OECD Science, Technology and Industry Scoreboard 2015

INNOVATION FOR GROWTH AND SOCIETY

OECD

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BETTER POLICIES FOR BETTER LIVES

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1. Footnote by 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”.

2. Footnote by all the European Union Member States of the OECD and the European Union
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Foreword

The OECD Science, Technology and Industry Scoreboard 2015 *draws on the latest internationally comparable data to uncover the strengths of the OECD and other leading economies, and examine current challenges to overcoming the effects of recent financial and economic crises and improving the well-being of societies.*

It features indicators traditionally used to monitor developments in science, technology, innovation and industry, and complements them with new and experimental indicators that provide new insights into areas of policy interest.

The aim of the STI Scoreboard is not to "rank" countries or develop composite indicators. Instead, its objective is to provide policy makers and analysts with the means to compare economies with others of a similar size or with a similar structure and monitor progress towards desired national or supranational policy goals. It draws on OECD efforts to build data infrastructure to link actors, outcomes and impacts, and highlights the potential and limits of certain metrics, as well as indicating directions for further work.

Indicators are pointers; they do not address causal relationships. Moreover, the validity of a set of indicators depends on its use. The selected indicators have been developed with the following criteria in mind:

- *Indicators should be based on high-quality statistics and robust analytical principles and be measurable internationally, over time and with prospects of improvement.*
- *Indicators should be relevant, particularly for decision makers.*
- *Experimental indicators that complement more established ones should bring new perspectives and advance the measurement agenda. They should help to stimulate policy debates and uncover new dynamics.*

The first chapter, **Knowledge economies: Trends and features**, *provides a broad perspective. It looks at innovation, firm dynamics, productivity and jobs against the backdrop of the recent economic crisis. It explores the new geography of growth from the perspectives of global value chains, the changing innovation landscape, current features of scientific research, and the characteristics of innovation beyond formal research and development.*

Five thematic chapters focus on key areas of policy interest:

- **Investing in knowledge, talent and skills** *examines the knowledge assets that many firms and governments view as current and future sources of long-term sustainable growth. It provides experimental metrics of knowledge-based capital, such as formal and on-the-job training and organisational assets, both in the private and public sector. It develops new indicators of research "excellence" pointing to the research performance of countries that follow different paths of scientific specialisation, as well as indicators of skills necessary for the new working environment shaped by ICT.*
- **Connecting to knowledge** *helps inform the policy debate with a set of metrics on the variety and nature of mechanisms for knowledge diffusion. It presents indicators on the international mobility of highly skilled individuals including students and scientists, the impact of scientific*

collaboration (based on patent citations), science-technology linkages (based on citations of non-patent literature in patent documents) and collaboration among firms in innovation processes. Also included are new indicators on the role of scientific leadership in international collaboration and open access to publicly funded research, based on an OECD experimental survey of scientists.

- **Unlocking innovation in firms** *explores the dynamism of the business sector and framework conditions crucial for innovation. It examines intellectual property bundles with a focus on firms' joint use of patents, trademarks and industrial designs to protect their innovations. New data on registered designs provide information on countries' approaches to protecting creativity and a novel technique is proposed to help track product areas characterised by emerging creative activities. New estimates of R&D tax incentives are combined with direct funding of R&D to provide a more complete picture of government efforts to promote business R&D, while new indicators based on innovation surveys look at the participation of innovative firms in public procurement markets. Other indicators address the broader policy environment for innovation.*
- **Competing in the global economy** *investigates how countries seek to build their competitive strengths and the extent to which economies are successful in integrating and specialising along global value chains. It assesses indicators on R&D specialisation, technological advantages and relative strengths, as well as the characteristics of innovative firms and their use of new technologies in business processes. New indicators building on the OECD* Trade in Value Added (TiVA) Database *shed light on economies' participation in global trade and value chains, and the implications of this participation for jobs and consumers everywhere. The greater sectoral detail provided by the new TiVA data release also enables analysis of economies' relative strengths in specific industry global value chains.*
- **Empowering society with science and technology** *focuses on the extent to which citizens participate in innovative processes, the degree of sophistication of demand, and readiness to accept and recognise the potential of science and technology. A set of key indicators examines individuals' access to and use of technologies from an early age, the level of sophistication of users, and their role as e-consumers and e-citizens. Another set of indicators explores support for innovation to tackle grand challenges, such as health and the environment, in relation to national leadership in the development of new technologies in those areas. Finally, new and experimental indicators make use of qualitative surveys to develop indicators of public perceptions of science and technology.*

The main audience of the STI Scoreboard is policy analysts with a good understanding of the use of indicators and those engaged in producing indicators for analytical or policy-making purposes. A few paragraphs introduce each indicator and offer some interpretation. Accompanying boxes entitled "Definitions" and "Measurability" provide detail on the methodologies used and summarise measurement challenges, gaps and recent initiatives.

All figures and underlying data can be downloaded via the StatLinks (hyperlink to a webpage). Additional data that expand the coverage of countries and time periods are available at the same links as "more" data. Several thematic briefs and country notes, as well as online tools to visualise indicators and help users develop analyses based on their own interests, are available at the STI Scoreboard website (www.oecd.org/sti/scoreboard.htm).

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Reader's guide

Acronyms

BERD	Business enterprise expenditure on research and development
CIPO	Canadian Intellectual Property Office
CIS	Community Innovation Survey
CIT	Corporate income tax
CPC	Cooperative Patent Classification
CTM	Community trademark
DPMA	Deutsche Patent- und Markenamt
DSL	Digital subscriber line
EFTA	European Free Trade Association
EPO	European Patent Office
EU	European Union
EUR	Euro
FDI	Foreign direct investment
FTE	Full-time equivalent
GBAORD	Government budget appropriations or outlays for R&D
GDP	Gross domestic product
GERD	Gross domestic expenditure on R&D
GVC	Global value chain
HERD	Higher education expenditure on R&D
ICT	Information and communication technology
IGE	Institut fédéral de la propriété intellectuelle
IMF	International Monetary Fund
INPI	Institut national de la propriété industrielle
I-O	Input-output
IP	Intellectual property
IP5	Five IP Offices (EPO, JPO, KIPO, SIPO, USPTO)
IP AUS	IP Australia
IPC	International Patent Classification
IPO	The IP Office of the United Kingdom
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
ISIC	International Standard Industrial Classification
JPO	Japan Patent Office
KBC	Knowledge-Based Capital
KIPO	Korean Intellectual Property Office
KLEMS	Capital, labour, energy, material and service inputs
LFS	Labour Force Survey
NACE	Statistical classification of economic activities in the European Community (*Nomenclature statistique des activités économiques dans la Communauté européenne*)
NPHRST	National Profiles Human Resources in Science and Technology
NPL	Non-patent literature

NS&E	Natural sciences and engineering
OEPM	Oficina Española de Patentes y Marcas
OHIM	Office for Harmonization in the Internal Market
PCT	Patent Cooperation Treaty
PPP	Purchasing power parity
R&D	Research and development
RCD	Registered Community Design
S&T	Science and technology
SIPO	State Intellectual Property Office of the People's Republic of China
SME	Small and medium-sized enterprise
SNA	System of National Accounts
TiVA	Trade in value added
UIBM	Ufficio Italiano Brevetti e Marchi
USD	United States dollar
USPTO	United States Patent and Trademark Office
Wi-Fi	Wireless fidelity
WIPO	World Intellectual Property Organization

Abbreviations

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

ARG	Argentina	**JPN**	Japan
AUS	Australia	**KOR**	Korea
AUT	Austria	**LIE**	Liechtenstein
BEL	Belgium	**LTU**	Lithuania
BGR	Bulgaria	**LUX**	Luxembourg
BMU	Bermuda	**LVA**	Latvia
BRA	Brazil	**MEX**	Mexico
BRB	Barbados	**MLT**	Malta
CAN	Canada	**MYS**	Malaysia
CHE	Switzerland	**NGA**	Nigeria
CHL	Chile	**NLD**	Netherlands
CHN	People's Republic of China	**NOR**	Norway
COL	Colombia	**NZL**	New Zealand
CRI	Costa Rica	**PAK**	Pakistan
CUW	Curaçao	**PHL**	Philippines
CYM	Cayman Islands	**POL**	Poland
CZE	Czech Republic	**PRI**	Puerto Rico
DEU	Germany	**PRT**	Portugal
DNK	Denmark	**ROU**	Romania
ESP	Spain	**RUS**	Russian Federation
EST	Estonia	**SAU**	Saudi Arabia
FIN	Finland	**SGP**	Singapore
FRA	France	**SVK**	Slovak Republic
GBR	United Kingdom	**SVN**	Slovenia
GRC	Greece	**SWE**	Sweden
HKG	Hong Kong, China	**THA**	Thailand
HRV	Croatia	**TUR**	Turkey
HUN	Hungary	**TWN**	Chinese Taipei
IDN	Indonesia	**UKR**	Ukraine
IND	India	**USA**	United States
IRL	Ireland	**VEN**	Venezuela
IRN	Iran	**VGB**	British Virgin Islands
ISL	Iceland	**VNM**	Viet Nam
ISR	Israel	**ZAF**	South Africa
ITA	Italy		

Country groupings

ASEAN	Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam.
BRIICS	Brazil, the Russian Federation, India, Indonesia, China and South Africa.
Euro area	Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, the Slovak Republic, Slovenia and Spain.
EU28	European Union
G7	Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.
NAFTA	Canada, Mexico and the United States.
OECD	Total OECD
ROW	Rest of the world
WLD	World

Scopus All Science and Journal Classification (ASJC)

Code	Field	Code	Field
ART	Arts and humanities	**HEA**	Health professions
AGR	Agricultural and biological sciences	**IMM**	Immunology and microbiology
BIO	Biochemistry, genetics and molecular biology	**MSC**	Materials science
BUS	Business, management and accounting	**MAT**	Mathematics
CHE	Chemistry	**MED**	Medicine
CEN	Chemical engineering	**MUL**	Multidisciplinary
COM	Computer science	**NEU**	Neuroscience
DEC	Decision sciences	**NUR**	Nursing
DEN	Dentistry	**PHA**	Pharmacology, toxicology and pharmaceutics
EAR	Earth and planetary sciences	**PHY**	Physics and astronomy
ECO	Economics, econometrics and finance	**PSY**	Psychology
ENE	Energy	**SOC**	Social sciences
ENG	Engineering	**VET**	Veterinary
ENV	Environmental science		

Executive summary

Downturns tend to accelerate structural change and create new challenges and opportunities. The *OECD Science, Technology and Industry Scoreboard 2015* shows how OECD countries and major non-OECD economies are starting to move beyond the crisis, increasingly investing in the future.

Investment in innovation is intensifying

By 2013, total R&D spending in the OECD area grew 2.7% in real terms to reach USD 1.1 trillion, while its share in GDP remained unchanged from 2012 at 2.4%. This increase was driven by business R&D, while government R&D was hit by budget consolidation measures. Innovation relies not only on investment in R&D, but also on complementary assets such as software, design and human capital, i.e. knowledge-based capital (KBC). KBC investment has proven resilient to the crisis, and 2013 data show KBC investment intensifying in every sector of the economy.

