notes.

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The OECD has pioneered a distributed approach to empirical analysis, which draws on confidential micro-data. The Organisation provides a common framework (experts meet and identify common research and policy questions, the indicators and the econometric modelling are agreed upon and software routines are developed in-house) and researchers with access to their own country's micro-data compile results, which are then compared and analysed by the OECD or lead countries. The latest and ongoing OECD initiative is the DYNEMP project, an analysis of the contribution of firms (young/old, small/large) to net job creation across 18 countries (Criscuolo *et al.*, 2014). As a follow up to the DYNEMP project, the MULTIPROD project will look at productivity dispersion (labour and possibly multifactor productivity) in different countries with a view to shedding light on differences across countries beyond averages. This analysis will highlight the dynamics of firms in the information industries relative to enterprises in the rest of the economy.

The OECD has also developed a Micro-data lab, which compiles and links large-scale administrative and commercial datasets at the micro level. The source datasets are not confidential, as in the case of micro-data from statistical offices, but in some cases data providers are private companies and licensing agreements are needed. The exploitation of large datasets, for example, on patents, trademarks, design rights, scientific publications and company information, enables analyses of emerging technologies, including ICTs, and their links to firms' performance.

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Key findings

While R&D provides a measure of innovation input, patent indicators reflect inventive output.

Patents can be observed by technology (classes), irrespective of the industry to which applicants belong. Patents also allow for analysis of the interaction of different technologies (see 4.8).

In 2009-11, patents in ICT technologies accounted for more than 38% of total patents filed under the Patent Cooperation Treaty (PCT), about the same share as in 1999-2001. In absolute terms, ICT-related patents almost doubled in number, reaching approximately 200 000 in 2011. At the OECD level, the share of ICT-related patents in 2009-11 represented about 36% of the total (a decrease of 3.5 percentage points with respect to 1999-2001), while in BRIICS this share more than doubled to almost 55%, largely as a result of the increasing share of China.

Computer, telecommunications and other ICT-related patents account for almost all applications, and have broadly similar weights. Telecommunication services, however, are comparatively more important in economies featuring relatively higher shares of ICT-related patents.

Overall, the distribution of patents filed under the PCT has evolved significantly since the beginning of the last decade. The United States continues to account for the largest number of patents, but its share has fallen from about 45% to just above 25%.

A similar pattern can be observed for most other countries, counterbalanced by the rising shares of Japan, Korea and especially China, which now ranks third at the global level, with a share of 13%. The patterns observed are the result of changes not only in trends in overall inventions, but also in the propensity to apply for PCT patents.

The positioning of countries in ICT-related patents nevertheless looks substantially different when indicators capturing the economic and technological value of patented inventions are employed. This can be seen, for instance, with respect to patent radical-ness indicators, which aim to capture the extent to which patented inventions differ from innovations and knowledge (i.e. the 'prior art') on which they rely.

In general terms, the share of radical inventions in ICT-related technologies is higher than for the average patent in most countries. Leading economies in this respect are Israel, India, Korea and the United States, where the indicator of radicalness is more than 20% higher than that for lagging economies.

Definitions

Patent documents contain a wealth of information related to ownership, inventors, references to prior art and technology fields to which inventions belong, as detailed in the *International Patent Classification* (IPC). An invention may be accorded one or several IPC codes during the patent examination process. Here, ICT-related technologies are identified based on a comprehensive allocation of 4-digit IPC codes developed by the OECD, which relies on a content examination of IPC classes and subclasses, as well as keyword-based searches performed on the full text of the patent.

Assessment of *patent radicalness* is based on citations: a patent that cites more prior patents in classes other than those it belongs to is considered to be more radical (Shane, 2001). Such relatively higher dissimilarity is deemed to indicate that the patent builds upon technologies different from those to which it is applied. Patent radicalness is thus measured as the time invariant count of the number of 4-digit IPC technology classes of prior patents cited by the given patent, but in which the patent itself is not classified. This number is then normalised by the total number of IPC classes cited, so that it ranges from 0 to 1 (Squicciarini *et al.*, 2013).

Measurability

Applicants can use different channels to obtain legal protection for inventions. Typically, such channels are local. While applications to national patent offices are thus usually characterised by home biases, data from different offices cannot be combined in a straightforward manner due to risks of double counting. PCT applications offer worldwide protection, but are not immune from (hardly measurable) biases.

The duration of the patenting process (patent applications are published at the earliest 18 months after having been filed) renders patent statistics unavoidably retrospective with respect to the dynamics of inventions.

To address these issues and simultaneously distil more valuable inventions, the OECD has developed computational algorithms that allow for the production of statistics for triadic patents (i.e. patents filed in all the three major [EU, Japan and US] patent offices), and for early estimates of patent applications.

Specialisation in ICT-related patents, 1999-2001 and 2009-11

ICT-related patents as a percentage of total PCT patent applications, by country
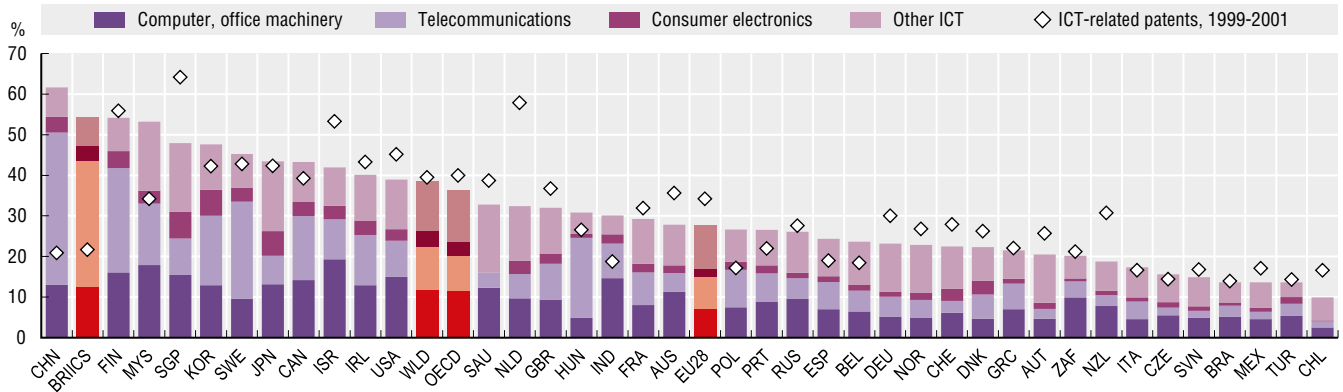
Legend: ■ Computer, office machinery ■ Telecommunications ■ Consumer electronics ■ Other ICT ◇ ICT-related patents, 1999-2001

Source: OECD, Patent Database, April 2014. See chapter notes.

StatLink ⟐ http://dx.doi.org/10.1787/888933148550

Top 15 applicants' share in ICT-related patent applications, 1999-2001 and 2009-11

Percentage of total PCT patent applications in ICT-related technologies
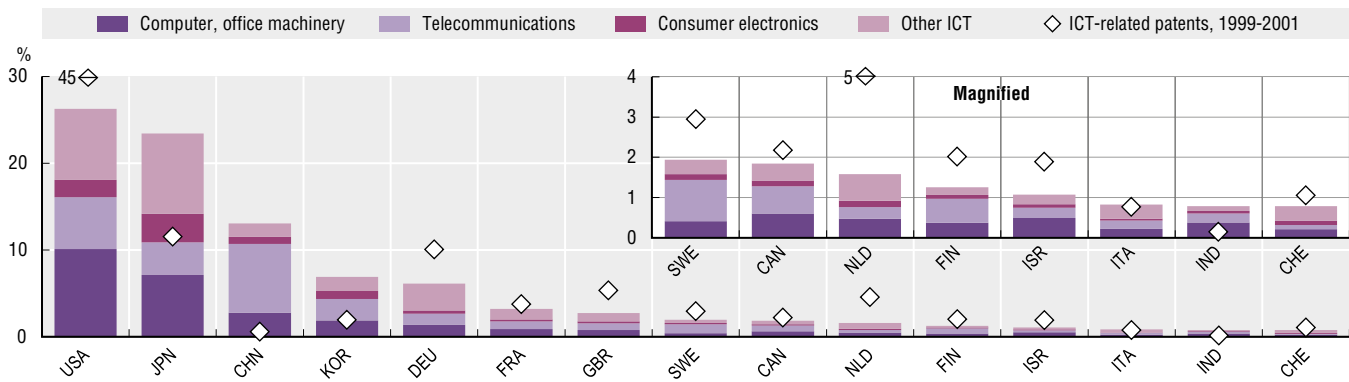
Legend: ■ Computer, office machinery ■ Telecommunications ■ Consumer electronics ■ Other ICT ◇ ICT-related patents, 1999-2001

Source: OECD, Patent Database, April 2014. See chapter notes.

StatLink ⟐ http://dx.doi.org/10.1787/888933148567

Radicalness of ICT-related patents, 2010-12

Average radicalness index based on PCT patent applications

Legend: ■ ICT-related patents ◇ All patents

Source: OECD, Patent Database, April 2014. See chapter notes.

StatLink ⟐ http://dx.doi.org/10.1787/888933148572
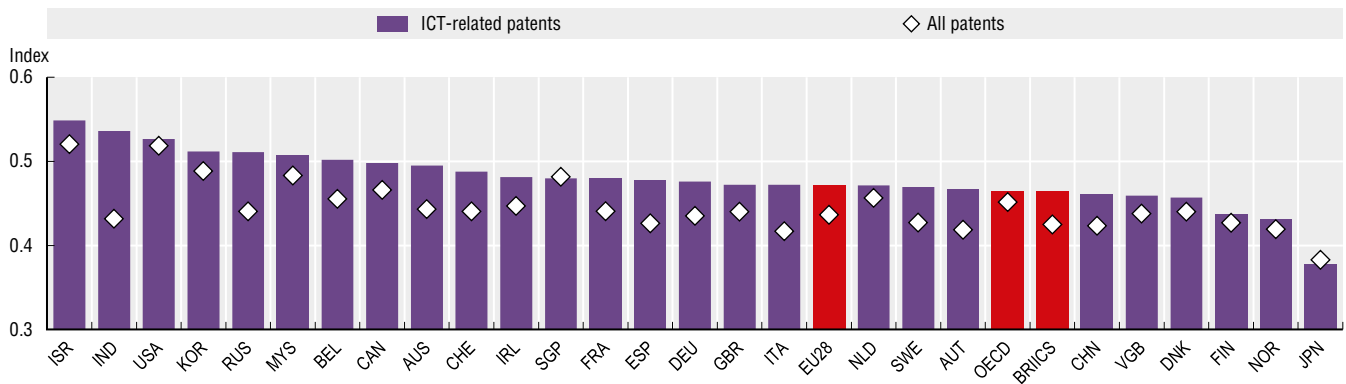
Key findings

The design of a product is the result of a creative process aimed at shaping one or more of its visual features to make its appearance appealing to consumers.

Administrative data related to registered designs provide information on how creativity moulds the "look and feel" of products; on the importance firms and customers attribute to their aesthetic features; on product differentiation and customisation and, more generally, on the role of design in shaping competition in the marketplace. The complexity of a product and the range of aesthetic features that may make it attractive to consumers can be better understood by looking at the number of distinct designs contained in design applications. On average, there are 3.5 designs per application overall and about 3 per application for ICT and audio-visual-related products.

ICT and audio-visual items are among the most represented product categories of European Registered Community Designs (RCD), following furnishing and clothing. In 2010-13, they accounted for 8.5% of total RCD, 1 percentage point more than in 2005-08.

Across all economies, about 60% of registered ICT and audio-visual-related designs refer to data-processing and recording equipment, followed by communication and audio-visual devices.

The United States and Korea are the most active economies in ICT and audio-visual-related RCD (both gaining shares with respect to 2005-08), followed by Germany and Japan (both losing shares) with the other large European economies tailing behind. China doubled its share but remains a minor player with regard to designs registered in Europe.

The United States scores high in data-processing equipment and Korea in communication equipment, while France and Japan lead in the design of audio-visual devices.

Design related to ICT and audio-visual products represents almost 60% of Korean total RCD (down by some percentage points from 2005-08). Other economies specialising in this field are Canada, Chinese Taipei, Japan and the United States.

Revealed comparative advantage (RCA) indicators highlight the relative specialisation of economies in different fields. The 2010-13 RCA values in ICT and audio-visual related design show an overall rebalancing across economies. Among the leaders, only Canada and the United States show an improvement in their RCA in ICT, while Finland, Japan and Korea register a decline. In the case of Korea, this decline mirrors a rise in shares and reflects the strong expansion of design in other areas.

Definitions

Registered Community Designs (RCD) protect the ornamental or aesthetic aspects of an article or its parts against copying or the independent development of similar designs. RCDs are valid in the European Union as a whole, have an initial life of five years from filing, and can be renewed for up to a maximum of 25 years.

Only products or parts thereof can be legally protected, not functionalities or services. A single application can include several designs (e.g. for similar products or different parts of the same product).

Industrial designs follow the Locarno Classification (established in 1968). Its 9th edition, which entered into force in 2009, contains 32 classes and 219 subclasses of goods. The classification is administrative in character and does not bind contracting economies with respect to the nature and protection afforded by the design. The owner of an RCD can act against infringement and request EU customs authorities to retain suspected counterfeit goods while under their control.

Measurability

Registered design data are used here as a proxy for the creativity that economies seek to protect on the European market. Such data are publicly available and provide a homogenous set of information related to ownership and the specific goods concerned, among others.

Design data suffer from some drawbacks, including selectivity and truncation. Indeed, not all designs are registered (designers and owners may decide not to seek intellectual property protection), nor can be registered (e.g. if they are exclusively dictated by technical functions). Furthermore, industrial designs cannot be registered everywhere in the world. The United States is a notable exception, as industrial design is protected through the concurrent use of design patents, copyrights and trademarks. Finally, no information about the value of the asset is available in administrative data.

Truncation mainly arises because of delays in making administrative data public and, in the case of RCD, because applicants have the right to keep the design confidential for up to 30 months from filing.

Top 20 applicants' share in ICT and audio-visual-related designs, 2005-08 and 2010-13

Percentage of total ICT and audio-visual-related Registered Community Designs
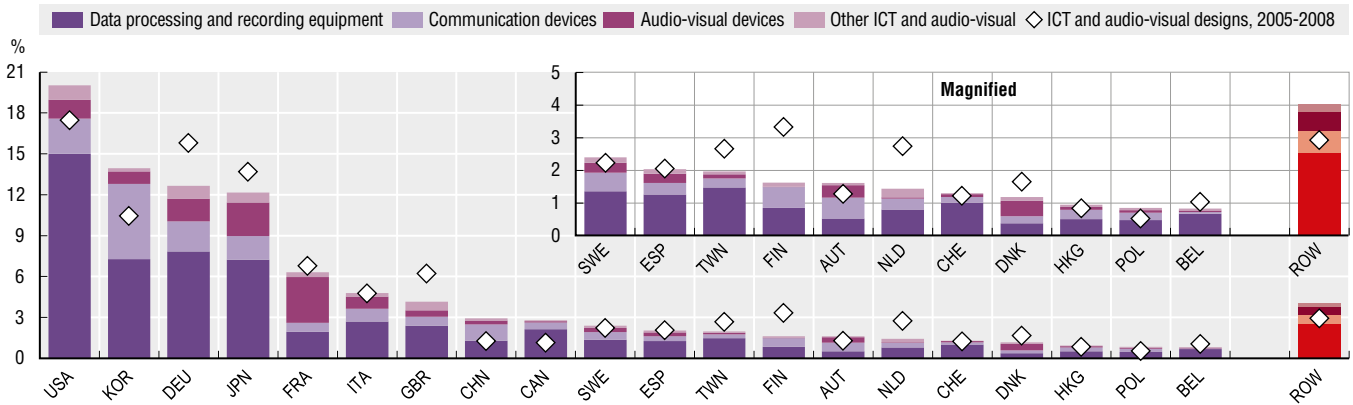
Source: OECD calculations based on OHIM, Registered Community Design Database, RCD Download, April 2014. See chapter notes.