The research "mix" matters

Since the mid-1980s, OECD spending on basic research has increased faster than applied research and experimental development, reflecting many governments' emphasis on funding scientific research. Basic research remains highly concentrated in universities and government research organisations. A significant share of R&D in such institutions is dedicated to development in Korea (35%) and China (43%). Overall in 2013, China invested relatively little (4%) in basic research compared to most OECD economies (17%), and its R&D spending is still heavily oriented towards developing S&T infrastructure, i.e. buildings and equipment.

Disruptive innovations are enabling the next production revolution

A new generation of ICT technologies, such as those related to the Internet of Things, big data, *quantum* computing, plus a wave of inventions in advanced materials and health, are laying the ground for profound transformations to how we will work and live in future. In 2010-12, the United States, Japan and Korea led invention in these domains (accounting collectively for over 65% of patent families filed in Europe and the United States), followed by Germany, France and China.

Government support for business R&D is on the rise, but demand matters

Firms investing in R&D are more likely to introduce innovations. In 2015, 28 OECD countries are using R&D tax incentives to support business R&D. This support accounted for nearly USD 50 billion in 2013. Demand also matters for innovation. Participation in procurement markets is more common among large firms than among SMEs, and is far more likely among innovative than non-innovative firms.

Scientific excellence relies on research hotspots and collaboration networks

A few centres of excellence continue to dominate the science and innovation landscape. The United States accounted for 22 of the top-30 universities with the highest relative impact over 2003-12. The top-30 high-impact, typically public, research institutions are spread over 14 different locations, including non-OECD economies. Four countries, the United States, the United Kingdom, Germany and China, accounted together for 50-70% of high-impact publications across all scientific disciplines. International collaboration has nearly doubled since 1996, reaching almost 20% of all scientific publications in 2013. The United States continues to play a central role in science networks, both as a destination and source of scientists.

Frontier innovation is highly concentrated across R&D corporations

In 2012, the 2 000 leading R&D corporations and their network of 500 000 affiliates accounted for more than 90% of global business R&D and 66% of patent families filed at the largest five intellectual property offices worldwide. Within the top-2000, 250 multinationals accounted for 70% of R&D expenditure, 70% of patents, almost 80% of ICT-related patents, and 44% of trademarks filings. Most of their headquarters (55%) and affiliates (40%) were based in the United States and Japan. Over 80% of the IP assets protected in Europe and the United States by the top-2000 R&D investors with global ultimate owners in Hong Kong, China; Bermuda; Ireland and the Cayman Islands are generated by foreign affiliates, mainly located in the United States and China.

Global value chains (GVCs) are still mostly regional in scope

International fragmentation of production has expanded rapidly, with intermediates now representing about 50% of world trade in manufactured goods. East and Southeast Asia ("Factory Asia") has become increasingly integrated and is a major player in global production, while China is a principal supplier of intermediates to many Southeast Asian economies further downstream in the production chain. By 2014, China had surpassed Canada and Mexico to become the biggest supplier of manufactured intermediates to the United States. The geographical scope of value chains remains mostly regional, reflecting linkages within Europe, NAFTA and "Factory Asia", with the role of regional networks varying by sector.

More workers are becoming engaged in GVCs

The number of jobs involved in GVCs increased between 2011 and 2013 for most European countries and the United States, as did the proportion of highly skilled workers employed along GVCs. In 2013, approximately 60 million business sector workers across 21 EU countries and the United States were engaged in GVCs, with about 36% of these jobs in highly skilled occupations. Meeting foreign demand requires relatively high shares of low- and highly-skilled workers, whereas domestic demand relies more on medium-skilled occupations.

The crisis and longer-term trends have changed the demand for jobs

More of the demand for manufactured goods in the OECD is being met by workers in emerging economies. Since the crisis, both large and small firms have shed jobs, particularly in manufacturing. In Europe, the crisis primarily affected routine-intensive occupations – for which workers' tasks may be automated, outsourced and/or offshored –

while in the United States non-routine (e.g. managerial) jobs were also affected. During the 2011-12 upswing, the United States regained jobs across all occupations, while gains in Europe occurred only in non-routine jobs.

Successful businesses invest in workers' capabilities

The organisational capabilities of firms, specifically their ability to manage production across GVCs, the skills of workers and functions they accomplish, are among the most important drivers of firms' performance and ability to succeed in global markets. Estimates of investment in organisational assets range between 1.4% and 3.7% of value added. Firm-specific training enables workers to cope with change while helping them improve productivity. Estimates of investment in training reached 6-7% of value added in 2011-12, with on-the-job training alone representing 2.4%.

1. KNOWLEDGE ECONOMIES: TRENDS AND FEATURES

This chapter presents a range of indicators that highlight long-term trends and characteristics of global knowledge economies. It addresses the following questions: What happened to productivity, firm dynamics, jobs and skills during the recovery? What are the implications for R&D and innovation, global investment and trade flows? What were the sources of growth over the last two decades? What is the role of knowledge-based capital in economies? What is the impact of growing economic interdependencies on jobs and the demand for skills? Are production networks global or regional? Are global value chains consolidating? Who are the emerging players in the new geography of growth? Who are the top players in the science and innovation landscape? How dispersed or how concentrated are economic and innovation activities? How intertwined are the actors in the innovation system? What are the features of scientific research today? How can research "excellence" be identified? What is the best approach to identify how technologies emerge, develop and mature? Who are the top players in new, disruptive technologies? What is the impact of the international mobility of scientists? How "collaborative" is the innovation process? What tools do governments use to support innovation? Indicators accompanied by short texts develop a narrative to help policy makers understand knowledge, science and innovation today.

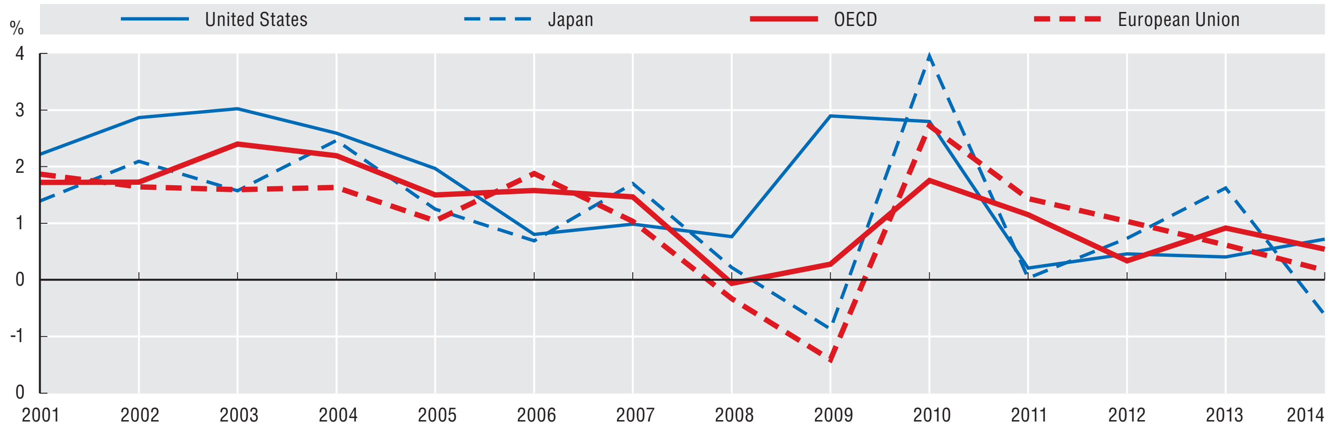
The growth and jobs challenge

Productivity and jobs challenge

The world today continues to feel the effects of the economic downturn seven years after the start of the crisis. In 2010, strong productivity growth signalled the start of a global recovery, however the pace of recovery has been unusually weak and labour productivity growth in the OECD area remains below pre-crisis levels. The failure to achieve a stronger cyclical upswing has had very real costs in terms of foregone employment, stagnant living standards in advanced economies, less vigorous development in some emerging economies, and rising inequality nearly everywhere (OECD, 2015a). The BRIICS (Brazil, the Russian Federation, India, Indonesia, the People's Republic of China and South Africa) economies were affected by the global slowdown to a lesser extent, with productivity growing at over 6% in 2009-14, compared to 1% in the OECD area. In China, GDP per employee grew at around 9% a year, compared to the 11% annual growth enjoyed in 2002-07.

1. Labour productivity growth based on hours worked, total economy level, 2001-14

Average annual growth rates in percentage points

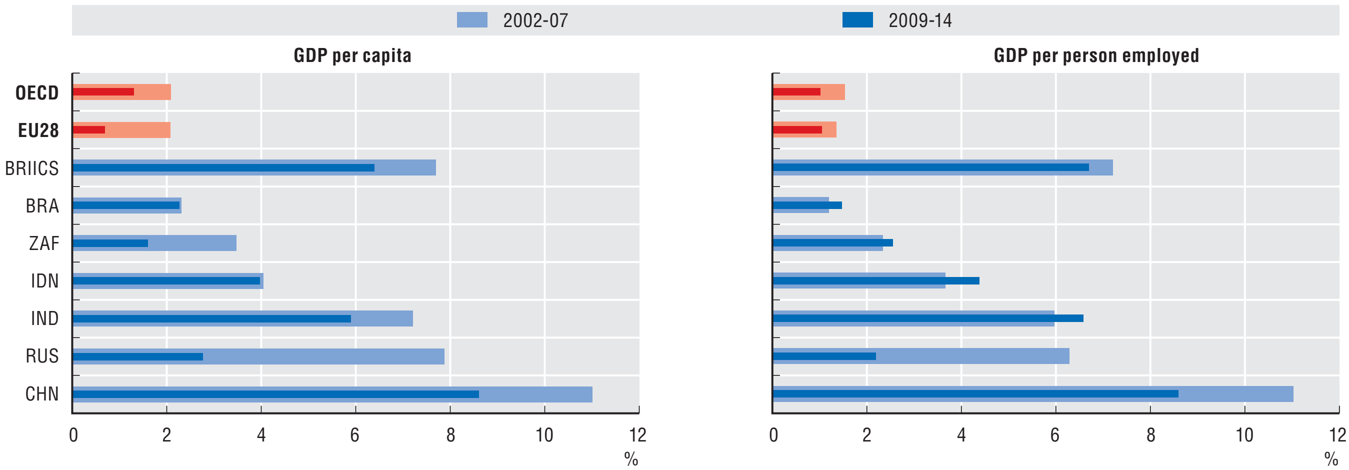


Source: OECD, *Productivity Database*, *www.oecd.org/std/productivity-stats*, May 2015.

StatLink http://dx.doi.org/10.1787/888933272766

2. GDP per capita growth and GDP per person employed growth in the BRIICS and the OECD, 2002-07 and 2009-14

Average annual growth rates in percentage points



Source: OECD, *Productivity Database*, *www.oecd.org/std/productivity-stats*, May 2015. See chapter notes.