StatLink ⟨≋⟩ http://dx.doi.org/10.1787/888933148580

Specialisation in ICT and audio-visual-related designs, top 20 applicants, 2005-08 and 2010-13

ICT and audio-visual-related designs as a percentage of applicants' total Registered Community Designs
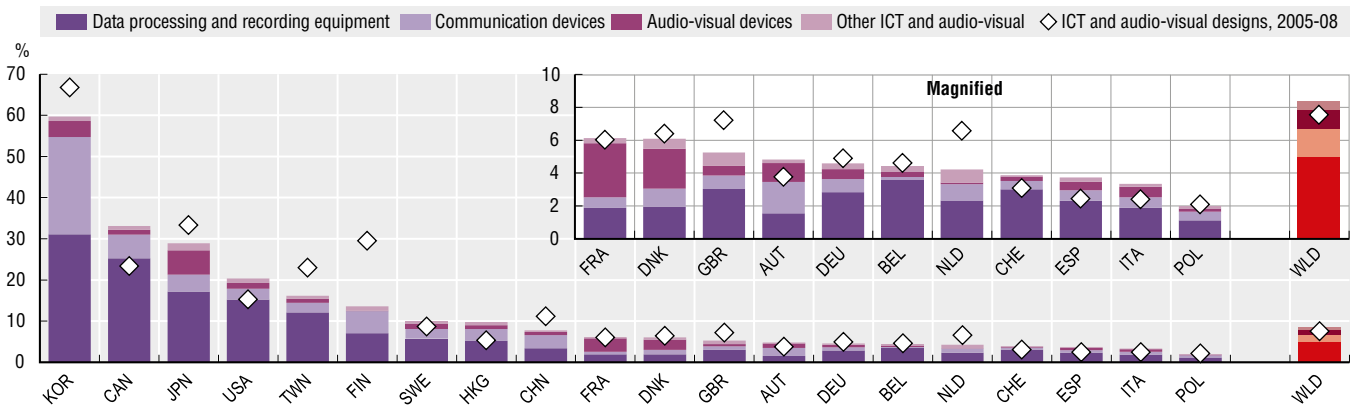
Source: OECD calculations based on OHIM, Registered Community Design Database, RCD Download, April 2014. See chapter notes.

StatLink ⟨≋⟩ http://dx.doi.org/10.1787/888933148592

Revealed comparative advantage in ICT and audio-visual-related designs, top 20 applicants, 2005-08 and 2010-13

Index based on Registered Community Designs
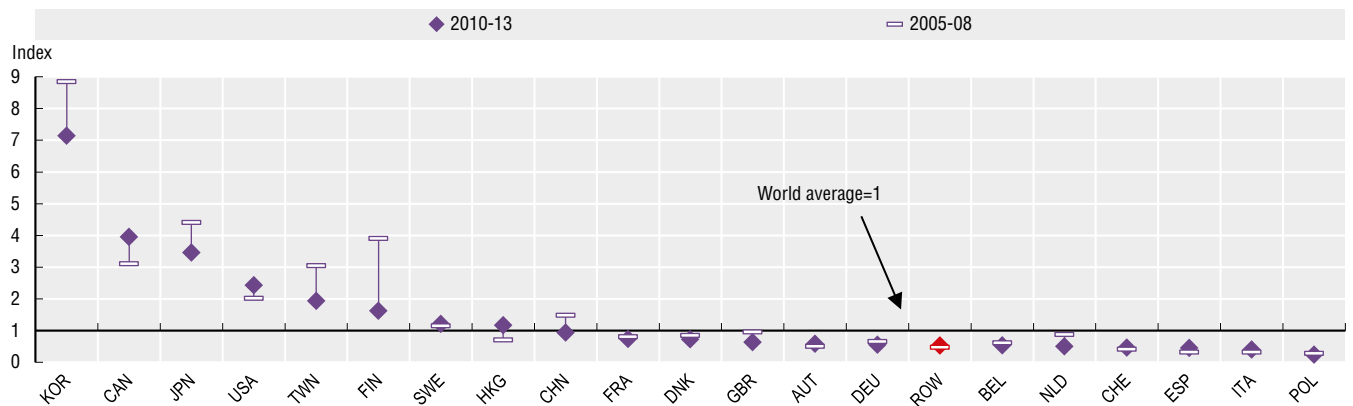
Source: OECD calculations based on OHIM, Registered Community Design Database, RCD Download, April 2014. See chapter notes.

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Key findings

Branding activities of ICT-related products, as measured by trademark registrations, are high and growing. In 2010-13 they reached about one third of total trademark filings at the European Office for Harmonisation in the Internal Market (OHIM), and one fifth at the United States Patent and Trademark Office (USPTO).

The distribution of trademarks offers a distinctive perspective on the competitive position of economies concerning ICT products. Indeed, national trademark shares do not align with R&D, patents or export shares. The local nature of trademarks, which need to be registered in each market where companies operate or sell, also leads to a very strong home bias.

The United States appears to be the largest overall player, accounting for almost 80% of total ICT-related applications at the USPTO and more than 12% at OHIM. ICT-related trademarks on the European market are conversely led by applicants in Germany, followed by the United States, the United Kingdom, Spain, France and Italy. The share of Italy and Spain in ICT branding activity at OHIM is notably higher than their relative importance in ICT industries (although their trademark presence on the US market is limited), while the opposite is the case for Japan and Korea.

With respect to the 2005-08 period, a number of large trademark players, including Japan and the United States but excepting Germany and Spain, lost shares in EU branding to the benefit of China, Korea and smaller EU economies.

The share of ICT-related trademarks as a proportion of total trademark registrations grew in nearly all economies. Korea is by far the most specialised economy; almost 60% of its total OHIM trademark registrations were ICT related in 2010-13, up from 40% in 2005-08. The composition of Korea's ICT trademarks is also more oriented towards goods than services, reflecting the economy's specialisation in ICT manufacturing. The same holds true for China, Chinese Taipei and Japan. Other key actors such as Germany, Italy and the United States have fallen behind, demonstrating the strong propensity of companies in these economies to seek brand protection across all sectors, not only in ICTs.

An examination of economies' revealed comparative advantage (RCA) in ICT trademarks, measured as the share of their ICT filings over the share of their total filings at OHIM and USPTO, allows a better appreciation of these recent changes. While Korea, Luxembourg and Spain show a high and growing RCA for both offices, the RCA in ICT at OHIM remains at around the world average for France, Germany and the United States, and lower than the average for Italy.

Definitions

A *trademark* is a sign (e.g. text or graphic) used to distinguish the goods or services of one enterprise from those of other enterprises.

Statistics on trademark registrations provide a measure of the relevance of branding in given product areas, conditional on the need to protect these brands against counterfeiting.

Trademark registrations typically remain in effect for 10 years and are renewable.

The four-year registration flows considered here are taken from OHIM and USPTO, the two offices representing some of the world's largest markets.

Trademark registrations are classified on the basis of the Nice Agreement Concerning the International Classification of Goods and Services for the Purposes of the Registration of Marks of 1957. Overall, 45 product classes exist, 34 of which are related to goods and 11 to services.

Here, ICT-related trademarks have been identified as trademarks belonging to classes 9, 28, 35, 38, 41 and/or 42 of the Nice Classification and containing ICT-related keywords in the description of products.

Measurability

Trademark registrations depend on the need to promote company value and gain legal protection against imitation.

Fees vary substantially across economies and are not always proportional to the number of designated classes (e.g. OHIM allows up to three classes for the same initial fee). This may affect overall statistics and the observed proportions of goods and services trademarked.

The lack of classes explicitly denoting ICT goods and services requires the performance of text-based counting, which can be imprecise and limits the opportunity to uncover possible synergies with other product areas.

Finally, national (or EU)-only coverage may be fraught with possible home biases in registrations. OHIM and USPTO are therefore considered separately to avoid double counting. However, this leaves unaddressed protection on other markets.

ICT-related trademarks, top 20 applicants, 2005-08 and 2010-13

As a percentage of total ICT-related trademark applications at OHIM and USPTO
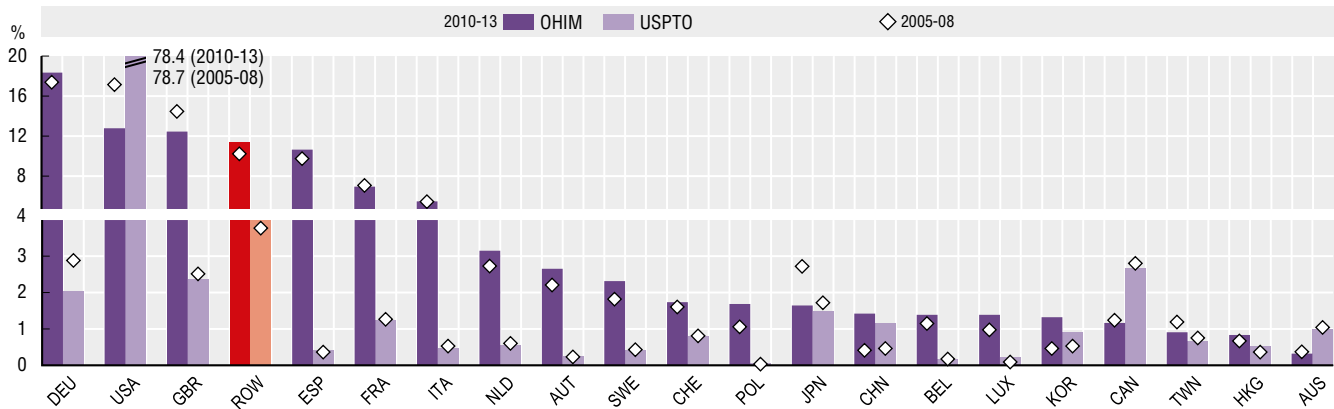
Source: OECD calculations based on US Patent and Trademark Office and OHIM Community Trademark Database, April 2014.

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Specialisation in ICT-related trademarks, top 20 applicants, 2005-08 and 2010-13

ICT-related trademarks as a percentage of applicants' total trademark registrations at OHIM and USPTO
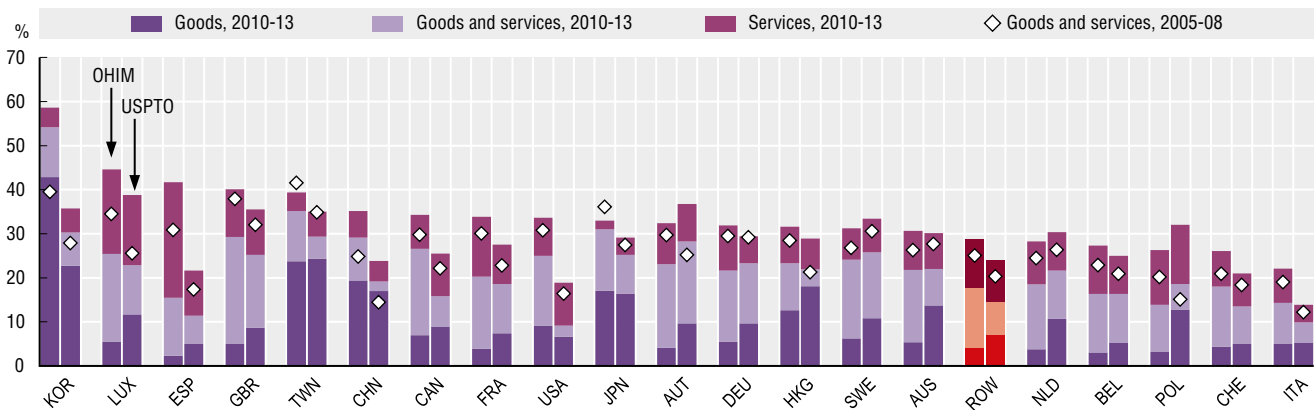
Source: OECD calculations based on US Patent and Trademark Office and OHIM Community Trademark Database, April 2014.

StatLink ᐁᓬ *http://dx.doi.org/10.1787/888933148628*

Revealed comparative advantage in ICT trademarks, top 20 applicants, 2005-08 and 2010-13

Index based on registrations at OHIM and USPTO
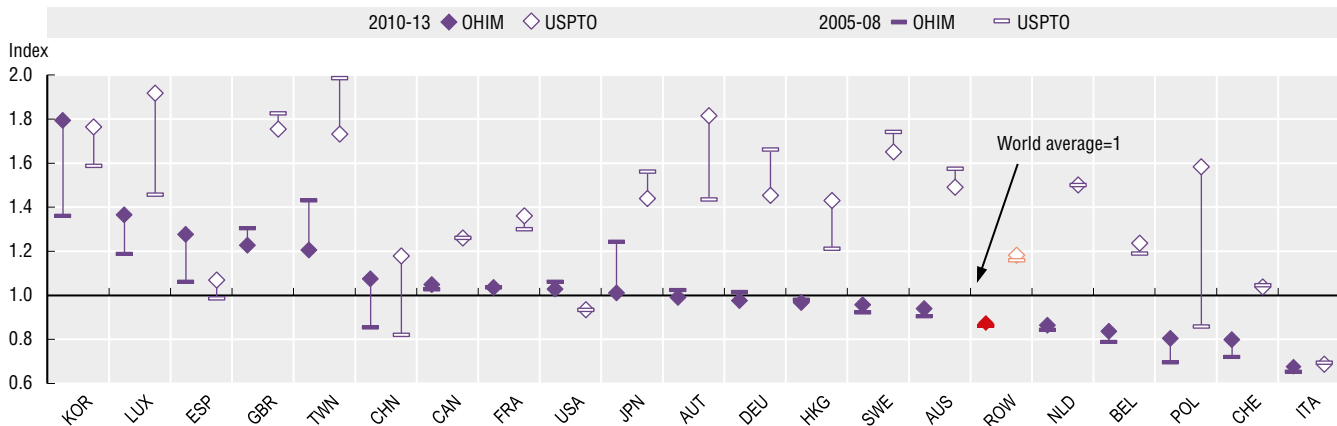
Source: OECD calculations based on US Patent and Trademark Office and OHIM Community Trademark Database, April 2014.

StatLink ᐁᓬ *http://dx.doi.org/10.1787/888933148639*

Key findings

ICTs are a key enabling factor in knowledge creation and diffusion. ICT-related innovations are adopted by firms in all sectors of the economy and are diffused to other science and technology fields.

The ICT sector itself is prone to innovation (see 4.2), and enterprises in ICT industries are keen to engage in innovative activity in collaboration with other organisations. According to the results of the 2010 Community Innovation Survey (CIS), more than of half of the innovative firms in ICT manufacturing collaborated in innovation with other organisations, as compared to 34% for manufacturing firms overall.

This difference is smaller for firms in the service sectors. In countries where data are available, on average 39% of innovative firms in the information and communication service industries engaged in collaboration in 2010, against 31% in all innovation core service firms that innovate.

Cooperation in innovation among innovators located in different countries provides a measure of international flows in knowledge. In 2009-11, with the exception of digital communication, the share of international co-inventions was lower in IT technology fields than in other technologies.

International co-inventions generally account for around 6% in computer technologies and telecommunications, 5% in semiconductors and about 4% in audio-visual technologies.

An examination of technological fields attributed to patents applications filed under the Patent Co-operation Treaty (PCT) can function as a proxy for knowledge flows between ICTs and other technological areas.

In 2009-11, about a quarter of ICT-related patents also belonged to one or more other technological fields. Patents in medical, biotechnology or pharmaceutical technology fields added up to about 14% of this group, while transport, logistics and machine tools amounted to 8%.

Many patents cover technological fields contiguous to ICTs, such as electrical machinery (14%) or audio-visual technologies (5%). Numerous examples include patents in technologies likely to be applied in the ICT field, such as basic chemistry or nano-technologies.

Often ICT-related inventions in this group lie at the crossroads between several other technological fields and their potential applications also bridge different industrial domains.

DID YOU KNOW?

In 2010, on average, about 54% of innovative firms in ICT manufacturing engaged in collaboration with other organisations, against 34% in the manufacturing sector overall.

Definitions

Collaboration involves "active participation in joint innovation projects with other organisations", but excludes pure contracting out of innovation-related work. It can involve the joint implementation of innovations with customers and suppliers, as well as partnerships with other firms or organisations. *Innovation core service activities* include ISIC Rev.4 Divisions G46, H, J58, J61, J62, J63, K and M71.

International co-inventions feature at least one foreign co-inventor in patents invented domestically.