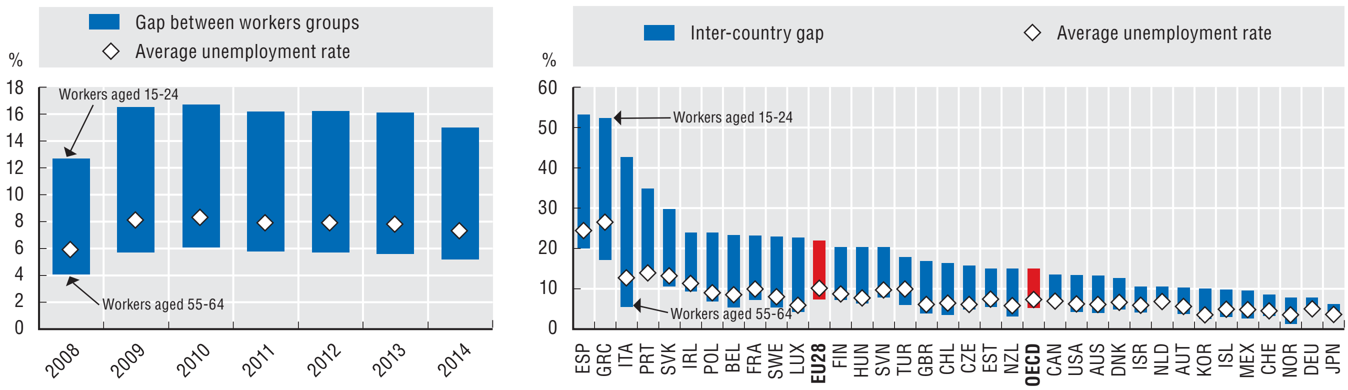
StatLink http://dx.doi.org/10.1787/888933272771

Productivity and jobs challenge

Job recovery is becoming more widespread and gaining momentum with unemployment declining in most countries, including those hardest hit by the crisis (OECD, 2015b). The OECD-wide unemployment rate declined by 1.6 percentage points from a post-war high of 8.5% in October 2009 to 6.9% in April 2015, with the average unemployment rate in the European Union remaining at almost 10%. However, youth employment rates remain of particular concern, especially in Europe, with average unemployment rates for younger workers (15-24 years old) at over 20%, rising to above 40% in Spain, Greece and Italy. Employment growth varied widely for different groups during the recovery, with unemployment rates for women slightly above those for men.

3. Unemployment rates in the OECD, gap between younger and older workers 2008-14 and differences by country in 2014

Percentage points

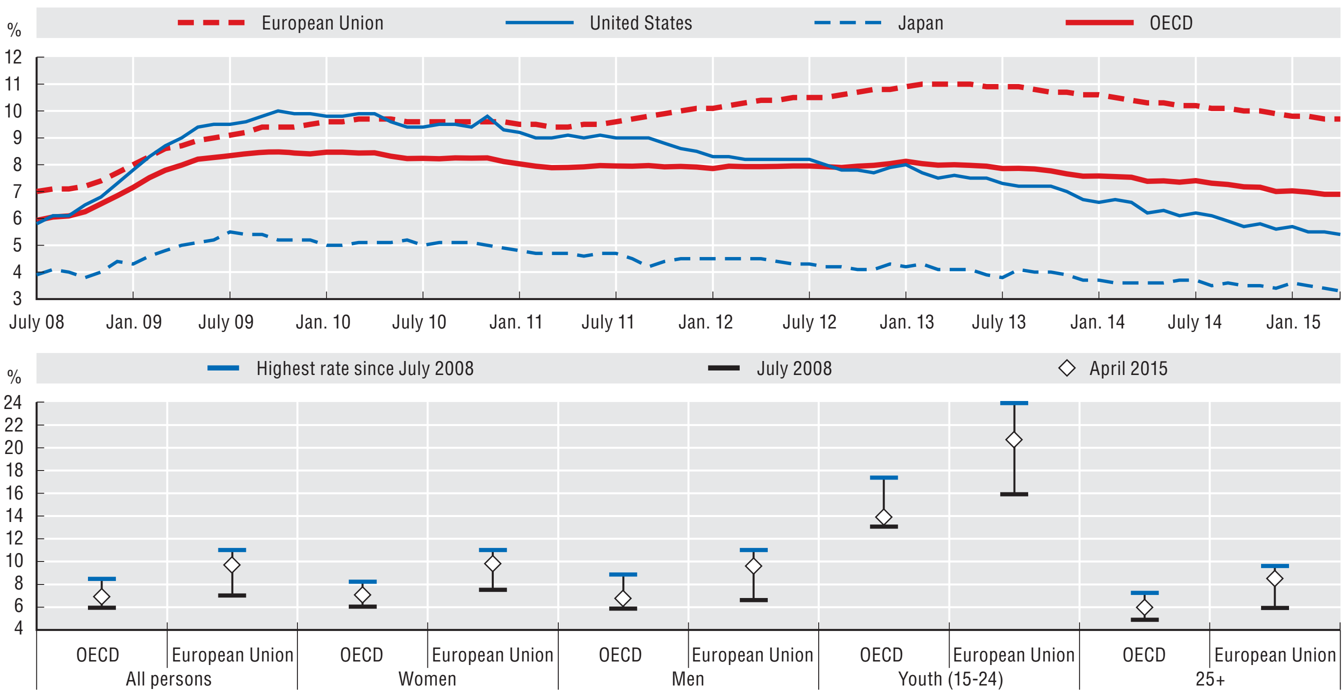


Source: OECD, *Short-Term Labour Market Statistics Database*, May 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933272781

4. Harmonised unemployment rates in the OECD, European Union, United States and Japan, July 2008-April 2015

Percentage points



Source: OECD, *Short-Term Labour Market Statistics Database*, June 2015.

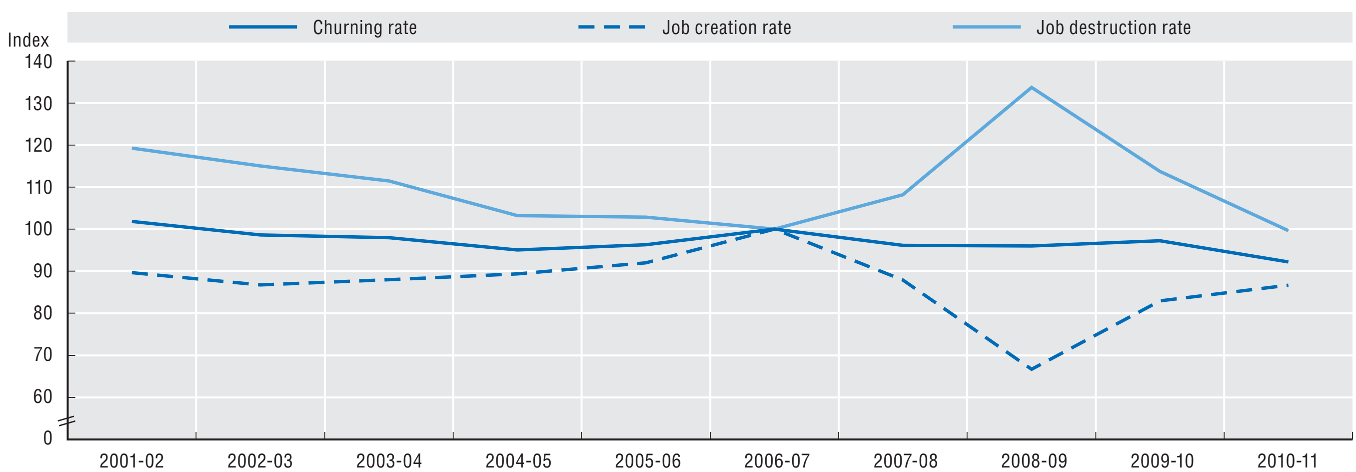
StatLink http://dx.doi.org/10.1787/888933272794

Firm dynamics and jobs

In the first decade of the 21st century, the job reallocation rate, as measured by the churning rate (i.e. the sum of job destruction and job creation rates) remained relatively stable. Prior to the crisis, the gap between job creation and job destruction was comparatively small, reflecting a Schumpeterian process of creative destruction which reallocates employment from firms destroying jobs to firms creating jobs. The 2008 economic crisis had a significant impact on this process, resulting in a sharp increase in gross job destruction and a drop in gross job creation. This gap contracted only partially over the 2009-10 biennium, with creation and destruction rates eventually aligning to pre-crisis levels during the following period.

5. Job creation, job destruction and churning rate, 2001-11

Unweighted average across countries, index 2006-07 = 100



Source: OECD, calculations based on the *DynEmp v.2 Database*, preliminary data, *www.oecd.org/sti/dynemp.htm*, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933272807

DynEmp and MultiProd: OECD projects on firm-level dynamics and productivity

The DynEmp project is based on a distributed data collection exercise (see Criscuolo et al., 2014b) aimed at creating a harmonised cross-country micro-aggregated database on employment dynamics from confidential micro-level sources. The primary sources of firm and establishment data are national business registers. Analysis of the DynEmp project has shown that young firms are the engines of job creation across all countries considered (see Criscuolo et al., 2014a and 2014c). The new *DynEmp v.2 Database* contains more detailed data on the within-sector contribution of start-ups and young firms to employment growth, taking into account the role played by national policies and framework conditions (see for example Calvino et al., 2015). Work on the differences in employment dynamics and job reallocation across sectors is ongoing.

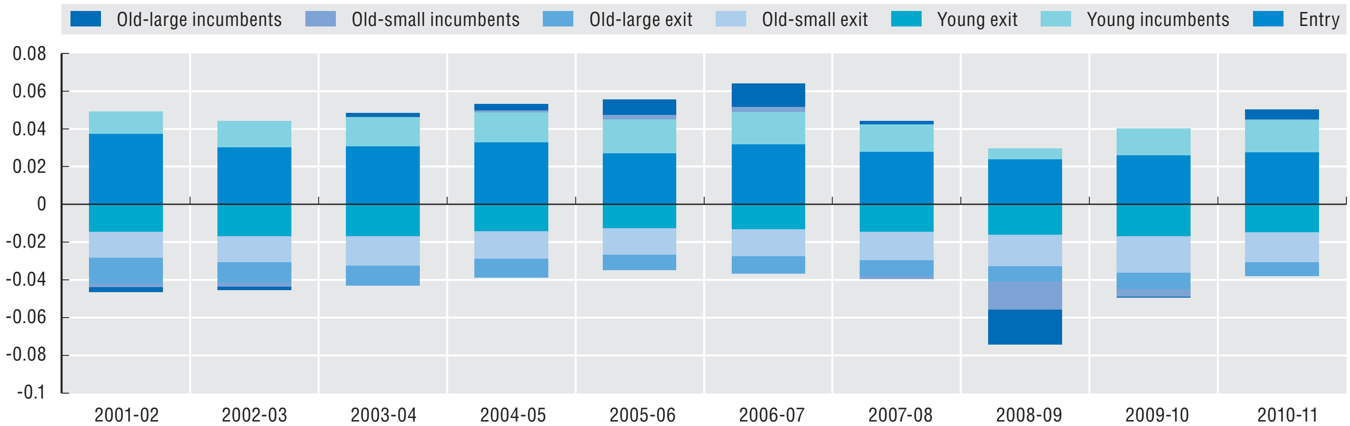
MultiProd is a companion project that uses a similar approach to examine the micro drivers of aggregate productivity. The project is presently building a micro-aggregated dataset using business registers and production surveys, with the aim of documenting the heterogeneity of productivity distribution within and across sectors, as well as its impact on aggregate outcomes. In particular, the project will investigate how policy frameworks affect resource allocation and productivity growth, measure the impact of (mis)allocations on aggregate productivity, and explore the link between productivity heterogeneity and wage inequality.

Firm dynamics and jobs

Between 2001 and 2011, entrants and young firms remained the main contributors to net job creation. During the pre-crisis period, adjustments in the exit margin for all firms across the age and size spectrum accounted for the majority of net job destruction. However, the picture changed dramatically during the crisis period. Both large and small incumbents shed jobs while remaining in business, resulting in a sizeable increase in net job destruction. The sharp decline in the job contribution of incumbents during the 2008-09 crisis, combined with their negative contribution to net job creation, was characteristic of all sectors – manufacturing, construction and services alike. However, the negative peak was especially sharp in the manufacturing sector. Conversely, incumbent firms in the services sector drove improvements in net job creation during 2009-10 and 2010-11.

6. Contribution to net job creation rate by group of firms, 2001-11

Unweighted average across countries in the non-financial business sector



Source: OECD, calculations based on the *DynEmp v.2 Database*, preliminary data, *www.oecd.org/sti/dynemp.htm*, July 2015. See chapter notes.

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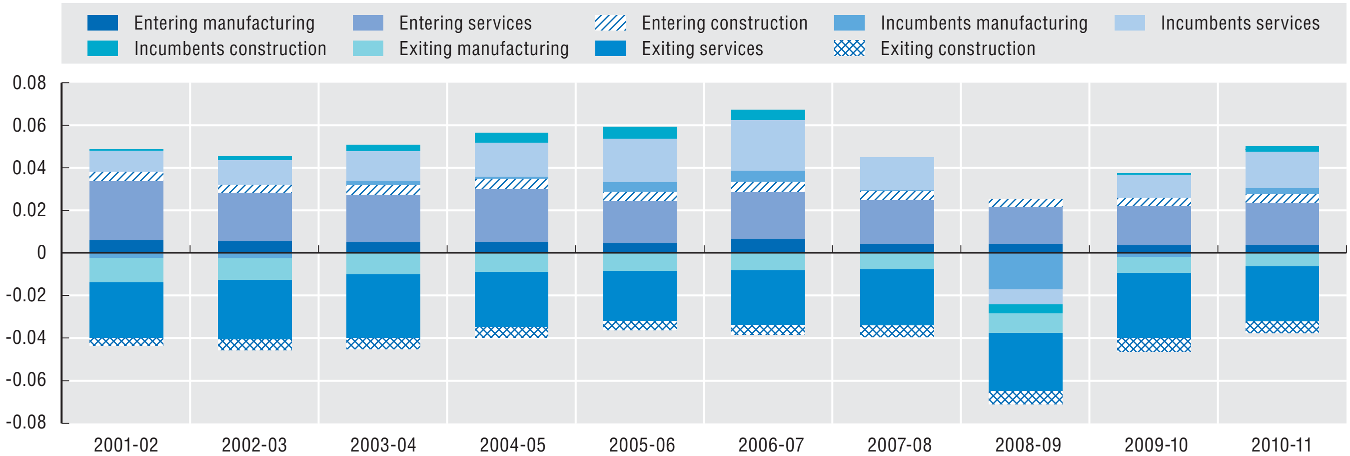
7. Contribution to net job creation rate by group of firms and macro sector, 2001-11

Unweighted average across countries in the non-financial business sector



Source: OECD, calculations based on the *DynEmp v.2 Database*, preliminary data, *www.oecd.org/sti/dynemp.htm*, July 2015. See chapter notes.

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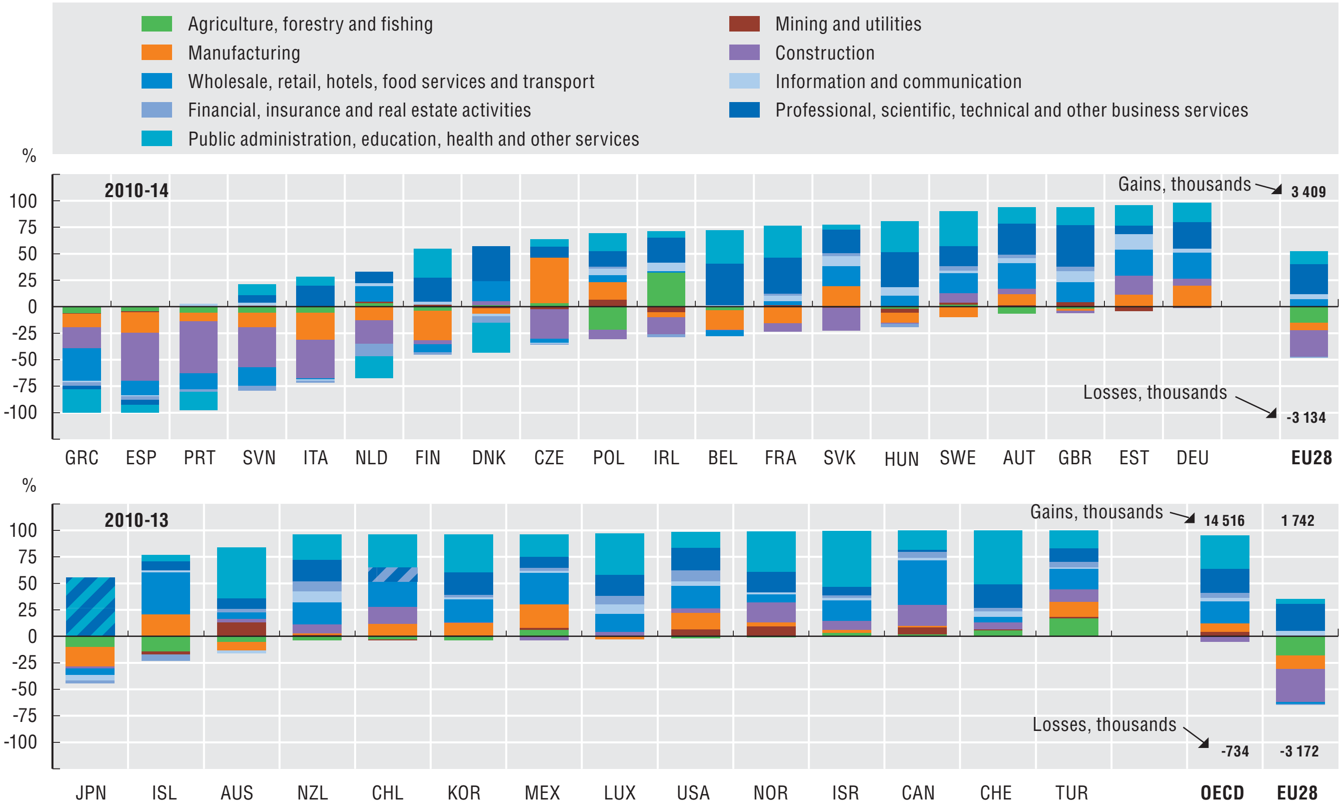
Jobs after the crisis

In the post crisis period between 2010 and 2013, total employment in the OECD area grew by 2.5% (a net gain of about 13.8 million jobs). This increase was driven mainly by non-EU countries with a net gain of over 8 million in NAFTA alone. Most increases occurred in service sectors with over 30% of net gains in OECD jobs coming from *Public administration, education, health and other services*. During the same period about 1.4 million jobs were lost in the European Union. In 2014, however, the European Union as a whole fared better with a net gain of about 275 000 jobs between 2010 and 2014, with a notable rise in *Professional, scientific, technical and other business services*. However, there was significant variation within the overall rise in EU employment, between 2010 and 2014, with Germany and the United Kingdom experiencing net gains of about 1.6 million and 1 million jobs respectively, while Greece, Italy, Portugal and Spain suffered a collective net loss of 3 million jobs, with the construction sector and, to a lesser extent, manufacturing, showing few signs of returning to pre-crisis levels of employment.

8. Where people lost and gained jobs, 2010-14 and 2010-13

Relative contribution to change in total employment by major sectors of economic activity



Source: OECD, *Annual National Accounts Database* and national statistical institutes, June 2015. See chapter notes.

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How to read these figures

Changes in employment levels by economic activity can be "normalised" to highlight their relative contributions, in each country, to the total change in employment between 2010-13 and 2010-14. This is achieved for each country by expressing the sectoral changes as a percentage of the sum of the absolute changes. The aggregate activity groups are defined according to ISIC Rev. 4 classes.

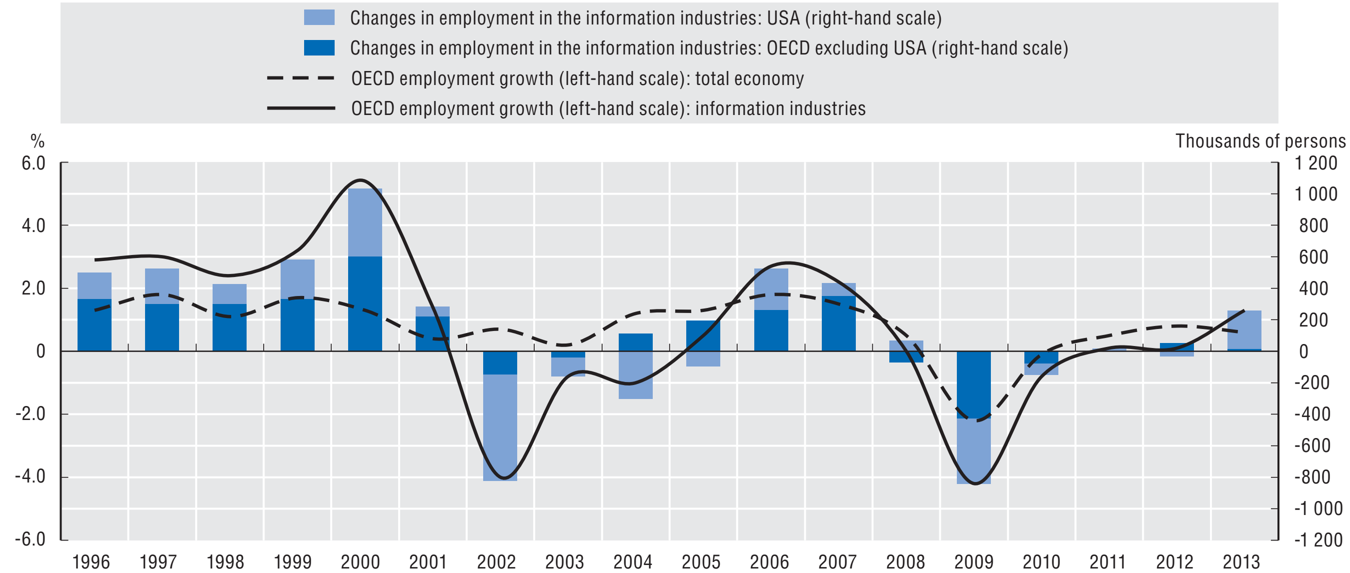
The employment data are drawn mostly from Annual National Accounts sources and are measured in terms of persons except for Canada which provides figures for jobs.