Technology fields are defined according to the classification proposed by Schmoch (2008) and rely on the International Patent Classification (IPC) codes contained in the patent document. An invention may be accorded one or several IPC codes during the patent examination process. *ICT-related patents* cover the following technology fields, based on selected IPC codes of the 8th edition of the IPC: Telecommunications, Consumer electronics, Computers, office machinery and Other ICT. *Combinations between ICTs and other technologies in patent applications* are computed on the basis of ICT-patents with at least one additional IPC class in other technology fields.

Measurability

Applicants can use different channels to obtain legal protection for inventions. Typically, such channels are local. While applications to national patent offices are thus usually characterised by home biases, data from different offices cannot be combined in a straightforward manner due to risks of double counting. PCT data reduce this risk as the protection for patent applications has a worldwide coverage.

In the case of emerging technologies, specific applications might not yet be incorporated into the IPC, rendering their identification difficult. ICT-related technologies are identified here on the basis of a comprehensive allocation of 4-digit IPC codes developed by the OECD, which relies on a content examination of IPC classes and subclasses, as well as keyword-based searches performed on the full text of the patent. Such a method might exclude, or include, patents that are, or are not, relevant for a specific domain, but provides a relatively good picture of the innovative activity in different technology fields.

Firms engaging in collaboration on innovation, by sector, 2010

As a percentage of product and/or process innovative firms
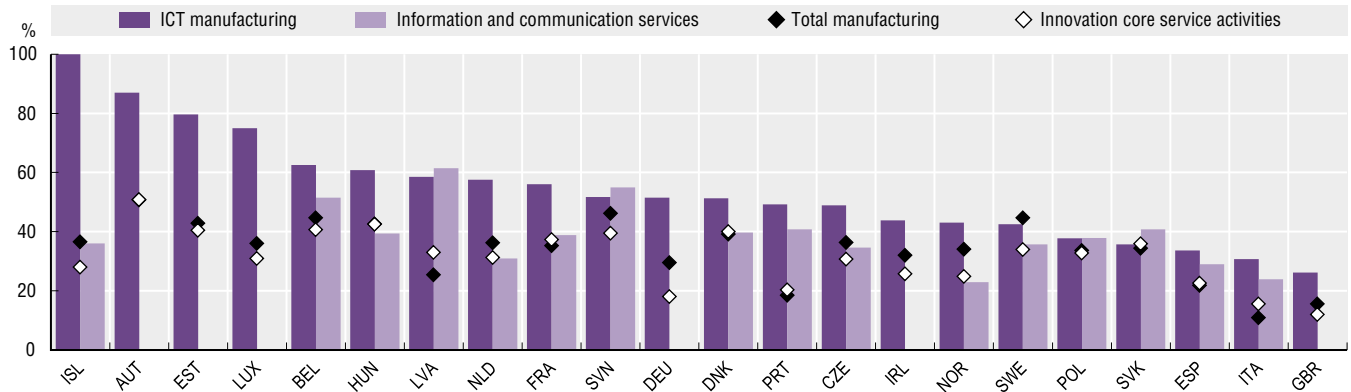
Source: OECD computations based on Eurostat, Community Innovation Survey (2010), June 2014.

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International co-inventions by technology fields, 1999-2001 and 2009-11

As a percentage of PCT patent applications
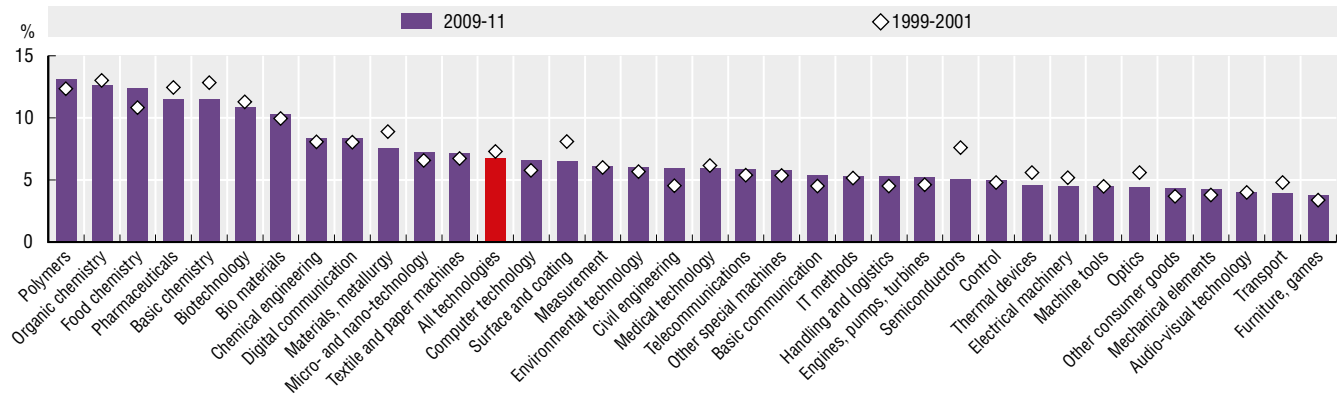
Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink ᔕᓀ *http://dx.doi.org/10.1787/888933148653*

Top 20 combinations between ICTs and other technologies in patent applications, 1999-2001 and 2009-11

As a percentage of all ICT-related patent applications also belonging to other technology fields

Source: OECD, Patent Database, April 2014. See chapter notes.

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Notes

4.1 ICT and R&D

Business R&D performed by information industries, 2011 or more recent year available

The category "ICT services not allocated" refers to industries within ISIC Rev.4 Divisions 58-63 that cannot be separated.

For Australia and the United States, GDP is computed according to the SNA 2008.

For Canada, the Czech Republic, Estonia, Finland, Germany, Hungary, Poland, the Slovak Republic, Slovenia, Switzerland and Turkey, data refer to 2012.

For China, data refer to 2009.

Business R&D intensity in ICT manufacturing industries, 2007 and 2011

For Canada and Japan, data refer to 2007 and 2009.

For Finland and the Netherlands, data refer to 2008 and 2011.

For the Czech Republic, data refer to 2007 and 2012.

For Portugal, the United Kingdom and the United States, data refer to 2007 and 2010.

For Switzerland, data refer to 2008 and 2012.

Business R&D intensity in information and communication service industries, 2007 and 2011

For Australia, Portugal, the United Kingdom and the United States, data refer to 2007 and 2010.

For Canada, data refer to 2007 and 2009.

For Finland and the Netherlands, data refer to 2008 and 2011.

For Switzerland, data refer to 2008 and 2012, and include ICT services only.

4.2 Innovation in ICT industries

Innovative enterprises in IT services and innovation core service activities, by type of innovation, 2010

For Slovenia, IT services include ISIC Rev.4 Section J (Information and communication services), consisting of ISIC Rev.4 Divisions 58 to 63.

4.3 E-business

The diffusion of selected ICT tools and activities in enterprises, 2013

For countries in the European Statistical System, e-commerce variables (online purchases and online sales) refer to 2012.

Supply chain management refers to the use of automated data exchange (ADE) applications, and data refer to 2012.

Data for Radio Frequency Identification (RFID) refer to 2011.

For Australia, e-purchases data refer to 2011.

Broadband connectivity, by size, 2010 and 2013

For Australia and New Zealand, data refer to the fiscal year ending 30 June 2012 instead of 2012. For Australia, the total includes Agriculture, forestry and fishing.

For Canada, data refer to 2007 instead of 2010; medium-sized enterprises have 50 to 299 employees and large enterprises have 300 or more employees.

For Japan and Korea, data refer to 2012.

For Japan, data refer to businesses with 100 or more persons employed instead of 10 or more; medium-sized enterprises have 100-299 persons employed and large enterprises have 300 or more persons employed.

For Switzerland, data refer to 2008 and 2011.

Use of enterprise resource planning software, by size, 2010 and 2013

Unless otherwise stated, sector coverage consists of all activities in manufacturing and non-financial market services. Only enterprises with ten or more persons employed are considered. Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249) and large (250 and above).

For Canada, medium-sized enterprises have 50 to 299 employees. Large enterprises have 300 or more employees.

For Switzerland, data refer to 2011.

4.4 Unleashing the potential of micro-data

ICT uptake among innovators and non-innovators in 13 European countries, 2004, 2008 and 2010

The figures show simple averages for all reporting countries across reference years in which the Community Innovation Survey (CIS) and the Community Survey on ICT Usage in Enterprises were performed.

Data refer to Austria, Denmark, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Slovenia, Sweden and the United Kingdom.

Cell values for each variable are reweighted to represent the business structure by employment size in each country.

Data for ERP in 2010 are limited to Finland, France and Luxembourg.

4.5 ICT patents

Specialisation in ICT-related patents, 1999-2001 and 2009-11

Patent counts are based on the priority date, the inventor's residence and fractional counts. Only economies that applied for more than 250 patents in 2009-11 are included.

Top 15 applicants' share in ICT-related patent applications, 1999-01 and 2009-11

Patent counts are based on the priority date, the inventor's residence and fractional counts. Only economies that applied for more than 1 000 patents in 2009-11 are included.

Radicalness of ICT-related patents, 2010-12

The radicalness index refers to the number of IPC classes in which patents cited by a given patent are classified, but in which the patent itself is not classified (Shane, 2001), normalised by the total number of IPC classes listed in the backward citations.

Data relate to patent applications filed under the PCT, by filing date and the applicant's residence.

Only economies with more than 250 ICT-related patents in 2010-12 are included.

4.6 ICT designs

General notes:

Figures are calculated using fractional counts of the Locarno classes mentioned in the design registration.

Data processing and recording equipment correspond to the Locarno subclasses 14-01, 14-02 and 14-04; communication devices correspond to subclass 14-03; audio-visual devices correspond to class 16. Total ICT and audio-visual designs correspond to designs in classes 14, 16 and 18.

Additional notes:

Revealed comparative advantage in ICT and audio-visual-related designs, top 20 applicants, 2005-08 and 2010-13

The revealed design advantage index is defined as the share of an economy's designs in a particular field relative to the share of total designs in that economy. The index is equal to zero when the economy has no design in a given field; is equal to 1 when the economy's share in the field equals its share in all fields (no specialisation); and above 1 when a positive specialisation is observed.

4.8 Knowledge diffusion

International co-inventions by technology fields, 1999-2001 and 2009-11

Patent counts are based on the priority date and fractional counts by technology fields.

Top 20 combinations between ICTs and other technologies in patent applications, 1999-2001 and 2009-11

Patent counts are based on the priority date. ICT-related patents are defined using a selection of International Patent Classification (IPC) classes. Additional IPC codes listed in ICT-related patent documents have been classified according to the IPC-Technology Concordance proposed by Schmoch (2008), revised in January 2013, available at www.wipo.int/ipstats/en/statistics/technology_concordance.html.

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Chapter 5

DELIVERING GROWTH AND JOBS

Key findings

Investment in ICT goods and services is an important driver of growth. However, in 2012 ICT investment as a share of GDP and gross fixed capital formation (GFCF) was significantly lower than the peak reached in 2000 in nearly all OECD countries for which data are available. Data for 26 OECD countries show that ICT investment dropped from 3.2% to 2.3% of GDP, and from 13.8% to 12.1% of total investment between 2000 and 2012.

The pro-cyclical nature of investment reinforced the fall in spending on IT and communication equipment, which was also partly driven by relative falls in unit prices compared to other forms of investment. At the same time, investment in software as a share of GDP remained stable or grew and, on average, increased its weight to 57% of total ICT investment, from less than 40% in 2000.

Depending on specialisation, position in the business cycle and structural features of the economy, national ICT investment figures vary from 3% of GDP and above in Austria, Denmark, Japan, New Zealand, Sweden, Switzerland and the United States to less than 1.5% in Greece, Ireland, Luxembourg, Mexico and the Slovak Republic. Significant falls in shares occurred in Sweden, as well as in Australia, Canada, the Czech Republic, Korea, Luxembourg, and the Slovak Republic, largely driven by falls in the equipment component.

The generalised fall in ICT investment does not correspond to a similar decrease in the contribution of the ICT sector to economic growth, employment and exports (see 5.3 for value added, 5.8 for employment and 5.9 for international trade), reflecting at least in part increasing embodiment of ICT intermediates in non-ICT goods and services. In assessing the relevance of ICT investment in the economy, it should also be considered that a growing share of ICT expenditure by businesses might be non-capitalised. In this respect, detailed information available for the United States reveals that about one third of total business expenditure in ICTs is non-capitalised and that the ICT sector itself is responsible for about 40% of capitalised expenditure. The overall decline in the share of ICT over total investment is partly due to price declines, which affected in particular the equipment component. Adjusting ICT investment by means of appropriate deflators reveals the relative contribution of ICT investment to GDP growth.

In the last decade, ICT investment has contributed between 0.6 and 0.2 percentage points to GDP annual growth. The contribution of ICT investment to growth was higher than that of non-ICT investment in 9 out of the 20 countries considered, particularly in Japan and Switzerland. The contribution of non-ICT investment has been relatively higher in Australia, Canada, Ireland, Korea, Portugal and Spain.

DID YOU KNOW?

ICT investment represents on average 12% of total investment, but its contribution to GDP growth during the 2000-12 period was comparable to that of non-ICT investment.

Definitions

The definition of GFCF used here follows the 1993 System of National Accounts (SNA). ICT investment has three components: *information technology equipment* (computers and related hardware), *communications equipment* and *software*. Software includes acquisition of pre-packaged software, customised software and software developed in-house.

ICT investment is shown below as a share of Gross Domestic Product and as a proportion of Gross Fixed Capital Formation. GFCF reflects investment gross of depreciation and includes expenditures – on buildings, machinery, equipment and intellectual property products – that satisfy the criteria set out in the SNA, namely that the acquired assets can be used repeatedly in production for more than one year. The *contribution of ICT investment to GDP growth* looks at the contribution made by the stock of capital and reflects the contribution of ICT capital services, as opposed to the contribution from non-ICT capital services, labour and multifactor productivity, by means of harmonised deflators.

Measurability

As ICT products, in particular software, are often included as intermediates to non-ICT capital goods, estimates of investment in ICT may understate the underlying importance of ICTs to overall investment.

Some care is needed in particular when comparing investment in software across countries and years, as levels may be affected by the degree to which software is bundled with other products, including other ICT equipment, and so, are not recorded as software investment. Timeliness and the level of detail with which information on ICT investment, and indeed all ICT expenditures, is made available across countries, also remain uneven.

At present, only a few countries, including the United States, collect data on total ICT expenditure by industry. But work is ongoing to improve this situation. A similar effort is planned in countries participating in the European Statistical System, where results are pending, and the OECD is promoting the inclusion of a specific module on ICT expenditure via its 2014 revision of the Model Survey on ICT Usage by Businesses.

ICT investment by asset, 2000 and 2012

As a percentage of GDP and Gross Fixed Capital Formation

Legend: Software | IT equipment | Communication equipment | Breakdown not available

GFCF values (top of chart): DNK 19, JPN 16, CHE 16, SWE 17, NZL 17, USA 17, AUT 15, BEL 14, KOR 10, AUS 9, GBR 18, PRT 14, FRA 13, ESP 12, CAN 9, CZE 9, NLD 12, SVN 12, FIN 9, ITA 9, DEU 9, GRC 10, IRL 13, MEX 6, SVK 6, LUX 6, Average 12

ICT investment as a percentage of GFCF (2012)

2012   2000
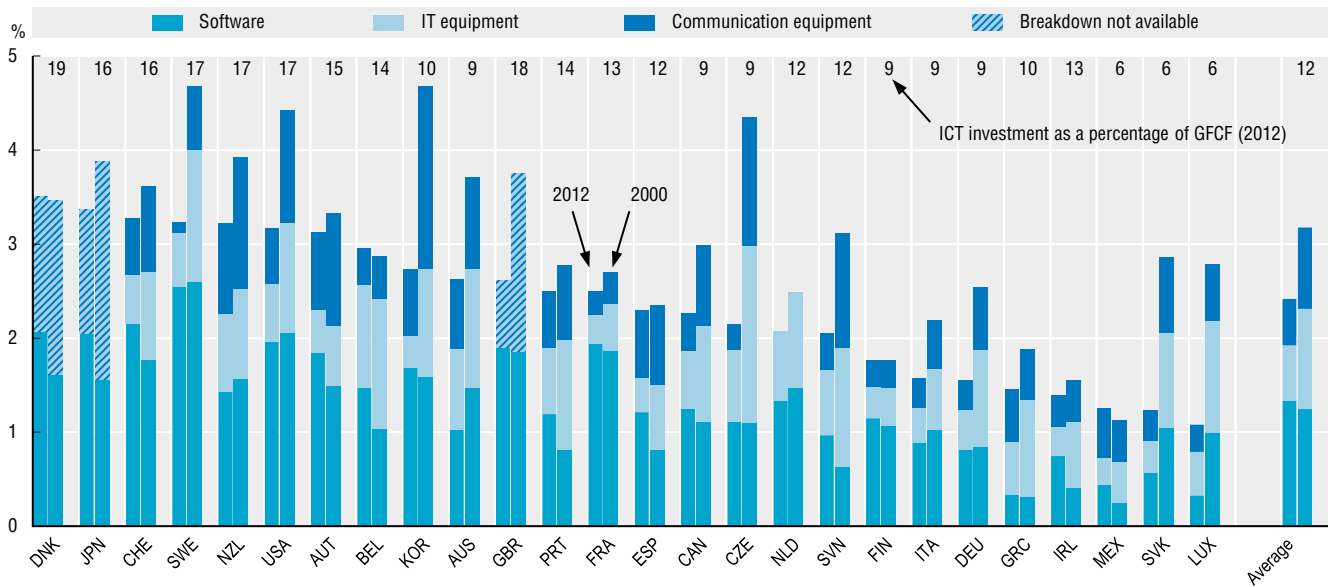
Source: OECD, Annual National Accounts (SNA) Database; Eurostat, National Accounts Statistics and national sources, June 2014. See chapter notes.

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Contribution of ICT and non-ICT investments to GDP growth, 2000-12

In percentage points, on yearly basis

Legend: ICT investment | Non-ICT investment
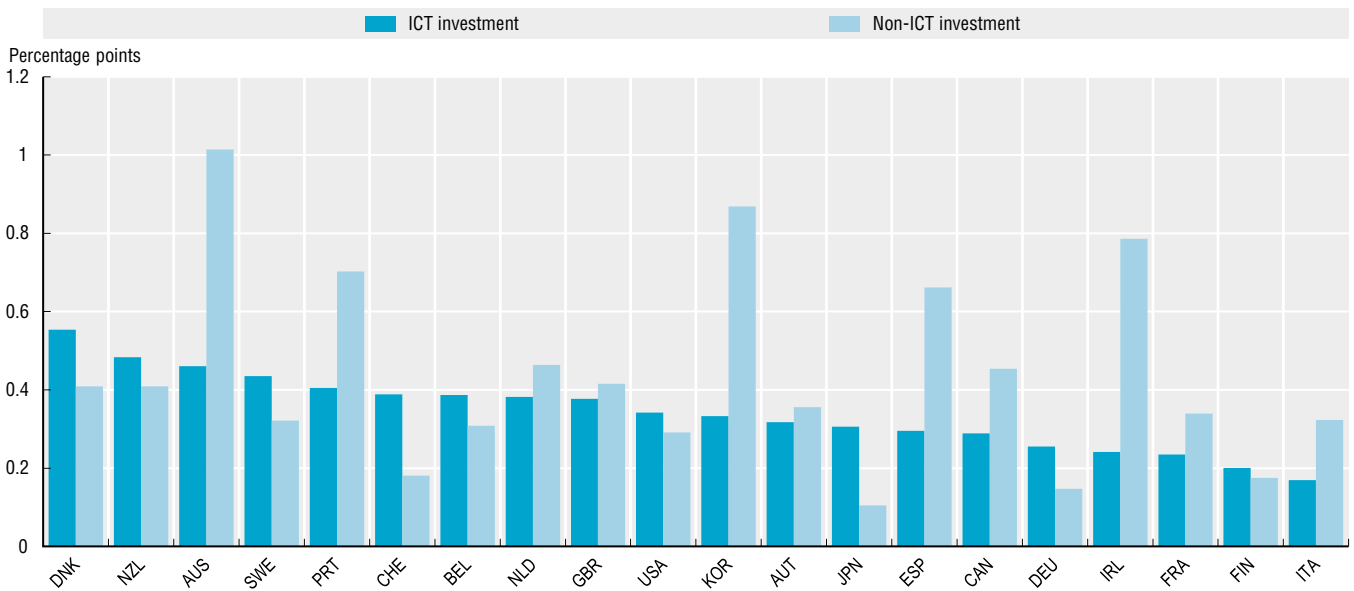
Source: OECD, Productivity Database, July 2014. See chapter notes.

StatLink ᴍᴼ *http://dx.doi.org/10.1787/888933148682*

Key findings

Entrepreneurship and entrepreneurial dynamics are at the heart of employment and productivity. The birth of new firms and the death of non-viable ones are essential to an economy's experimentation with new technologies and business models.

Between 2009 and 2012, net business population growth in the ICT sector was about 4.5% on average as compared to 1% in the business economy overall. Typically, the ICT sector is also characterised by higher rates of survival among start-ups after five years.

The rate of net business population growth varies widely across countries depending both on the economic cycle and structural factors. Over the recent period, business population in the ICT sector grew at an average annual rate of about 8% or more in Latvia, Poland, the Slovak Republic and Turkey, while Austria, the Czech Republic, Italy and Portugal were characterised by slightly negative growth rates of their ICT business population.

In almost all countries, the ICT sector outperformed the rest of the economy in terms of net business population growth. In Estonia, Hungary, Ireland, Spain and the United Kingdom, the ICT sector was the exception to the negative trend in net business population growth observed in the business economy overall.

The dynamism of ICT businesses can also be observed through figures on medium and high-growth enterprises (MHGEs). Based on their employment performance, in 2012, MHGE represented on average about 21% of all active enterprises with ten or more employees in ICT manufacturing, against 10% in the manufacturing sector overall. This share was 17% in information and communication services against about 10% in total business sector services.

The figures vary considerably across countries for the ICT manufacturing sector, where MHGE shares ranged from 30% and above in Finland and Germany to less than 10% in Belgium, Latvia and Luxembourg. Cross-country differences were less pronounced for information and communication services.

For both aggregates, the share of MHGEs among ICT firms was higher than the average in nearly all countries.

In 2012, across all European countries, the employment share of MHGEs in the ICT sector was 7.3% against 4.8% in the business economy overall. MHGEs are usually larger than average enterprises, but this difference is smaller in ICT industries.

Definitions

Net business population growth reflects the change in the population of active enterprises (in terms of employment and/or turnover) between the beginning and the end of the period.

ICT industries cover ISIC Rev. 4 Groups C261 to C264 and C268 for ICT manufacturing and Groups G465 (Trade), J582 (Software publishing), J61 (Telecommunications), J62 and J631 (IT services) and S951 (Repairs) for ICT services.

Business economy figures include all sectors except agriculture, public services and activities of holding companies.

Medium and high-growth enterprises (MHGE), here measured by employment, are enterprises with an average annual growth in employees greater than 10% a year, over a three-year period, and with ten or more employees at the beginning of the observation period. Due to data availability, MHGE numbers are expressed as a percentage of the population of enterprises in the previous year. ICT manufacturing figures refer to the ISIC Rev.4 Division C26.

Measurability

The concepts underlying indicators of business demography (i.e. definitions of active enterprises, births, deaths, etc.) follow the guidelines agreed in the *Eurostat-OECD Manual on Business Demography Statistics* (2008). These require that only real events be considered. For instance, when two enterprises merge into a new entity, two exits and one entry would be recorded in administrative registers, while in statistical business registers no demographic event should be recorded except a variation in the stock of active enterprises. In practice, distinguishing real from purely administrative events is a hard task. Indeed, more dynamic enterprises in particular can undergo mergers, acquisitions, demergers and so on, and are thus more prone to errors and the inclusion of some "administrative noise". In addition, the implementation of recent guidelines on business demography requires time and a robust statistical infrastructure. In recent years, the quality of demographic indicators has been substantially enhanced and their diffusion broadened.

Net business population growth between 2009 and 2012

Average annual growth rate

Legend: ■ ICT sector ◇ Business economy
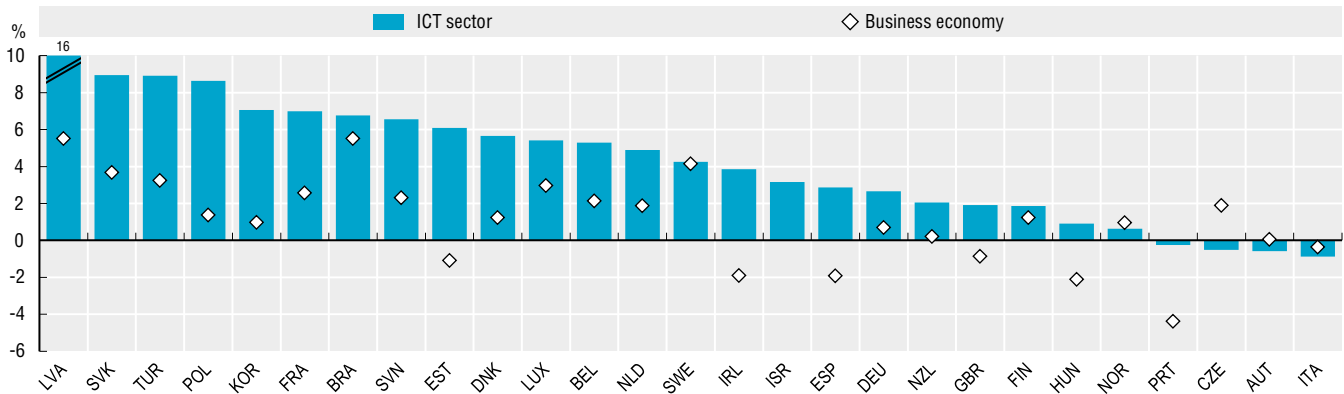
Source: OECD computations based on OECD, Structural and Demographic Business Statistics and Eurostat, Business Demography Statistics, August 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148696

Medium and high-growth enterprises in ICT and total manufacturing, measured by employment growth, 2012

As a percentage of active firms with ten or more employees in the previous year
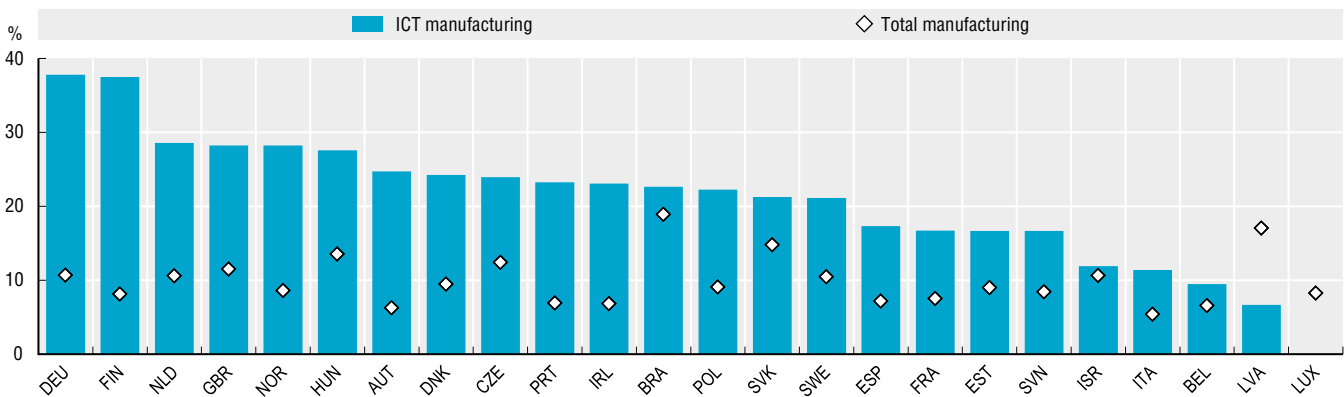
Legend: ■ ICT manufacturing ◇ Total manufacturing

Source: OECD computations based on OECD, Structural and Demographic Business Statistics Database and Eurostat, Business Demography Statistics, August 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148706

Medium and high-growth enterprises in ICT and business sector services, measured by employment, 2012

As a percentage of active firms with ten or more employees in the previous year
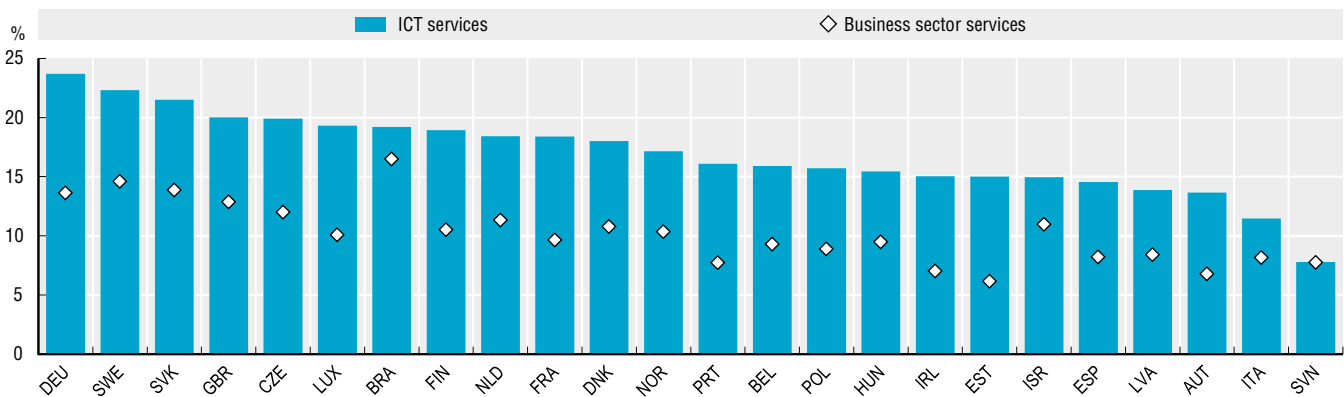
Legend: ■ ICT services ◇ Business sector services

Source: OECD computations based on OECD, Structural and Demographic Business Statistics Database and Eurostat, Business Demography Statistics, August 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148717

Key findings

Demand for information and communication products has increased continuously since 2000. In most OECD economies, however, the share in values added of information industries remained the same or diminished. On average, it decreased slightly, to little less than 6% of GDP.

This overall trend hides important changes in the composition of the aggregate, as well as some country-specific patterns.

Computer and electronics manufacturing and, to a lesser extent, telecommunication services saw their weight in total value added diminish as production shifted to other, mostly non-OECD, economies, and unit prices fell as a result of productivity growth and increased competition.

On average, the share of ICT manufacturing activities dropped from 1.5% to 1.1% of total value added. This share grew only in Switzerland and in a few countries in Eastern Europe, which benefited from offshoring, and fell steeply in Finland and Ireland.

The share of telecommunication services also decreased from 2% to 1.7% on average with respect to 2000, and even further with regard to the 2003-04 peak, as a result of a steep fall in prices.

Meanwhile, the share of publishing and media activities in total value added remained the same at 1.2-1.3%, while the share of IT services rose in all reporting economies, from 1.3% to 1.9% on average, largely offsetting losses in the other ICT sectors.

In the Czech Republic, Estonia, Hungary, Ireland, the Slovak Republic and Slovenia, the share of IT services in total value added increased by about 1 percentage point or more. Even in larger economies such as Germany, Japan, Spain, the United Kingdom and the United States the share of IT services rose by about 0.5 percentage points.

Despite the increasing importance of IT services, country differences in the overall weight of the information economy sector remain mainly driven by the relative importance of ICT manufacturing industries and, to a lesser extent, publishing, audio-visual and broadcasting activities.

DID YOU KNOW?

Information industries account for about 6% of total industry GDP in the OECD.

Definitions

Value added consists of the value of production net of the costs of intermediate inputs. In practice, it includes both gross profits and wages, and at an aggregate level is equivalent to GDP.

The OECD in 2007 defined the information economy sector (see the *OECD Guide to Measuring the Information Society 2011*) as the aggregate combining ICT and digital media and content industries in the current version of the International Standard Industry Classification (ISIC Rev.4). Here these are all referred as *information industries*.

This aggregate includes ISIC Rev.4 Division 26 (Manufacture of computer, electronic and optical products) and Section J (Information and communication services), consisting of Divisions 58-60 (Publishing and broadcasting industries), 61 (Telecommunications) and 62-63 (Computer programming and information services). ICT trade and repair activities (in Groups 465 and 951) are also included, but are not considered here due to issues of data availability.