Jobs after the crisis

The information industries are considered by many as an important source of growth in OECD countries despite accounting for less than 4% of total OECD employment. Between 1995 and 2013, OECD employment in information industries grew by about 15% – marginally less than the growth in total employment during the same period. However, employment in the information sector has been susceptible to relatively high volatility over the business cycle since 1995. For example, during the 2008-09 financial crisis, OECD information industry employment fell by 4%, compared to 2% for total employment, shedding over 800 000 jobs. This drop was similar to that which occurred between 2001 and 2002 following the bursting of the dot-com bubble, which peaked in 2000 after relatively strong growth in the preceding years. The United States now accounts for about 30% of OECD employment in the information industries (from a peak of about 34% in 2001), and has been a main driver of observed changes in OECD information sector employment over recent years. Most post-crisis growth in information sector employment can therefore be attributed to the United States.

9. Employment growth in information industries, OECD, 1995-2013

Annual change in percentage and in thousands of persons



Source: OECD calculations based on OECD, *Annual National Accounts Database* and *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and national sources, June 2015. See chapter notes.

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Definition of information industries

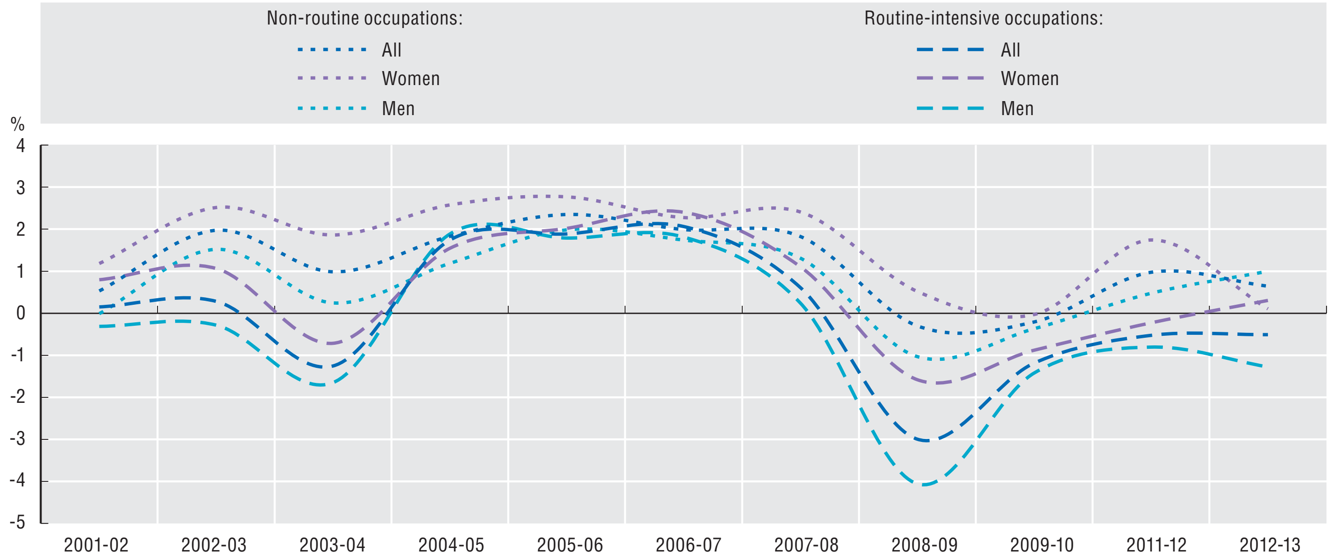
For this analysis, "Information industries" are defined according to ISIC Rev. 4. They cover ISIC Rev. 4 Division 26, *Manufacture of computer, electronic and optical products* and Section J, *Information and communication services*, which consists of *Publishing activities* (Division 58), *Audiovisual and broadcasting activities* (59-60), *Telecommunications* (61), and *IT and other information services* (62-63). This aggregate covers both the ICT sector and the Content and Media sector as defined by the OECD according to ISIC Rev. 4. See OECD (2011).

Jobs hit by the crisis

Occupations provide another way of looking at changes in employment. Job losses affect different types of workers in different ways, depending on their skills and the type of tasks carried out on the job. Experimental OECD work categorising occupations according to their routine intensity – the extent to which the tasks carried out follow precise patterns and may or may not be done differently, by someone else or somewhere else (i.e. automated, outsourced and/or offshored) – suggests that, in Europe, routine intensive occupations are more affected by layoffs during downturns and benefit less from growth spells. However, women in non-routine and routine-intensive occupations tend to suffer proportionally less during crises and to benefit relatively more during expansions. Among the factors that may contribute to explaining these gender-specific patterns are differences in the distribution of employment of men and women in the public and private sectors, industry-and-gender specific dynamics such as the marked decline of construction activities (a male-dominated sector), and the specific type of job accomplished (e.g. personal care).

10. The Great Recession hit routine intensive occupations harder, 2001-13

Growth in occupations by routine intensity and gender, selected European economies



Source: OECD, calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database* and Eurostat, European Labour Force Surveys (EULFS), June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933272854

Measuring routine jobs: A new methodology using PIAAC data

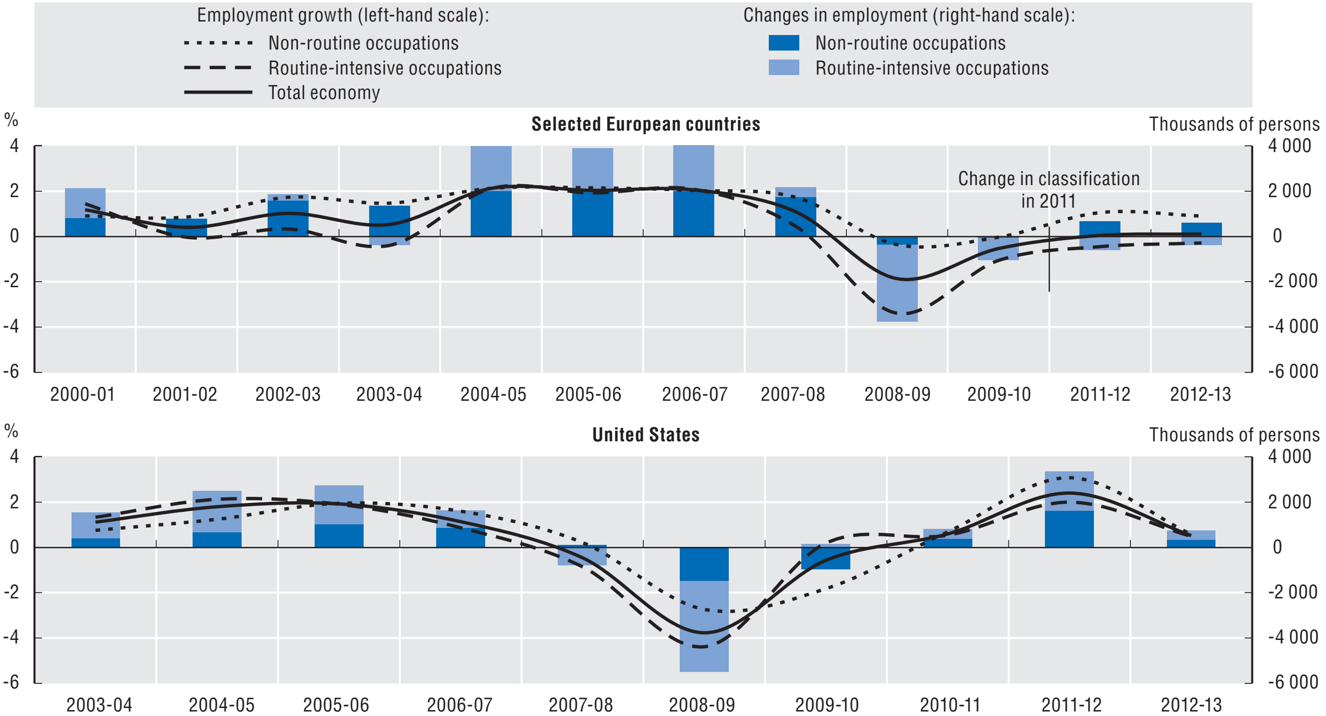
Experimental OECD work categorises occupations according to the routine intensity of the tasks performed on the job and investigates how such routine intensity relates to employment patterns. Routine-intensive occupations are broadly defined as jobs entailing the performance of tasks that are mainly accomplished by following a set of well-defined rules or patterns. Conversely, non-routine tasks entail performing more complex activities, such as creative problem solving and decision making, and involve greater autonomy for workers in carrying out the work. The proposed methodology exploits data from the OECD Programme for the International Assessment of Adult Competencies (PIAAC) survey and assesses the routine content of occupations using information about the possibility of making independent choices, and of altering the sequence and manner in which tasks are performed. This information is combined in an index, which is then used to subdivide occupations into four categories, homogenous with respect to the routine-intensity of the tasks accomplished. These are: low-routine-intensive occupations (e.g. managing directors and chief executives); medium-low-routine-intensive occupations (e.g. administrative and specialised secretaries); medium-high-routine-intensive occupations (e.g. machinery mechanics and repairers); and high-routine-intensive occupations (e.g. assemblers, food preparation assistants). Low and medium-low routine-intensive occupations are here denoted as “non-routine”, whereas medium-high and high-routine-intensive occupations are denoted as “routine-intensive”. Thanks to the richness of PIAAC, it is possible to redefine the routine intensity of occupations at the country and industry levels, and to examine, for example, gender-related and firm-size-related patterns. In addition, the routine intensity of occupations is being related to skill characteristics such as educational attainment, numeracy and the problem-solving ability of workers. This can help inform policies addressing issues such as the requalification and re-employment of workers (for more details about this new methodology, see Marcolin et al., 2015).

Jobs hit by the crisis

In Europe, the crisis disproportionnally affected the construction sector, where employment levels had increased significantly in previous expansion years thanks to investment in public infrastructure and housing booms. In general, while the United States shows more cyclical responsiveness than the EU, in both areas routine-intensive occupations appear more cyclical than non-routine ones, which are more resilient. In the depths of the crisis (2008-09), job losses in Europe mainly concerned routine-intensive occupations while in the United States they affected both groups. During the upswing of 2011-12 the United States gained jobs in both routine-intensive and non-routine occupations, while gains in Europe were only in non-routine occupations. In the United States these dynamics were driven by a mix of long-term trends, such as the growing role of occupations linked to the information economy or health care services, together with responses to both cyclical and unforeseen shocks (e.g. economic crisis). For instance, routine-intensive workers in health grew by 2 million and non-routine ICT-related occupations grew by 800 000 jobs over the decade.

11. Contribution of routine-intensive and non-routine occupations to employment growth, 2000-13

Yearly growth rates, selected European countries and the United States



Note: Yearly figures for the United States are calculated as simple averages over monthly data. Figures for Europe are based on annualised quarterly data. 2012 figures for the United States are based on a simple eight-month average (i.e. May to December 2012), to avoid possible biases due to changes in the occupational codes used by the US Census to address confidentiality issues. See Eckardt and Squicciarini (2015) for details.

Source: OECD, calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*, June 2015; Eurostat, European Labour Force Surveys (EULFS), June 2015 and United States Current Population Survey (CPS), June 2015. See chapter notes.

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How to read this figure

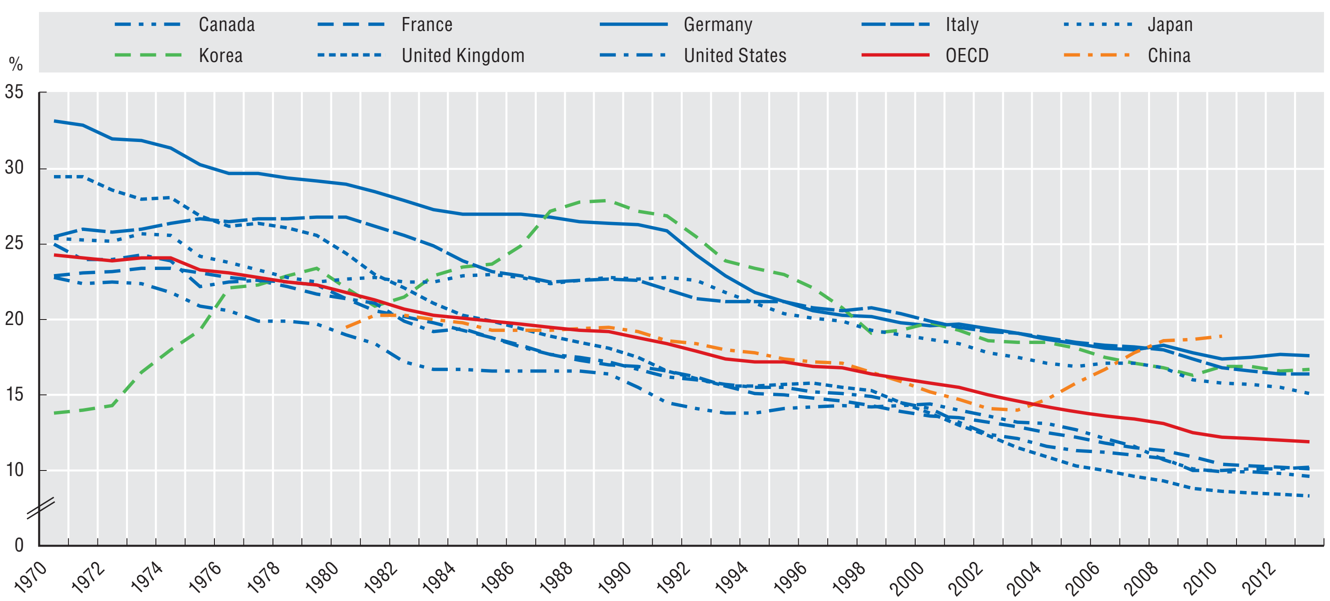
During the peak years of the crises (i.e. 2008-09), more than 3.7 million jobs were lost in Europe and about 5.5 million in the United States (right-hand scale, below the zero axis). In both economies, mostly routine-intensive workers were made redundant (about 3.4 million in Europe and 4 million in the United States). This corresponded to negative growth rates of 3.4% in Europe and 4.4% in the United States (left-hand scale). The crises affected non-routine workers significantly more in the United States than in Europe, with negative growth rates of -0.4% and -2.7%, respectively.

Long-term decline in manufacturing jobs

Since the early 1970s, most OECD countries have experienced a steady and persistent decline in employment in the manufacturing sector. Around 35 years ago, manufacturing typically accounted for about a quarter to a third of employment, whereas today in some OECD countries, such as Canada, France, the United Kingdom and the United States, the share has dwindled to 10% or lower. Broad deindustrialisation across OECD countries has been accompanied by waves of industrialisation in non-OECD countries, particularly in East and Southeast Asia. In Korea, prior to joining the OECD, the manufacturing base increased steadily, reaching a peak in employment in the early 1990s before its slow decline. This was followed by China, which by 2010 had become the world's leading manufacturer. These global shifts in manufacturing employment reflect major changes in production strategies among OECD firms, particularly those of multinational enterprises, with many production stages and tasks becoming distributed across economies as global value chains have become more widespread.

12. Long-term decline in manufacturing jobs, 1970-2013

Manufacturing as a percentage of total employment, selected economies



Source: OECD, *Annual National Accounts Database*, *Structural Analysis (STAN) Database*, *http://oe.cd/stan*; Eurostat, *National Accounts Database* and national sources, June 2015; *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014; RIETI, *China Industrial Productivity (CIP) Database 3.0*, *www.rieti.go.jp/en/database/CIP2015/*, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933272877

Definition of R&D intensive industries

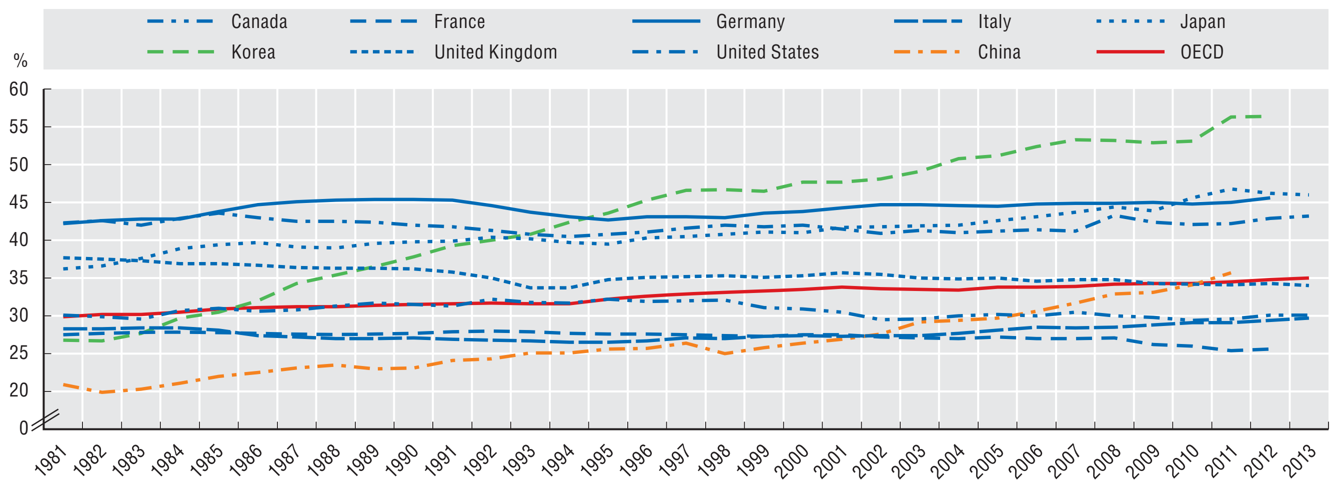
Industry R&D intensity is usually defined as the ratio of industry R&D expenditure to a measure of industry output – usually gross value added or gross output (production). In order to group industries according to R&D intensity, for each industry, the average R&D expenditure to output ratio is calculated over as many (usually OECD) countries as possible for the most recent year(s). The industries are then ranked. Recent work at OECD using the latest ISIC Rev. 4 data identified five high R&D-intensive industries: *Pharmaceuticals* (ISIC Rev. 4 Division 21), *Computer, electronic and optical products* (26) *Air and spacecraft* (303), *Software publishing* (582) and *Scientific R&D services* (72). To take account of the availability of employment data, this analysis employs a broader definition covering High and Medium-high R&D intensive manufacturing activities: *Chemical and pharmaceutical products* (ISIC Rev. 4 Divisions 20 and 21), *Machinery and equipment* (26, 27 and 28) and *Transport equipment* (29 and 30). As the R&D intensity classification is based on averages, in some countries some of the industries listed above may not be R&D intensive. Conversely, firms in some countries may perform high levels of R&D in activities allocated to a low R&D intensity group.

Long-term decline in manufacturing jobs

The loss of manufacturing jobs in the OECD area has affected some industries more than others. Over the past 30 years or so, a steadily increasing share of OECD manufacturing employment has come from R&D-intensive industries, rising from 30% to about 35%. In other words, relatively fewer jobs have been shed in this group of industries (chemicals, machinery and transport equipment) compared to others (e.g. textiles, plastics and basic metals). Relative to other OECD countries, Germany, Japan and Korea have retained high shares of jobs in manufacturing (over 15%), and employment in R&D intensive industries has remained comparatively buoyant, while the United States now accounts for over 40% of total manufacturing employment. Changes in global production patterns have seen manufacturing in China become more orientated around R&D-intensive industries, with the share of employment rising from 20% in the early 1980s to about 35% in recent years. However, a high presence of R&D-intensive industries does not necessarily indicate high levels of R&D expenditure, as much R&D can be embodied in imported intermediate goods.

13. Long-term trends in R&D-intensive manufacturing employment, 1980-2013

As a percentage of total employment in manufacturing, selected economies



Source: OECD, *Annual National Accounts Database*, *Structural Analysis (STAN) Database*, *http://oe.cd/stan*; Eurostat, *National Accounts Database* and national sources, June 2015; *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014; RIETI, *China Industrial Productivity (CIP) Database 3.0*, *www.rieti.go.jp/en/database/CIP2015/*, July 2015. See chapter notes.