Measurability

The current breakdown of Section J (Divisions 58-63) provides a better appraisal of key ICT activities with respect to the previous ISIC (Rev.3) classification, thanks to the newly created Division 61 devoted to telecommunications.

However, it is not always possible to isolate ICT activities or obtain a comprehensive overview, as data are usually made available only at the Division level (2 digits).

In particular, software publishing (Group 582) is included under Division 58 on publishing (although part of IT services), while news agencies and other information services activities (Group 639) are found under Division 63 on IT services, although they belong to media and content industries.

Value added of information industries, 2000 and 2012

As a percentage of total value added at basic prices
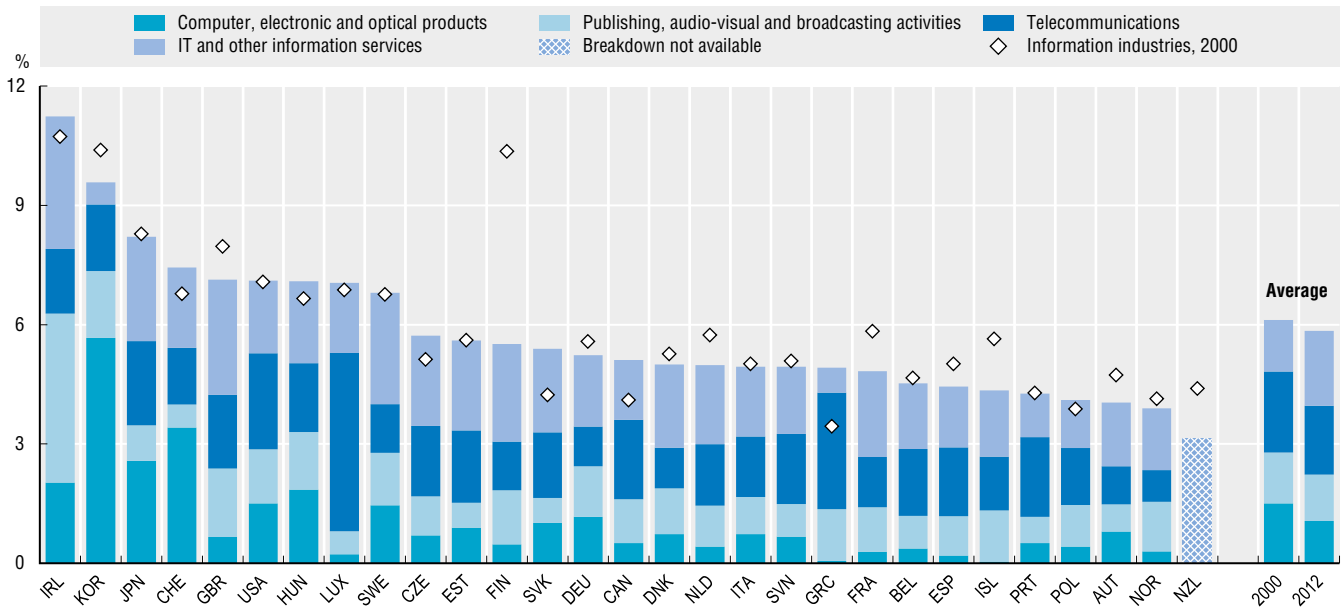
Source: OECD, STAN Database, ISIC Rev.4, www.oecd.org/sti/stan; Eurostat, National Accounts Statistics and national sources, June 2014.
See chapter notes.

StatLink http://dx.doi.org/10.1787/888933148726

Change in the share of information industries in total value added between 2000 and 2012
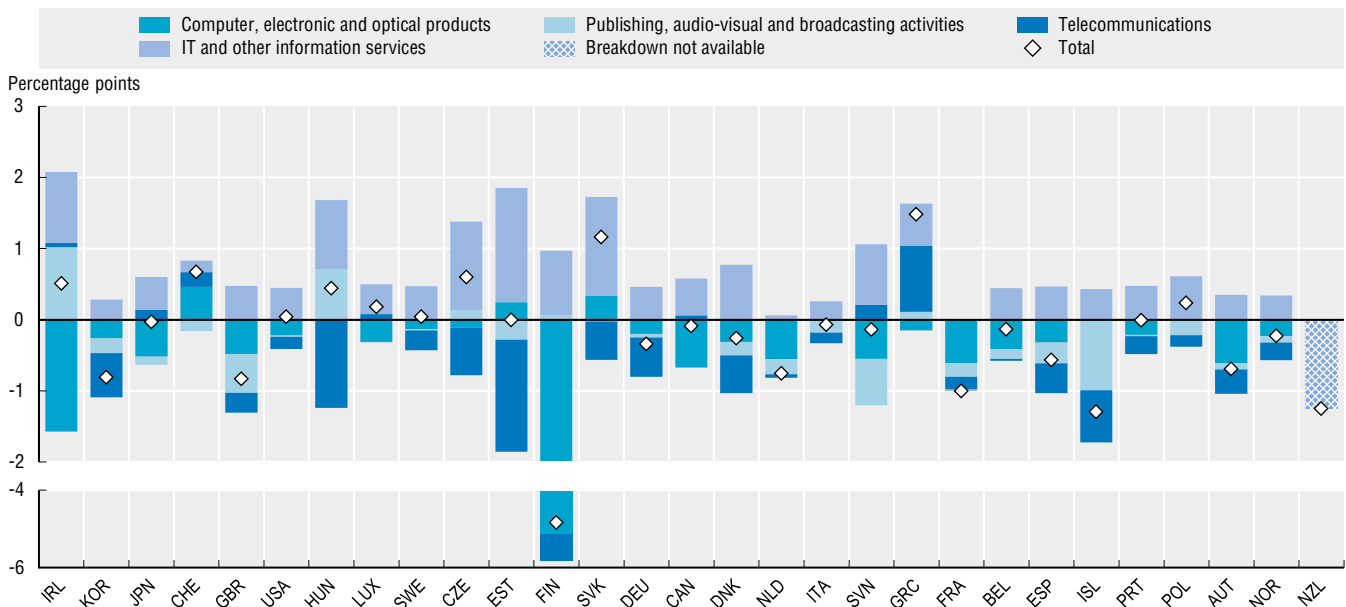
Total and industry contributions

Source: OECD, STAN Database, ISIC Rev.4, www.oecd.org/sti/stan; Eurostat, National Accounts Statistics and national sources, June 2014.
See chapter notes.

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Key findings

Information industries are characterised by higher than average levels of labour productivity across all OECD economies, reflecting their relative intensity in fixed and knowledge-based capital.

On average, labour productivity measured on persons employed stands at more than three times that of the whole economy in Telecommunication services, is 50% higher for Publishing and audio-visual services (which include packaged software), and around 15% and 25% higher than average for Computer manufacturing and IT services, respectively.

Ratios of the information industries to total economy levels and underlying figures for individual activities are very diverse across countries. Aggregate ratios range between 1.9 to 2.7 in the United States, Ireland, Canada, Portugal and Greece, reflecting the strength of these industries in the three first countries and the relative weakness of the rest of the economy in the latter ones (see 5.1 and 5.8). In Denmark, Finland and Norway, productivity level of the information industries are just above the national average.

Variability is higher between industries than across countries.

For ICT manufacturing, productivity levels are between 1.5 and 2.1 times the average in Austria, Portugal, Sweden, the United Kingdom and the United States. Values are below the total economy average in a number of countries, including Finland (where the huge drop in value added due to the Nokia crisis was not matched by a similar fall in employment), France, Luxembourg, Norway and some offshoring destinations, such as the Czech Republic, Hungary and Poland.

In almost all countries, labour productivity is very high in telecommunication services (up to six times average levels) while productivity levels in IT services are between 1 and 1.6 times the average. In Publishing and media industries, relative levels of productivity present a greater variability.

Part of the strategic importance of information industries lies in the substantial contribution they provide to the aggregate dynamics of labour productivity, resulting from both within-industry dynamics and compositional effects (i.e. shifts in employment shares), although this is not uniform across countries and industries.

Over the period 2001-11, the contribution of information industries to total economy labour productivity growth ranged from 10% to 40%, and from about 0.1 to more than 1 percentage point on a yearly basis, rising to 0.5 percentage points or more in Estonia, Sweden, the Slovak Republic and the United States.

Definitions

Labour productivity is defined as the amount of output produced by a unit of labour input. Typically, value added is used as the measure for output (an alternative measure being turnover), while the input consists of the total amount of hours worked. Due to data availability, here the number of persons employed (national accounts estimate) is used instead. Industry values are computed relative to the whole economy (i.e. to GDP per person employed in each country), netting the indicator for differences in productivity levels across countries.

The OECD defined the information economy sector (here referred as *information industries*) in 2007 (see the *OECD Guide to Measuring the Information Society 2011*) as combining ICT with media and content industries, as specified in the current version of the International Standard Industry Classification (ISIC Rev.4). This aggregate includes ISIC Division 26 (Manufacture of computer, electronic and optical products) and Section J (Information and communication services), consisting of Divisions 58-60 (Publishing and broadcasting industries), 61 (Telecommunications) and 62-63 (Computer programming and information services). ICT trade and repair activities (in Groups 465 and 951) are also included, but are not considered here due to issues of data availability.

Measurability

The measurement of labour productivity using persons employed instead of hours worked does not take into account differences in average working hours across sectors within each economy. Additionally, data do not refer to a homogeneous period across all economies, as in some countries the availability of detailed industry-level information is lagging behind by two or more years. Yearly estimates are affected by the business cycle, as is the case for Finland.

Finally, the use of hedonic deflators to take into account the quality of ICT products has a high impact on value added in volume terms, which is reflected in the contribution of the sector to productivity growth. Such treatment is not homogeneous across countries and, more importantly, quality adjustment is applied to ICT manufacturing only, while similar quality changes are now happening in services, notably with respect to broadband. To address this issue, the OECD is currently working to develop guidelines on quality adjustment criteria for telecommunication services.

Apparent labour productivity in information industries, relative levels, 2012

By industry ratios to productivity in total economy (Total economy level = 1), logarithmic scale
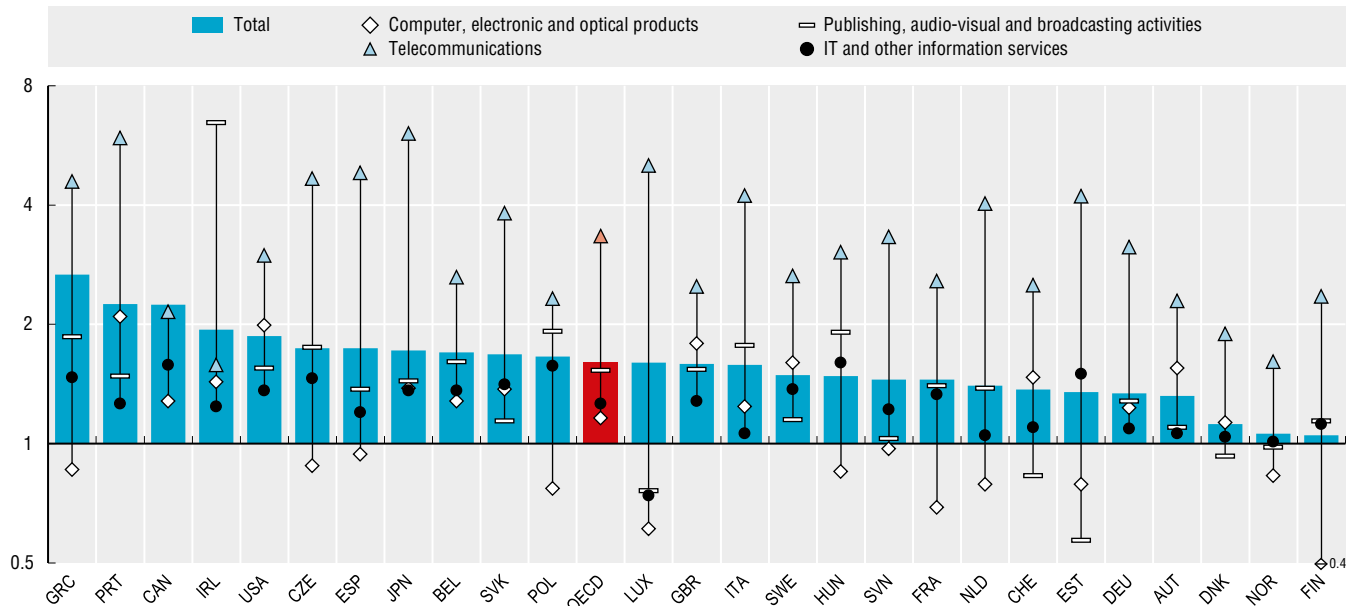
Source: OECD, STAN Database, ISIC Rev.4, www.oecd.org/sti/stan and Eurostat, National Accounts Statistics, May 2014. See chapter notes.

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Contribution of information industries and of other sectors to labour productivity growth, 2001-11

Yearly rates
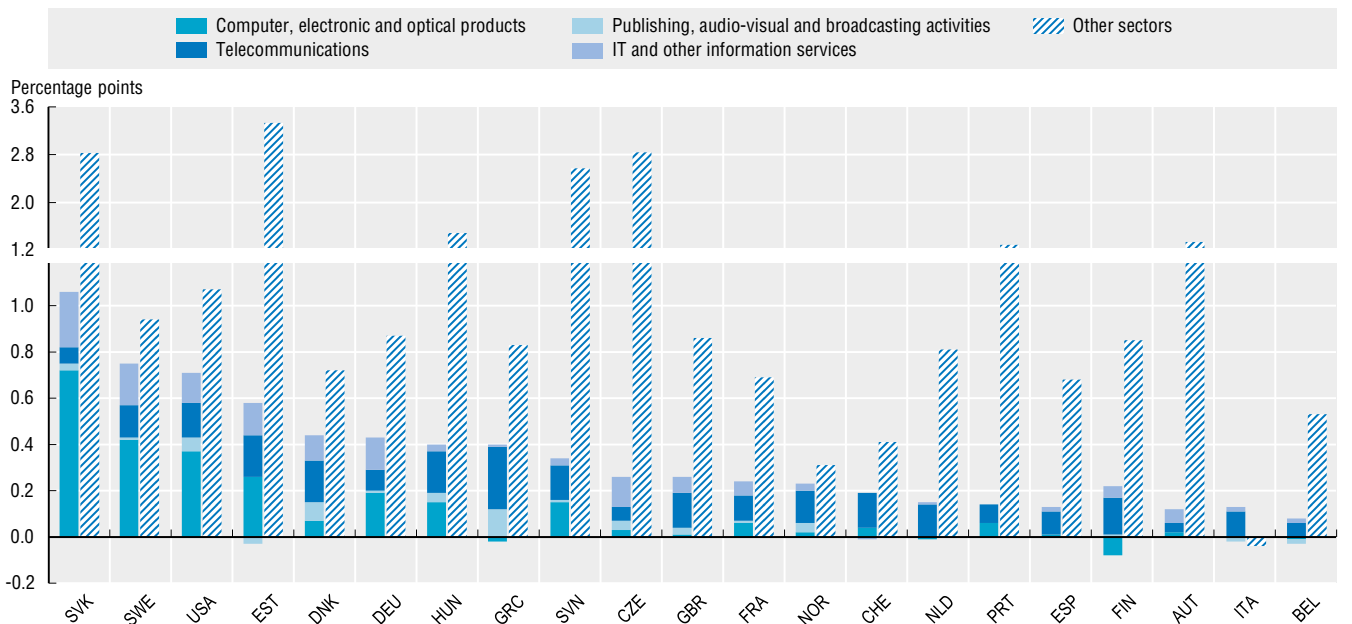
Source: OECD, STAN Database, ISIC Rev.4, www.oecd.org/sti/stan and Eurostat, National Accounts Statistics, May 2014. See chapter notes.

StatLink ᴖᴤᴘ *http://dx.doi.org/10.1787/888933148755*

Why do we need indicators?

In the digital economy, measuring the quality of communication services is essential for several reasons. First, observed price differences for communication services among operators and across countries may reflect either differences in the quality of the services provided or imperfect competition in upstream and downstream markets. These two factors have opposite policy implications: while service quality is a key ingredient for competition, non-competitive prices call for appropriate policy measures.

Second, measuring real growth in communication services requires an appropriate price deflator to separate increases in prices due to quality improvements from actual inflation. For example, many consumers are buying more communication services with a constant level of communication expenditures due to the "better quality" of these services (e.g. higher speed, broader geographic coverage, new features, etc.).