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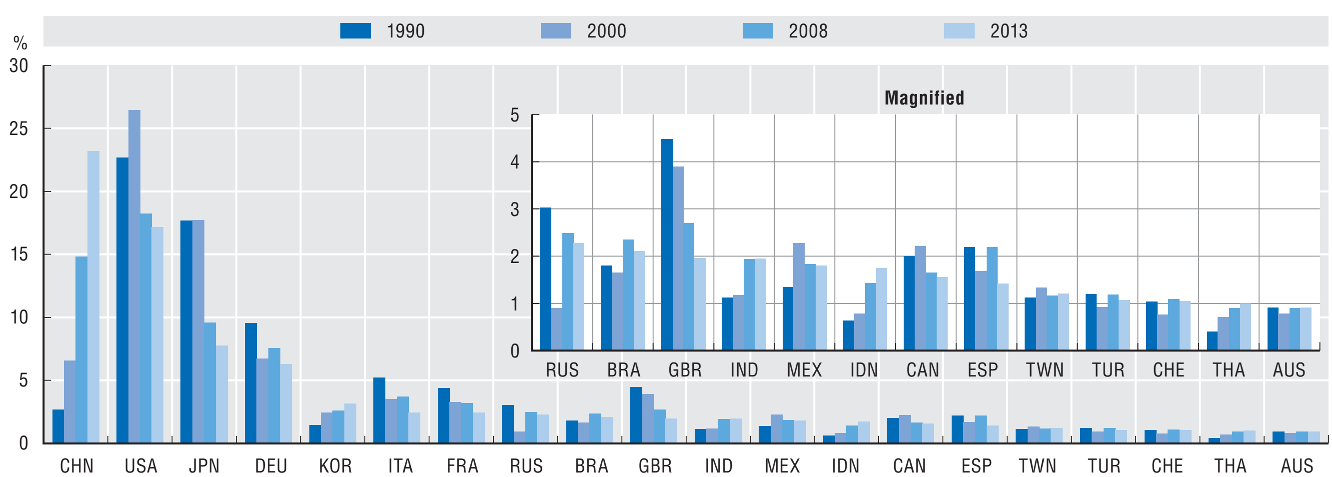
14. Top manufacturers in the last 20 years

Percentage share of total world manufacturing value added



Source: United Nations Statistical Division, *National Accounts Main Aggregates Database*, May 2015. See chapter notes.

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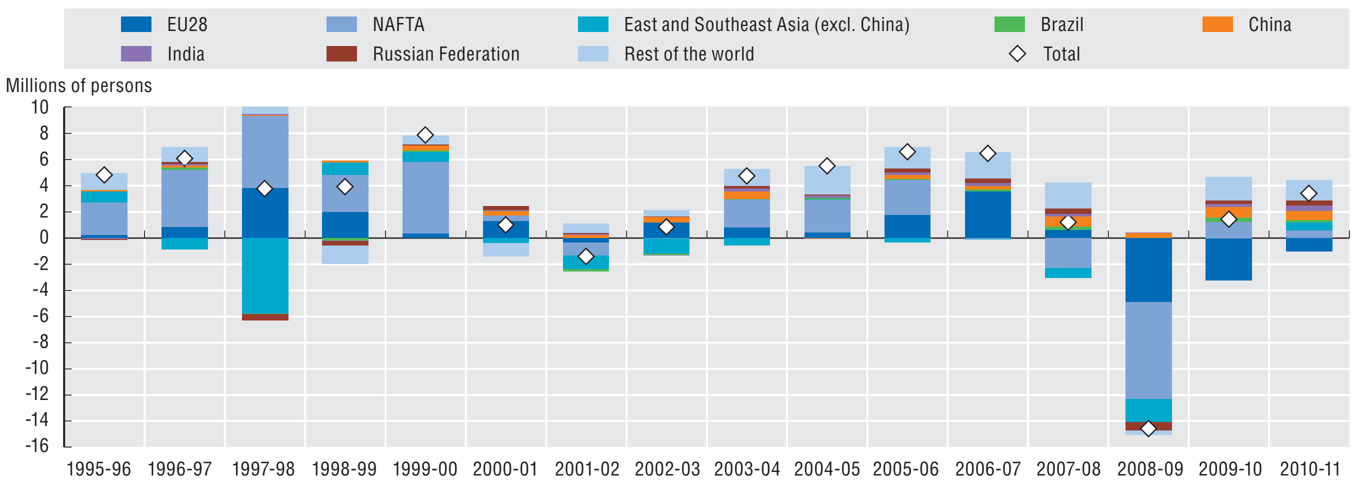
Changing sources of job demand

Growing economic and political integration worldwide has increased the sensitivity of employment in one country or region to changes in demand in other countries or regions. The OECD's Inter-Country Input-Output (ICIO) database enables researchers to derive experimental indicators that reveal how annual changes in OECD employment can be decomposed to account for changes in final demand for goods and services across different countries and regions. For example, an apparent overall increase of about 4 million business sector jobs in the OECD area, between 1997 and 1998, hides an increase of about 10 million jobs to meet demand in the European Union and the United States, which was offset by a loss of about 6 million jobs due to the financial crisis that hit Southeast Asia in 1997. In general, changes in OECD employment are affected by changes in OECD demand. This is illustrated by the significant loss of jobs during the most recent financial crisis, which was attributed to the decrease in demand across OECD countries. The immediate post-crisis period saw modest increases in OECD employment driven by demand from emerging economies, while sluggish demand in the European Union contributed to increased job losses.

15. Origin of demand for business sector jobs in OECD, 1995-2011

Millions of persons, annual changes by region of demand



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*, June 2015; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and *Annual National Accounts Database*, June 2015; *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014. See chapter notes.

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Towards measuring jobs sustained by foreign final demand

The goods and services people buy are composed of inputs imported from various countries around the world. However, the flows of goods and services within these global production chains are not always apparent from conventional international trade statistics, nor from national Input-Output or Supply and Use tables, which reveal flows of intermediate goods and services between industries (or product groups) used *within* a country for production to meet domestic and foreign demand. Building on these data sources, and many others, the OECD's *Inter-Country Input-Output (ICIO) Database* provides estimates of flows of goods and services between 61 economies and 34 economic activities (including 16 manufacturing and 14 service sectors) over seven years between 1995 and 2011.

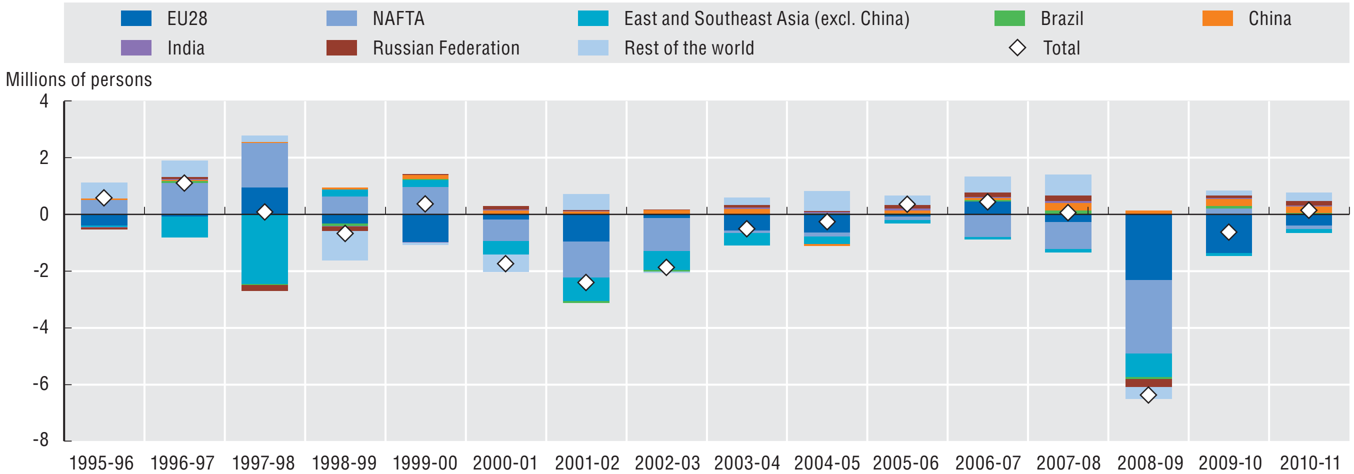
The most visible use of the ICIO is the construction of a suite of Trade in Value Added (TiVA) indicators under the joint OECD-WTO TiVA initiative. In general, these indicators reveal the value added origin (both domestic and foreign) of countries' exports and final demand. These indicators enable estimation of jobs *embodied* in (or sustained by) foreign final demand, in a manner similar to estimates of *Domestic value added embodied in foreign final demand*. However, experimental jobs-related indicators rely on some broad assumptions – in particular, that within each industry labour productivity in exporting firms is the same as firms producing goods and services for domestic use only, and that all firms use the same share of imports for a given output, whether exporters or domestic producers only. However, evidence suggests that exporting firms have higher labour productivity and use more imports in production. More efforts are required to account for firm heterogeneity within the ICIO framework, in order to reduce the potential upward biases resulting from the current assumptions.

Changing sources of job demand

The long-term decline in OECD employment in manufacturing can generally be attributed to the fall in demand in OECD countries for goods manufactured in the OECD area. In other words, as global value chains have propagated, more of the demand for manufactured goods in the OECD has been met by workers in emerging economies. In addition, evolving demand in these economies has had a positive impact for many manufacturing firms in the OECD area in recent years. For example, combined demand in Brazil, China and India apparently contributed to a net increase of over 300 000 manufacturing jobs in the OECD per year in the immediate aftermath of the 2009 crisis. Meanwhile, increasing specialisation in business services in OECD countries, and the accompanying increase in jobs in these sectors, occurred while meeting general global demand – although predominantly from OECD countries. Where there have been job losses in the business service sector, these often occur in services closely linked to manufacturing, such as transport and wholesale. Falling OECD demand for financial services also contributed to the decrease in business sector services during the financial crisis.

16. Origin of demand for manufacturing jobs in OECD, 1995-2011

Millions of persons, annual changes by region of demand



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*; *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and *Annual National Accounts Database*, June 2015; *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014. See chapter notes.

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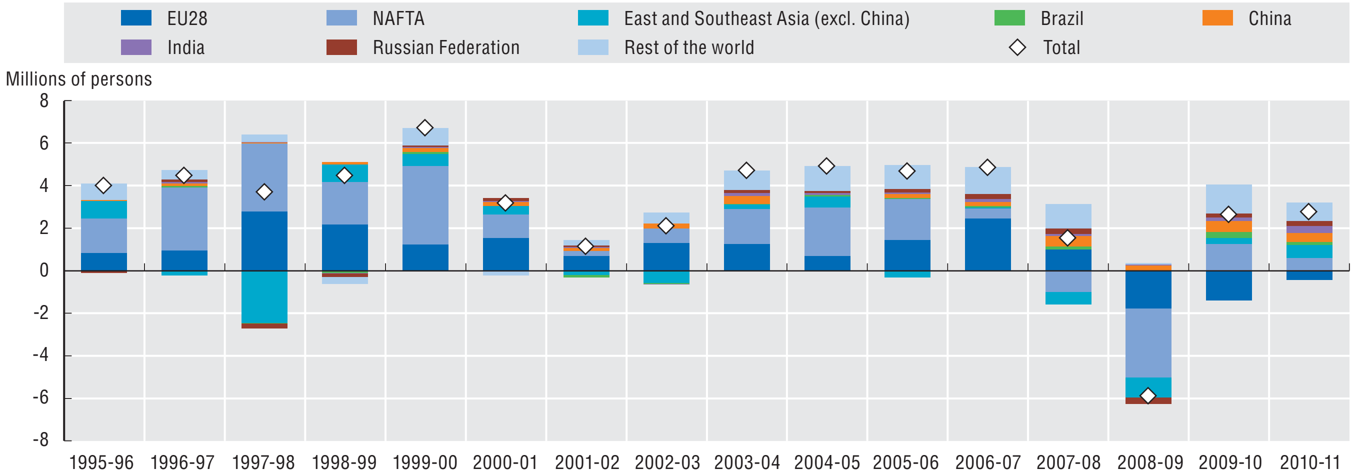
17. Origin of demand for business services jobs in OECD, 1995-2011

Millions of persons, annual changes by region of demand



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*; *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and *Annual National Accounts Database*, June 2015; *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014. See chapter notes.