Finally, the contribution of communication investments to value added growth depends on the extent to which new equipment deliver better services (i.e. are more productive). In the past, poor measurement of technical progress embodied in newly installed capital goods led to underestimation of the contribution of hardware and software to growth, thus contributing to the so-called Solow paradox. As an example, the figure below shows the dramatic decline in producer prices for computers and software in the United States once quality improvements are controlled for.

Producer price indices for computer and software in the United States, 2003-13
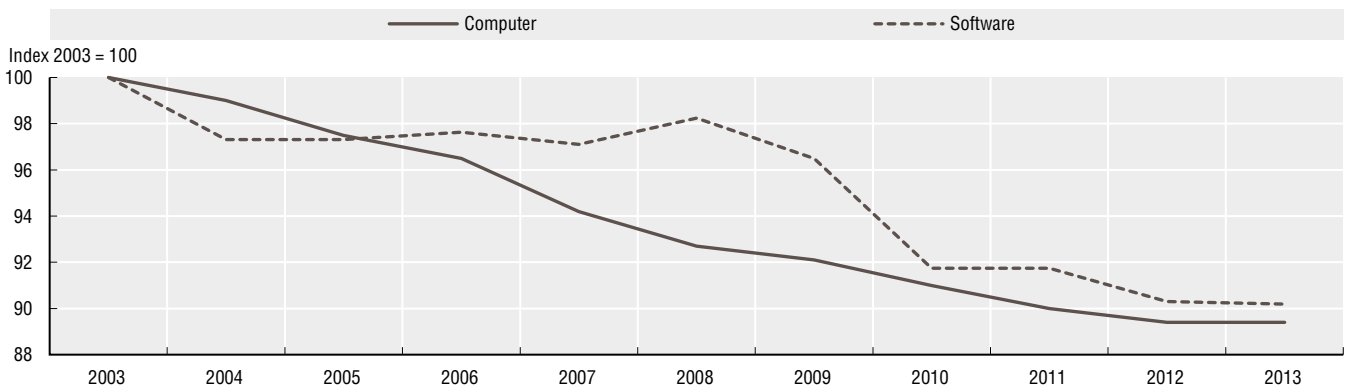
Source: OECD based on BLS Producer Price Index Industry Database, July 2014.

StatLink ⟦⟧ *http://dx.doi.org/10.1787/888933148766*

While the issue of quality is not specific to communication services, its measurement is particularly important due to the rapid rate of technological progress in the sector, and because bundles of different communication services render price comparison among offers difficult.

What are the challenges?

There are two main approaches to the measurement of quality in communication services: basket benchmarking and hedonic models.

The first approach is the one currently used by the OECD and most regulators of communication services. The underlying rationale is to group offers of communication services in clusters of similar consumption patterns, which in turn are compared across countries. The OECD has developed price-benchmarking baskets, in use since the 1990s, through a consensus-based and harmonised methodology for price comparison among all member countries. The basket methodologies were updated in 2009 (OECD, 2010) and a wireless broadband basket was developed in 2012 (OECD, 2012). Some improvements and updates were introduced for fixed broadband services by the OECD Broadband Metrics Workshops in 2011 and 2012.

In recent times, increasing availability of bundles of communication services has made the basket benchmarking approach more challenging. For example, nearly half of all households in the European Union purchase communications services as part of a bundle (46%). In particular, Internet access purchased through a bundled offer represents 64% of all Internet connections in the EU (European Commission, 2014). This is why some communication regulators, such as OFCOM in the United Kingdom, have developed baskets that benchmark a bundle of services against other countries.

Communication bundles are typically sold with a significant price discount over stand-alone prices. Indeed, these discounts are crucial in comparing price levels in the market, but their inclusion in the established OECD price-benchmarking baskets on a permanent basis is challenging, given that communication bundles can vary greatly across the OECD area.

One possible approach to evaluating the influence of bundled prices is to calculate the discount of the bundle over the purchase of stand-alone services (e.g. voice, television and broadband in the case of a triple-play bundle). However, such an approach would face serious limitations, the most important being that all the stand-alone services are not necessarily available from all operators.

Options for international action

The OECD is looking at the feasibility of hedonic models as a complementary approach to measuring quality in communication services across countries. Hedonic models can be described as a tool designed to isolate and measure the influence on price of economically meaningful product characteristics. For instance, the price of a bundle of communication services can be modelled as a function of the prices of the different characteristics of the services included in that bundle. As the prices of these characteristics (e.g. speed, geographic coverage, contract length, etc.) are not observable, a hedonic model permits users to estimate them. These implicit prices provide values for the quality adjustments when product characteristics change over time.

Hedonic models require a large sample of service plans, including detailed information about their quality characteristics, in order to properly assess cross-country differences in prices. The hedonic approach is therefore very data intensive.

A further issue relates to the method for measuring cross-country differences in communication prices. One common method at the national level is the dummy variable approach. Dummy coefficients may be interpreted as the price differential among countries after controlling for all quality features. This estimation, however, relies on hypotheses that are highly problematic for international comparisons.

The first hypothesis is that all relevant characteristics of the bundle are included in the model. If some relevant characteristics are omitted, these would be captured by the country dummy (e.g. one country may turn out to have higher prices because its bundle provides for valuable characteristics that are not included in the regression). The second hypothesis is that the implicit price for each characteristic of the communication services is the same in all countries. In fact, consumer preferences and production costs may differ across countries, causing variance in the prices of such characteristics as well. For instance, consumers in some countries may value broadband speed more than in others. In addition, the deployment costs of broadband infrastructures may not be the same in countries with a large territory as in small countries.

For the above reasons, other hedonic methods may be more suitable, as discussed in the OECD *Handbook for Hedonic Indexes and Quality Adjustments in Price Indexes* (Triplett, 2006). These methods include the characteristics price index method, the imputation method and the hedonic quality adjustment method. In practice, statistical agencies that have implemented hedonic indexes have mostly used the latter, partly because of the necessity for producing a timely index.

The OECD is currently reviewing existing practices in member countries (e.g. Statistics Canada, ANACOM in Portugal, the FCC and BLS in the United States) with the aim of developing those most suited to international comparison.

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Key findings

Electronic business (e-business) can help drive growth by enlarging the market reach of enterprises and helping them to save on costs.

Businesses increasingly operate online. In 2013, on average more than three out of four businesses in the 30 reporting countries had a website, including homepages hosted by a third party, up from about 70% in 2009.

The share of enterprises with a web presence ranges from over 90% in Denmark, Finland and Switzerland, to about 60% in Greece, Hungary, Korea and Portugal. Progress since 2009 was particularly strong in Ireland and New Zealand, as well as in France, Hungary, Portugal and Spain among lagging countries.

In all countries except Hungary, Korea, the Slovak Republic and Turkey, 90% or more of larger enterprises have a website, while web presence in SMEs ranges between 90% and above in Denmark, Finland and Switzerland, and less than 60% in Hungary, Greece, Korea, Portugal and Turkey.

In most cases, a web presence is still used as a window to provide information on the enterprise. Indeed, figures on participation in e-commerce are much lower, particularly for web sales, which in the EU28 represent less than 30% of the total turnover from e-commerce in 2012, the bulk of value being generated by transactions between businesses (B2B) over EDI applications.

On average in 2012, 21% of firms in reporting OECD countries with at least 10 persons employed received electronic orders, 4 percentage points more than in 2009. Differences among countries are considerable. In New Zealand the share is above 45%, while in Greece, Italy, Mexico, Poland and Turkey it is about 10% or less.

These figures closely mimic shares of smaller firms, which dominate in numbers. For enterprises with 250 or more persons employed the average value is 40% and the share is above 30% even in some lagging countries.

The overall economic relevance of e-business transactions, measured by the share of e-commerce sales in turnover, stands at about 16% of total turnover on average in reporting countries. Up to about 90% of the value of e-commerce (based on proxy information) comes from B2B transactions.

Results are dominated by the economic weight of large enterprises, for which e-commerce sales represent, on average, about 20% of turnover against 7% for small firms. This also renders differences among countries less sizeable than for the propensity to engage in e-commerce.

Definitions

An e-commerce transaction is the sale or purchase of goods or services, conducted over computer networks by methods specifically designed for the purpose of receiving or placing of orders *(OECD Guide to Measuring the Information Society 2011)*. The goods or services are ordered by those methods, but the payment and the ultimate delivery of the goods or services do not have to be conducted online. Transactions can occur between enterprises, households, individuals, governments and other organisations. In this respect, they are classified as *business-to-business* (B2B), *business-to-consumer* (B2C), *business-to-government* (B2G) and, more recently, *consumer-to-consumer* (C2C).

For enterprises, *e-commerce sales* figures presented here include all transactions carried out over webpages, extranet or Electronic Data Interchange (EDI) systems and exclude orders by telephone calls, fax or manually typed e-mails.

Size classes are defined as small (from 10 to 49 persons employed), medium (50 to 249) and large (250 and more).

Measurability

Measurement of e-commerce presents many methodological challenges that can affect the comparability of estimates, such as the adoption of different practices for data collection and estimations, and the treatment of outliers and e-commerce by multinationals, or for the imputation of values from ranges recorded in surveys.

Other issues include differences in sectoral coverage of surveys, and a lack of measures concerning the actors involved (B2B, B2C, etc.).

For this last aspect, Korea provides direct estimates, while the United States Census Bureau uses transactions originating from the retail sector as a proxy for B2C.

For European countries the best available proxy consists of EDI (B2B and B2G) vs. web sales (B2C, etc.). Convergence of technologies brings additional challenges for the treatment (and surveying) of emerging transactions, notably over mobile phones, via SMS or using devices that enable near field communication.

Enterprises with website or home page, by size, 2009 and 2013

As a percentage of enterprises in each employment size class
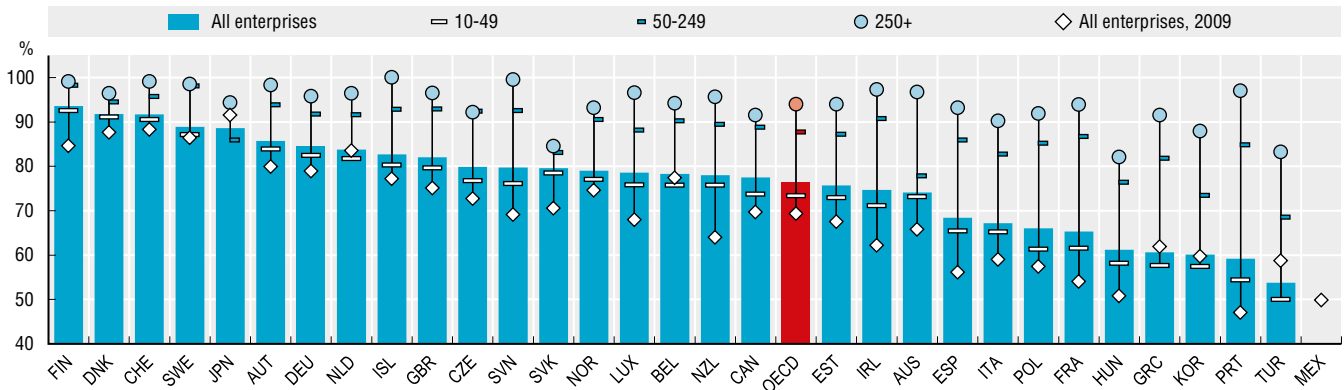
Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, July 2014. See chapter notes.

StatLink ⟡ *http://dx.doi.org/10.1787/888933148775*

Enterprises engaged in sales via e-commerce by employment size, 2008 and 2012
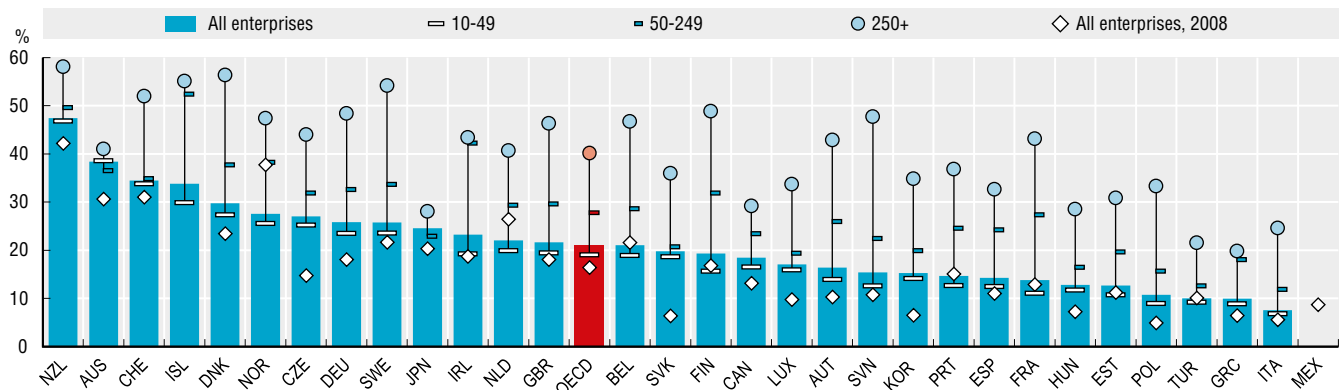
As a percentage of enterprises in each employment size class

Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, July 2014. See chapter notes.

StatLink ⟡ *http://dx.doi.org/10.1787/888933148789*

Turnover from e-commerce, by size, 2008 and 2012

As a percentage of turnover in each employment size class
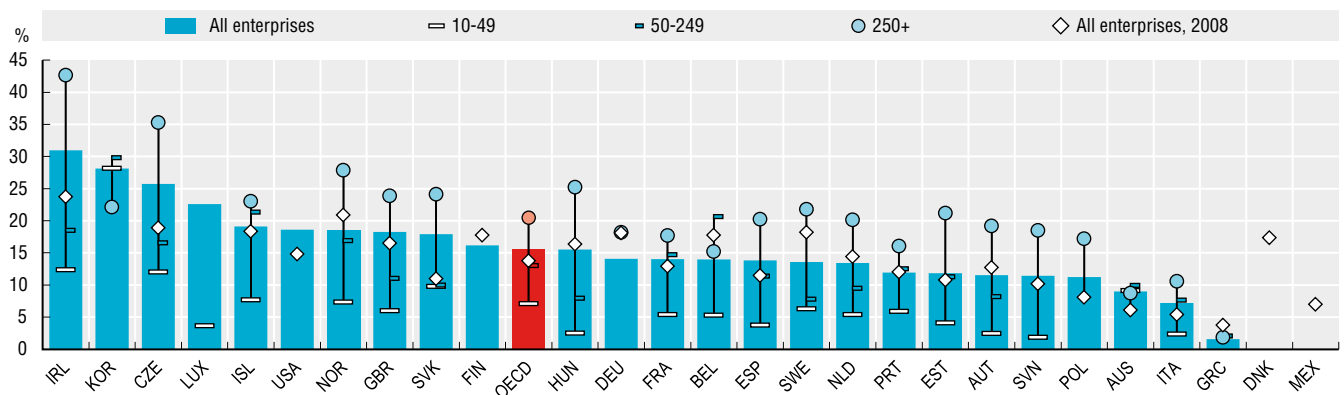
Source: OECD, ICT Database; Eurostat, Information Society Statistics and national sources, July 2014. See chapter notes.

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Key findings

In today's information-driven economy, human resources have become a key asset for economic growth and worker employability. Specialised skills in ICT, in particular, are key knowledge assets required to sustain innovation and productivity growth.

In 2012, the share of computer science tertiary graduates in all graduates in the OECD was just above 3%, down by almost 2 percentage points from 2005. The country with the highest share of computer science graduates was New Zealand (6%), although it also experienced a declining share.

Attracting women to tertiary-level courses in computer science remains a challenge in many countries. On average, women represent only around 20% of graduates in this field. Some countries such as Ireland and South Africa have a better gender balance with over 40% of women, while Indonesia is the only country where women accounted for the majority of computer science graduates in 2012.

Over the period 2005-12, the largest declines in the number of computer science graduates, relative to the population of 20-34 year-olds, were observed in Australia, Belgium, Canada, Ireland, Norway, Mexico, Switzerland and the United Kingdom. Countries that experienced the most important increase in the share of computer science graduates relative to those in the 20-34 age cohorts were the Czech Republic, Slovenia and Turkey.

Innovation depends crucially on the availability of research personnel and skilled employees. In the OECD area, on average 30% of researchers in the business enterprise sector are employed in information industries. This share rises above 50% in Finland, Israel and Korea, which also account for the largest shares of R&D performed by information industries (see 4.1).

Reflecting industrial specialisation, in these three countries and in Japan ICT manufacturing industries alone employ between around 20% and 40% of total business sector researchers, while in Estonia, Iceland, Ireland, Israel, Poland and Turkey, information and communication service activities employ over 30% of total researchers in the business sector.

Definitions

Tertiary graduates in computer science have attained a degree in the field of Computing (48) based on the International Standard Classification of Education (ISCED-97), levels 5A and 5B. Tertiary type-A programmes are theory-based programmes, while type-B programmes are more vocational.

Researchers in information industries are defined as professionals engaged in the conception and creation of new knowledge, products, processes, methods and systems working in the ICT industries (except trade and repair) and media and content industries. Researchers are measured in full-time equivalents (FTE), a more accurate measure of the volume of human resources devoted to research in a country than headcounts or jobs.

This aggregate includes ISIC Rev.4 Division 26 (Manufacture of computer, electronic and optical products) and Section J (Information and communication). This section includes the production and distribution of information and cultural products, and the provision of the means to transmit or distribute these products, as well as data or communications, information technology activities, and the processing of data and other information service activities.

Measurability

Tertiary graduates in the field of Computing may underestimate the actual number of ICT graduates in countries where equivalent ICT degrees are granted by other faculties (e.g. engineering). The Career of Doctorate Holders (CDH) data collection provides complementary and useful data on doctorate holders employed as ICT professionals (ISCO-08, Sub-major Group 25) by field of doctoral degree. The latest data available are for 2009, but a new data collection is scheduled for the end of 2014. For the first time the new data will include numbers of employed doctorate holders by industry.

Tertiary graduates in computer science, by gender, 2005 and 2012

As a percentage of all tertiary graduates
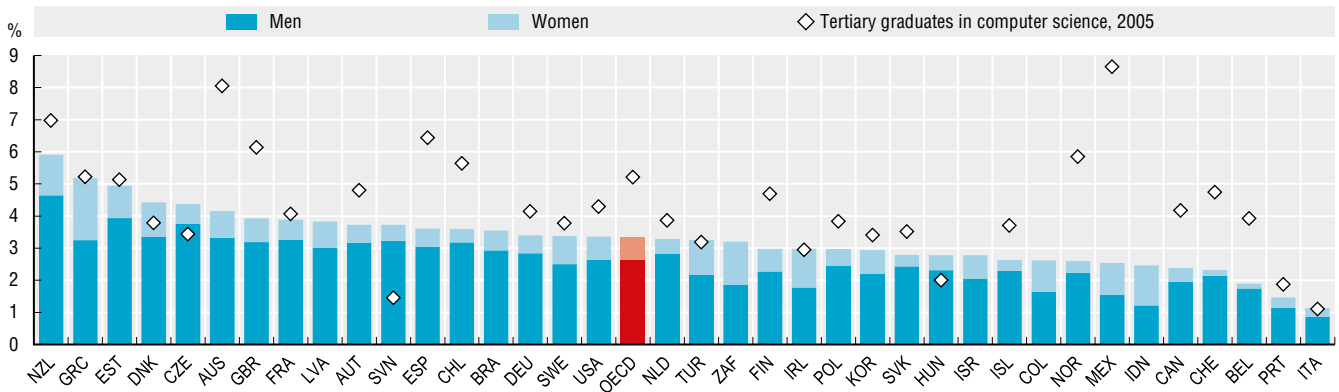
Source: OECD, Education Database, www.oecd.org/education/database.htm, September 2014 and OECD (2014), *Education at a Glance 2014: OECD Indicators*, OECD Publishing. See chapter notes.

StatLink ⬛🖵 *http://dx.doi.org/10.1787/888933148808*

Supply of tertiary graduates in computer science, 2005 and 2012

Tertiary graduates in computer science as a percentage of all 20-34 year-olds
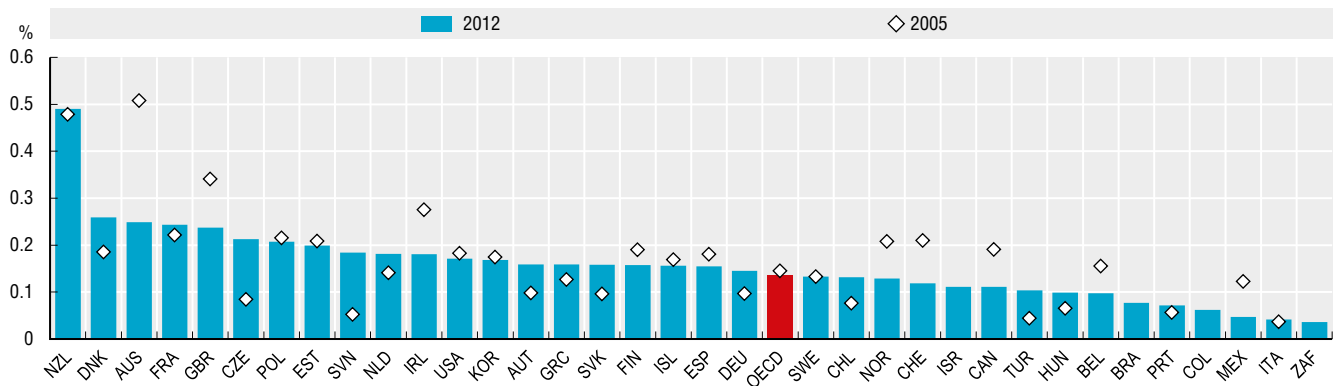
Source: OECD, Education Database, www.oecd.org/education/database.htm, September 2014. See chapter notes.

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Researchers in information industries, 2011

As percentage of researchers in the business sector
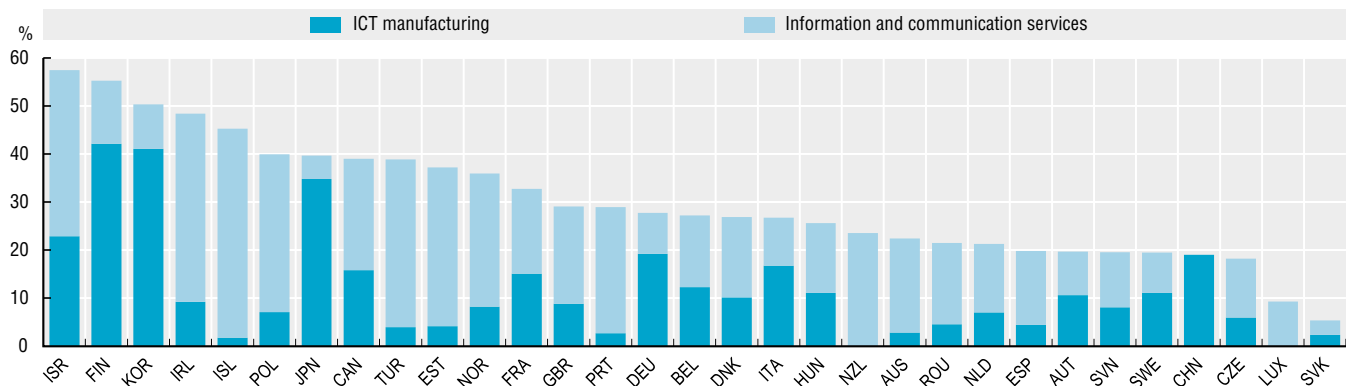
Source: OECD, RDS Database, www.oecd.org/sti/rds, June 2014. See chapter notes.

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Key findings

Statistics on ICT-related occupations and on employment in information industries offer complementary perspectives on the importance of ICT in OECD countries.

In OECD countries, on average, ICT-related occupations accounted for about 3.5% of total employment in 2013. This figure ranged from about 6% in Finland to just above 1% in Turkey. The breakdown of employment by occupational groups shows that most of ICT-related workers are employed in high-skill occupations and that by country variations are mainly due to the different weight of professionals and engineers in the workforce.

In 2012, about 40% of ICT-related jobs were in the ICT sector. This figure rises to 45% accounting for the information industries aggregate.

On average, employment in information industries accounted for 3.6% of total employment in OECD countries in 2012, slightly less than in 2000.

By country shares (and trends) in employment are similar to those reported for value added (see 5.3) although in general much lower, given the comparatively high level of labour productivity in these industries (see 5.4). The share was above 5% in Finland, Ireland and Switzerland and below 2% in Australia, Greece and Portugal.

In nearly all countries, IT and other information services have become the largest information industry in employment terms.

Cross-country differences in ICT employment still reflect the relative importance of ICT manufacturing activities, although the employment share of these activities has declined due to productivity gains and offshoring.

Since 2000, the employment shares of ICT manufacturing, publishing activities and telecommunication services have fallen nearly everywhere, while the share of IT and other information services has increased in all countries except Australia.

Overall, the employment share of information industries decreased between 2000 and 2012 in a majority of countries; with the most important decline being observed in the United States followed by Sweden.

Definitions

ICT-related occupations, originally defined as ICT specialists, consist of (individuals employed in) "tasks related to developing, maintaining or operating ICT systems, and where ICTs are the main part of their job" (see OECD, 2004). This definition has been revisited in light of the latest edition of the International Standard Classification of Occupations (ISCO-08) and includes Minor Groups 133 (ICT service managers), 215 (Electrotechnology engineers) and 742 (Electronics and telecommunications installers and repairers), as well as Sub-major Groups 25 (Information and communications technologies professionals) and 35 (Information and communications technicians).

The OECD in 2007 defined the information economy sector (see the *OECD Guide to Measuring the Information Society 2011*) as the aggregate combining ICT and digital media and content industries in the current version of the International Standard Industry Classification (ISIC Rev.4). Here these are all referred as *information industries*. This aggregate includes ISIC Rev.4 Division 26 (Manufacture of computer, electronic and optical products) and Section J (Information and communication services), consisting of Divisions 58-60 (Publishing and broadcasting industries), 61 (Telecommunications) and 62-63 (Computer programming and information services). ICT trade and repair activities (in Groups 465 and 951) are also included but are not considered here due to issues of data availability.

Measurability

Employment by occupation data are usually collected in the labour force surveys. Data for the United States are based on the Current Population Survey.

National classifications of occupations are not easily comparable across countries and are not always consistent with ISCO. The latest revision (ISCO-08) allows for a better description of ICT occupations. However, the lack of a direct correspondence with several occupational categories in the previous edition (ISCO-88) has resulted in a break in time series that the OECD is currently addressing.

Employment in ICT-related occupations, 2011 and 2013

As a percentage of total employment
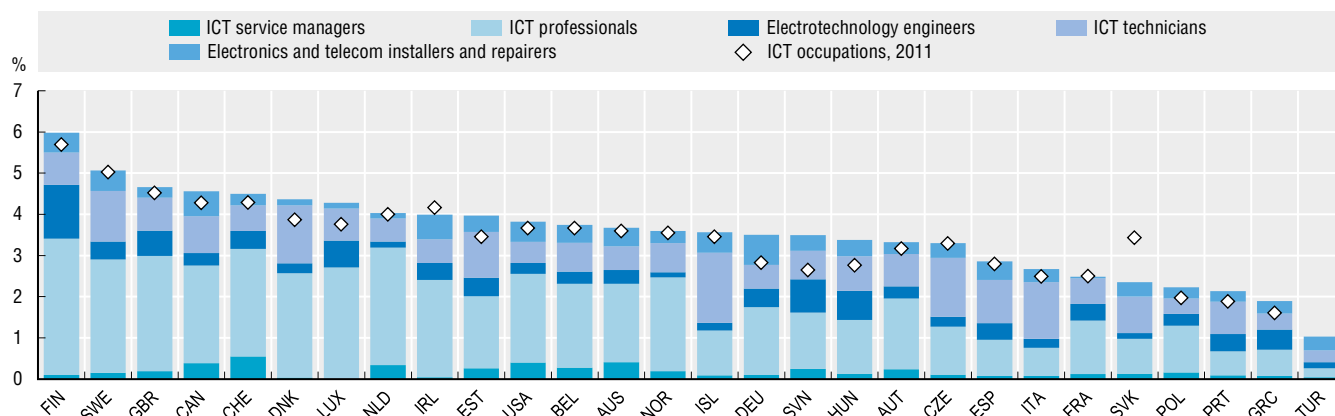
Source: OECD computations based on Australian, Canadian and European labour force surveys and United States Current Population Survey, May 2014. See chapter notes.

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Employment in information industries, 2000 and 2012

As a percentage of total employment

Source: OECD, STAN Database, ISIC Rev.4, www.oecd.org/sti/stan and Eurostat, National Accounts Statistics, May 2014. See chapter notes.

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Change in employment shares of information industries between 2000 and 2012

Total and industry contributions

Source: OECD, STAN Database, ISIC Rev.4, www.oecd.org/sti/stan and Eurostat, National Accounts Statistics, May 2014. See chapter notes.

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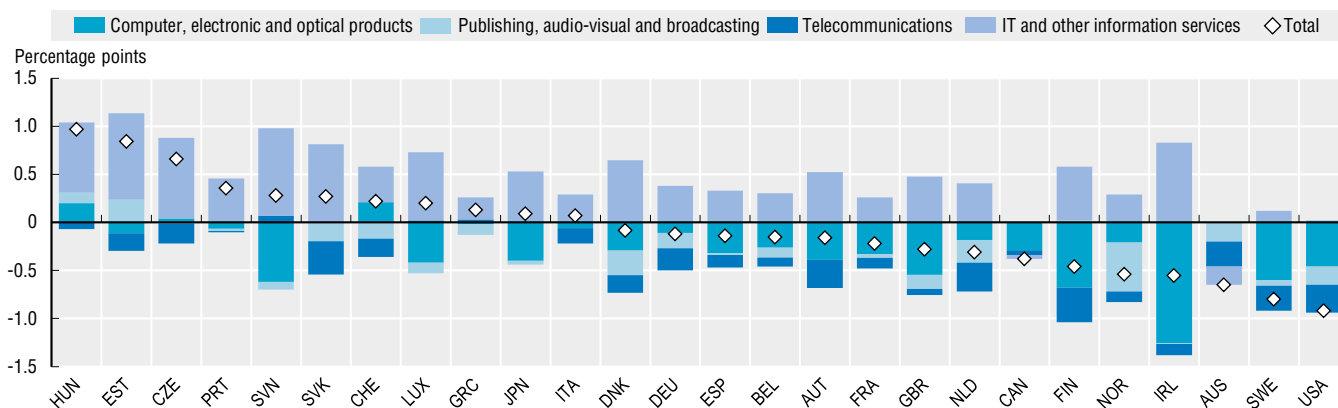
Key findings

Between 2000 and 2012 world exports of manufactured ICT goods grew by 65% to more than USD 1.5 trillion. However, their share in total world exports of goods decreased by about 5 percentage points, partly due to widespread falls in unit prices. This reflects a major shift in world trade and consumption patterns, with demand for communication equipment and consumer electronics growing much faster than that for computers and peripherals.

Production and exports of ICT goods are increasingly concentrated in a few economies. Owing in part to the offshoring of production, the shares of Japan and the United States in world exports of ICT goods halved from 2000 to 2012, while China's grew from 4.4% to over 30%, with a tenfold increase in USD terms. Korea and Mexico were the only OECD economies of the top ten exporters to maintain their share of the world market for ICT goods, where Mexico benefited from the relocation of international (not only the United States) activities linked to NAFTA.

An alternative perspective, albeit only up to 2009, is obtained by comparing such "gross export" shares with corresponding shares of exports in value added terms. China and Mexico's shares of value added embodied in the global final demand of ICT products are much lower than their shares of gross exports, reflecting the high import content of their ICT exports. Germany, Japan and the United States instead have higher shares in global final demand, as providers of intermediate goods and services to economies producing final ICT goods.

International trade in ICT services grew much faster than that of ICT goods, increasing five-fold in current USD terms to USD 400 billion between 2000 and 2013. In particular, the share of Computer and information services doubled from 3% to 6% of world exports of services, while that of communication services increased marginally to 2.4%. For the OECD, the combined share of Computer and information and Communication services rose from 5.3% to 8.9% of total service exports.

As with trade in ICT goods, a few economies account for a significant share in global exports of ICT services, with some major shifts in recent years. India is now the leading exporter of ICT services, having started from a very modest level, followed by Ireland, which benefits from the presence of transnational corporations. China is also becoming a major exporter along with Germany, the United Kingdom and the United States. Together, these countries account for more than 60% of total exports of ICT services. The top exporters of communication services include the United States, the largest European economies and the Netherlands.

DID YOU KNOW?

The share of China in world exports of ICT products is more than double that of the United States. However, both economies hold a similar position in ICT global value chains, measured in value added terms.

Definitions

ICT goods exports data are based on international trade statistics, which typically report gross flows. To improve comparability, data have been adjusted to remove China's re-imports of ICT goods via Hong Kong, China. These are also recorded as re-exports by Hong Kong, China. Adjustments were not made for other countries due to a lack of exhaustive data. *Exports of ICT services* are computed from balance of payments statistics.

Domestic value added embodied in foreign final demand (or "exports of value added") are derived from the OECD-WTO, Trade in Value Added (TiVA) Database in which inter-country and inter-industry flows of inter-mediate goods and services are presented. The database captures the industry value added in foreign demand coming from both exports of domestically produced final goods and services and, indirectly, via exports of intermediates present in goods and services produced by other countries for their final consumption or export to third countries and beyond. Industries upstream in a value chain may be connected to final demand in other countries, even where no direct trade relationship exists. The indicator can thus reveal the full impact of final demand in foreign markets on domestic production.

Measurability

There are many asymmetries in trade statistics: reported exports may not match corresponding imports reported by partners. Besides valuation differences, a principle reason for such asymmetries is re-exports present in reported exports, notably for economies acting as regional trade hubs, such as Hong-Kong China or the Netherlands. A key requirement when building an Inter-Country Input-Output (ICIO) system, such as that underlying the OECD-WTO, TiVA Database, is that gross trade flows are adjusted so that they balance across countries. Consequently the gross flows used to compare with value added flows may not match the gross flows reported by countries.

Service exports are also affected by measurement issues. In particular, efforts are being undertaken by UNCTAD, jointly with the OECD, to identify the role of *ICT-enabled* (and related) services within the large aggregate of *Other Business services*. ICTs are also likely to be a major component of *Royalties and fees*.

Global trade in ICT goods and top ten exporters, 2000 and 2012
Billions of USD and percentage shares (right-hand and logarithmic scale)
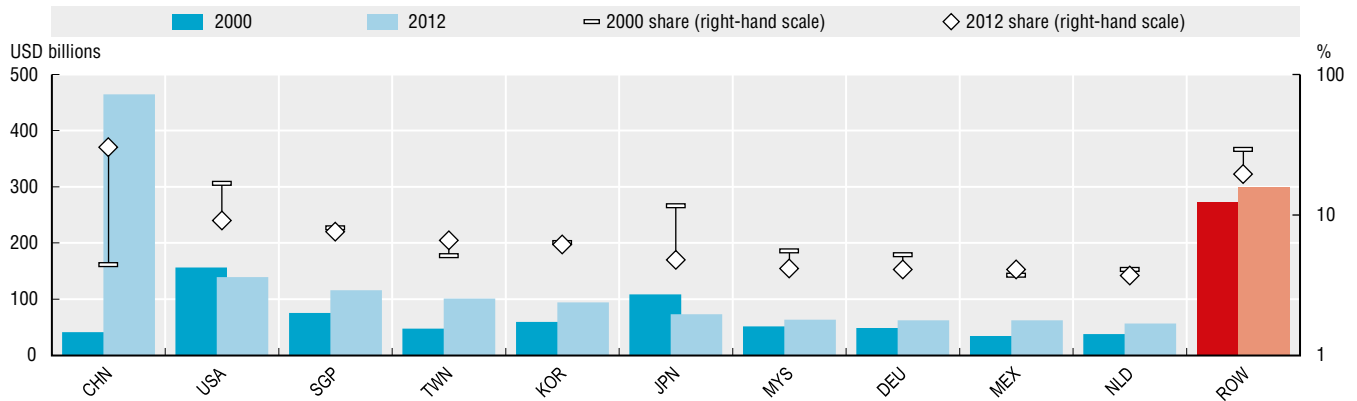
Source: OECD, STAN Bilateral Trade Database by Industry and End-use category (BTDIxE), http://oe.cd/btd, May 2014. See chapter notes.

StatLink ⌨📊 *http://dx.doi.org/10.1787/888933148862*

Gross exports of ICT products and ICT domestic value added embodied in foreign final demand, 2009
Percentage shares on world total
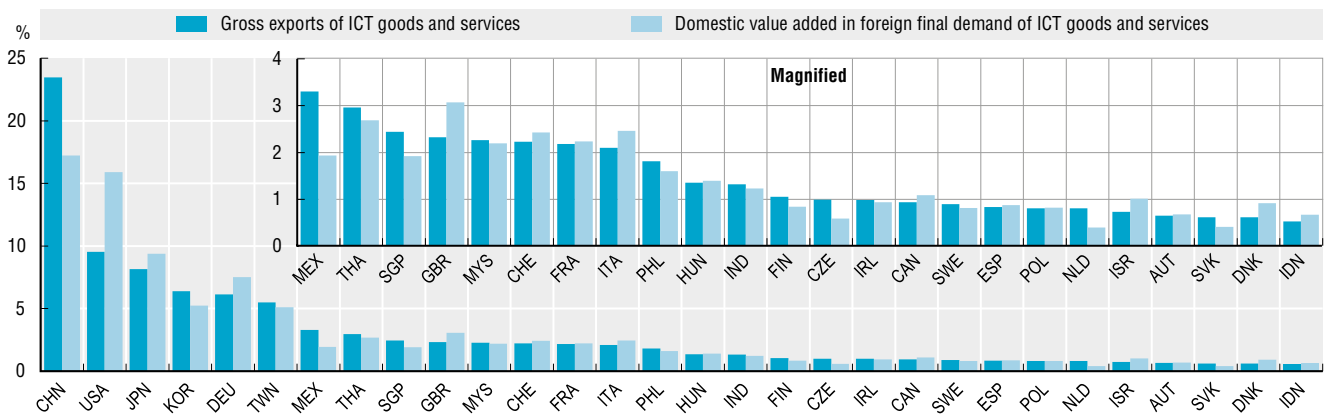
Source: OECD, Inter-Country Input-Output (ICIO) Database, May 2014.

StatLink ⌨📊 *http://dx.doi.org/10.1787/888933148876*

OECD and major exporters of ICT services, 2000 and 2013
Percentage shares of total world exports and in absolute values
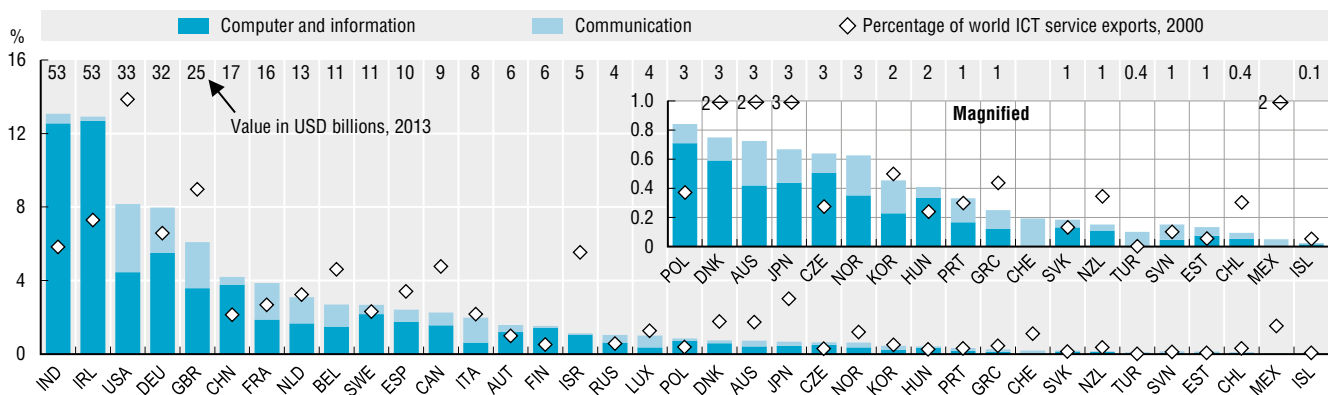
Source: OECD based on UNCTAD, UNCTADstat, July 2014. See chapter notes.

StatLink ⌨📊 *http://dx.doi.org/10.1787/888933148882*

Notes

> **Israel**
>
> "The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities or third party. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

5.1 ICT investment

ICT investment by asset, 2000 and 2012

For Denmark, Japan and the United Kingdom, investment in communications equipment is included under IT equipment.

For Denmark, data refer to 2009. Software investment represented 2.36% of GDP in 2012, but data on IT and communications equipment are not yet available for 2009 onwards due to ongoing changes in SNA.

For Germany, Greece, Korea, New Zealand, Portugal, Sweden, Switzerland and the United Kingdom, data refer to 2011.

For Mexico, data refer to 2003 instead of 2000.

For the Netherlands, data on investment in communication equipment are not available.

For the Slovak Republic, data refer to 2004 instead of 2000.

Contribution of ICT and non-ICT investments to GDP growth, 2000-12

For Denmark, Korea, Netherlands, New Zealand, Portugal, Sweden, Switzerland and the United Kingdom, data refer to 2000-11.

5.2 ICT business dynamics

Net business population growth in ICT industries and the business economy, 2009-11

For Brazil, data include only employer enterprises and refer to 2010-11. The ICT sector includes ICT manufacturing and Information and communication services (ISIC Rev.4 Divisions C26 and J58 to 63).

For Estonia and Finland, data refer to 2008-11.

For Ireland and the Netherlands, data refer to 2008-10.

For Israel, data include only employer enterprises and refer to 2011-12. Business economy aggregate is not available. The ICT sector includes ICT manufacturing and Information and communication services (ISIC Rev.4 Divisions C26 and J58 to 63).

For Korea, data include only employer enterprises and refer to 2011-12. The ICT sector includes Information and communication services (ISIC Rev.4 Divisions J58 to 63) only. Business economy refers to service activities in ISIC Rev.4 Divisions 45 to 82 only.

For New Zealand, data include only employer enterprises and refer to 2010-12. The ICT sector includes ICT manufacturing and Information and communication services (ISIC Rev.4 Divisions C26 and J58 to J63), with the exception of Electronic components and boards (C261), Magnetic and optical media (C268), and of Satellite telecommunications (J613).

For Turkey, data refer to 2009-11.

Medium and high-growth enterprises in ICT and total manufacturing, measured by employment growth, 2012

For Ireland, data refer to 2011 for medium and high-growth enterprises and to 2010 for the total number of active firms.

Medium and high-growth enterprises in ICT and business sector services, measured by employment, 2012

For Brazil, Estonia and Israel, data refer to the aggregate of Information and communication services (ISIC Rev.4 Divisions J58 to 63) instead of ICT services.

For Estonia, business sector services aggregate does not include Accommodation.

For Ireland, data refer to 2011 for medium and high-growth enterprises and to 2010 for the total number of active firms. Information and communication services do not include Repair of computers and communication equipment (ISIC Rev.4 Division S951).

5.3 ICT value added

General notes:

For Canada, data refer to 2009.

For Germany, Greece, Iceland, Korea, Luxembourg, Mexico, New Zealand, Poland, Portugal, Sweden, the United Kingdom and the United States, data refer to 2011.

For Japan, data refer to 2008.

For New Zealand, data refer to the fiscal years 1999/2000 and 2010/11 ending on 31 March, instead of 2000 and 2012. Data refer to information and communication services only. Therefore, the average figures do not include New Zealand.

For Switzerland, data refer to 2010.

5.4 Labour productivity in information industries

General note:

For Switzerland, data refer to 2010.

Additional notes:

Apparent labour productivity in information industries, relative levels, 2012

For Canada, data refer to 2009.

For Japan, data refer to 2008.

For Germany, Greece, Luxembourg, Poland, Portugal, Sweden, the United Kingdom and the United States, data refer to 2011.

5.6 E-commerce

General notes:

Unless otherwise stated, sector coverage consists of all activities in manufacturing and non-financial market services. Only enterprises with ten or more persons employed are considered. Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249), large (250 and more).

For Canada, medium-sized enterprises have 50-299 employees. Large enterprises have 300 or more employees.

For Japan, data refer to businesses with 100 or more employees. Medium-sized enterprises have 100-299 employees. Large enterprises have 300 or more employees.

For Mexico, data refer to businesses with 20 or more persons employed.

For Australia, data for the fiscal years 2009/10 and 2011/12 include agriculture, forestry and fishing activities.

Additional notes:

Enterprises with website or home page, by size, 2009 and 2013

For Australia, data refer to the fiscal years 2008/09 and 2011/12, ending on 30 June, instead of 2009 and 2013.

For Canada, data refer to 2007 instead of 2009.

For Japan and Korea, data refer to 2012.

For Mexico, data refer to 2008.

For New Zealand, data refer to the fiscal years 2007/08 and 2011/12, ending on 31 March, instead of 2009 and 2013.

For Switzerland, data refer to 2011.

Enterprises engaged in sales via e-commerce, by size, 2008 and 2012

For Australia, data refer to any transaction where the commitment to purchase was made via the Internet, including via email, for the fiscal years 2007/08 and 2011/12, ending on 30 June, instead of 2008 and 2012.

For Canada, data refer to 2007 and 2013. In 2013, data refer to sales online over the Internet.

For New Zealand, data refer to orders received via the Internet for the fiscal years 2007/08 and 2011/12, ending on 31 March, instead of 2008 and 2012.

For Switzerland, data refer to 2011. In 2008, data refer to businesses with five or more persons employed.

Turnover from e-commerce, by size, 2008 and 2012

For Australia, data refer to the fiscal years 2009/10 and 2011/12, ending on 30 June, instead of 2008 and 2012.

For Belgium, data refer to 2011 instead of 2012.

For Denmark and Mexico, data refer to 2008.

For Denmark, Finland, Mexico and the United States, data are not available by firm size.

For Greece, data refer to 2010 instead of 2008.

For Luxembourg, data refer to 2011 for the total and to 2012 for the size class 10-49.

5.7 Human capital in ICT

Tertiary graduates in computer science, by gender, 2005 and 2012 and;
Supply of tertiary graduates in computer science, 2005 and 2012

For Australia, data refer to 2011 and data on ISCED 5B is not available.

For France, data refer to 2011.

For Israel, data on ISCED 5B is not available.

For Japan, data are not available at such detailed level.

For Luxembourg, data are not available.

Researchers in information industries, 2011

For Luxembourg, data on ICT manufacturing researchers are confidential.

For New Zealand, data refer only to researchers in Computer programming.

5.8 ICT jobs and jobs in the ICT sector

Employment in ICT-related occupations, 2011 and 2013

For Canada, data refer to 2012.

Employment in information industries, 2000 and 2012 and;
Change in employment shares of information industries between 2000 and 2012

For Australia, data refer to 2009.

For Canada, Germany, Greece, Luxembourg, Poland, Portugal, Sweden, Switzerland and the United States, data refer to 2011.

For Japan, data refer to 2008.

For Poland, data refer to 2004 instead of 2000.

For Spain, data refer to 2010.

5.9 Trade competitiveness and GVCs

Global trade in ICT goods and top ten exporters, 2000 and 2012

China and world data are computed net of China's re-imports and Hong Kong, China re-exports. Gross of these components, world exports of ICT products totalled USD 986 billion in 2000 and USD 1 830 billion in 2012, while China's exports totalled USD 44 billion in 2000 and USD 554 billion in 2012, with no substantial change in its shares. Netting for the flows of goods mediated by Hong Kong, China and for Chinese re-imports removes two key intertwined elements of distortion in ICT trade statistics. Indeed, re-exports account for 99% of Hong Kong, China exports of ICT goods, while China makes extensive use of East Asian logistics hubs (including Hong Kong, China) for internal trade. Estimates do not consider similar flows for all other countries owing to a lack of exhaustive data.

OECD and major exporters of ICT services, 2000 and 2013

For Denmark, data refer to 2004 instead of 2000.

For Iceland and Israel, data refer to 2012.

For Luxembourg, data refer to 2002 instead of 2000.

For Mexico and Switzerland, exports of computer and information services are not included.

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