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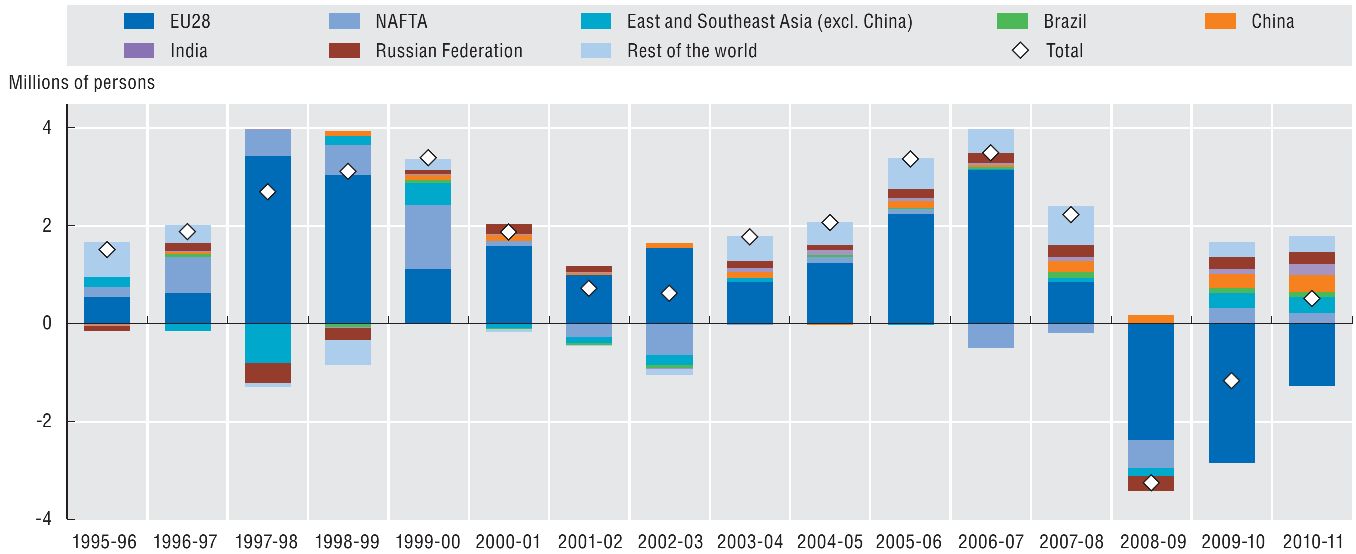
Jobs and skills in global value chains

Between 1995 and 2011, net changes in employment across the European Union were driven mainly by changes in EU final demand, with the impact of shifting demand patterns in NAFTA most noticeable prior to 2001. Subsequently, increasing demand from emerging economies, such as the Russian Federation and East and Southeast Asia and, to a lesser extent, Brazil and India, has made steady positive contributions to employment in the European Union. In general, overall improvements in EU employment following the crisis seem to have stemmed from increasing final demand in emerging economies, with China leading the way. Net EU job losses between 2009 and 2010 would have been significantly higher without demand for EU goods and services from outside the European Union, with a loss of 2.9 million jobs due to continuing falls in EU demand being partly offset by gains of 1.7 million due to demand elsewhere. Between 2010 and 2011, there was a modest net increase in EU employment despite the negative impact of faltering EU demand.

18. Origin of demand for jobs in Europe, 1995-2011

Millions of persons, annual changes by region of demand



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*; *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and *Annual National Accounts Database*, June 2015; *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014. See chapter notes.

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What do we mean by "jobs sustained by foreign final demand"?

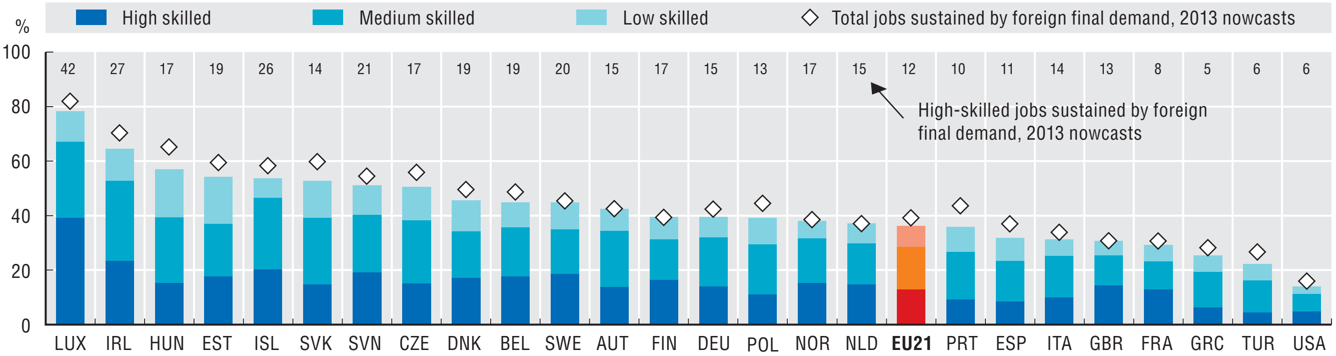
The notion of *jobs sustained by foreign final demand* attempts to capture the average number or share of jobs engaged in producing output that satisfied foreign demand for final goods and services. Accordingly, if foreign demand accounts for a quarter of a firm's output in a given year (whether intermediate or final goods), that firm's workers could be said to have used a quarter of their time to fulfil foreign demand. If half the output from the same firm in the following year, employing the same number of workers, is consumed abroad, then that firm's workers have used half their time to sustain foreign final demand. Thus, estimates of jobs sustained by foreign final demand reflect the fluctuating origins of demand (both domestic and foreign) for goods and services produced domestically i.e. an increase in the number of jobs sustained by foreign final demand does not necessarily translate into an increase in the total number of jobs; if the number of jobs sustained by domestic demand decreases. The use of hours worked or a measure of full-time equivalent employment could provide better metrics for determining the impact of global demand on domestic job markets. However, due to data availability this analysis used estimates of total numbers engaged (usually measured in persons) relative to output, by industry. Finally, biases may occur due to assumptions about homogenous labour productivity within industrial activities in countries and when aggregating country results to regions.

Jobs and skills in global value chains

In 2013, approximately 53 million and 14 million business sector workers across 21 EU countries and the United States, respectively, were engaged in production to satisfy foreign final demand. Preliminary results for 21 European countries suggest that about 36% of these jobs were in high-skilled occupations – a share that varies from about 20% in Turkey to about 50% in Luxembourg. For six other countries these shares are greater than 40% – the United Kingdom (47%), France (44%), Sweden (42%), Finland (41%), Norway (41%) and the Netherlands (40%). In the United States, the skill composition of jobs sustained by foreign final demand is similar to that of the EU aggregate, with 36% coming from high-skilled occupations. Preliminary *nowcasts* suggest that for most European countries and the United States, the share of jobs sustained by final demand increased between 2011 and 2013, as did the proportion of high-skilled workers. Greater integration in global value chains has implications for the demand for skills in countries. This results from differences in skills required in production for domestic consumption or for exports, differences in skill profiles of workers in foreign versus domestic companies, or differences in the structural composition of domestic versus foreign final demand. Regarding the latter, the results suggest that higher shares of low- and high-skilled workers are usually required to meet foreign demand than to meet domestic demand – which relies relatively more on medium-skilled occupations.

19. Jobs sustained by foreign final demand, by skill intensity, 2011 and 2013 estimates

As a percentage of total business sector employment



Note: Estimates for jobs sustained by foreign final demand in 2011 are derived directly from OECD's Inter-Country Input-Output (ICIO) table for 2011, while the estimates for 2013 are preliminary projections or *nowcasts*. This experimental indicator decomposes total employment sustained by foreign final demand into three groups of skill intensity defined according to major groups of the International Standard Classification of Occupations 2008 (ISCO-08): High-skilled occupations (ISCO-08 major Groups 1 to 3), medium-skilled (4 to 7) and low-skilled (8 and 9).

Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*, *Annual National Accounts Database*, June 2015; Eurostat, European Labour Force Surveys (EULFS), June 2015; United States Current Population Survey (CPS), July 2015; and *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014.

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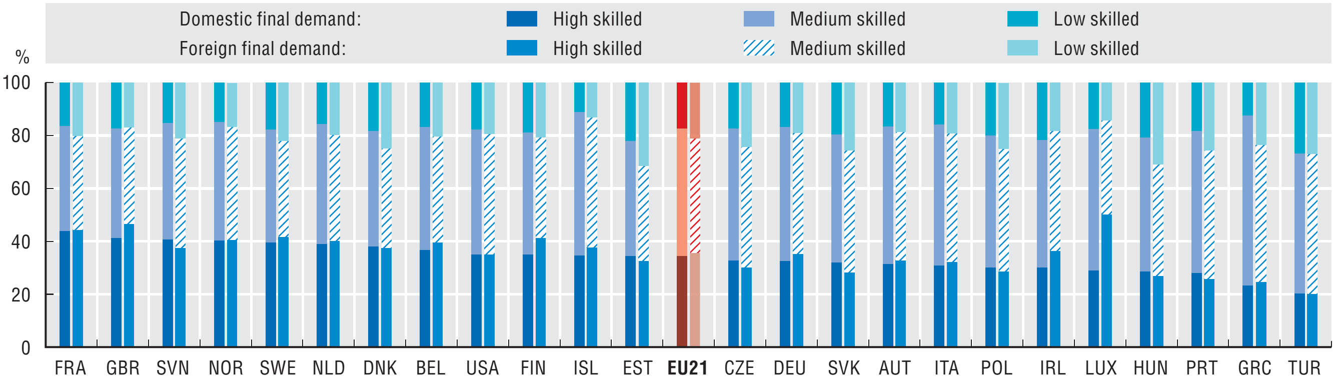
20. Skill content of employment sustained by domestic and foreign final demand, 2011



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*, *Annual National Accounts Database*, June 2015; Eurostat, European Labour Force Surveys (EULFS), June 2015; United States Current Population Survey (CPS), July 2015; and *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014.

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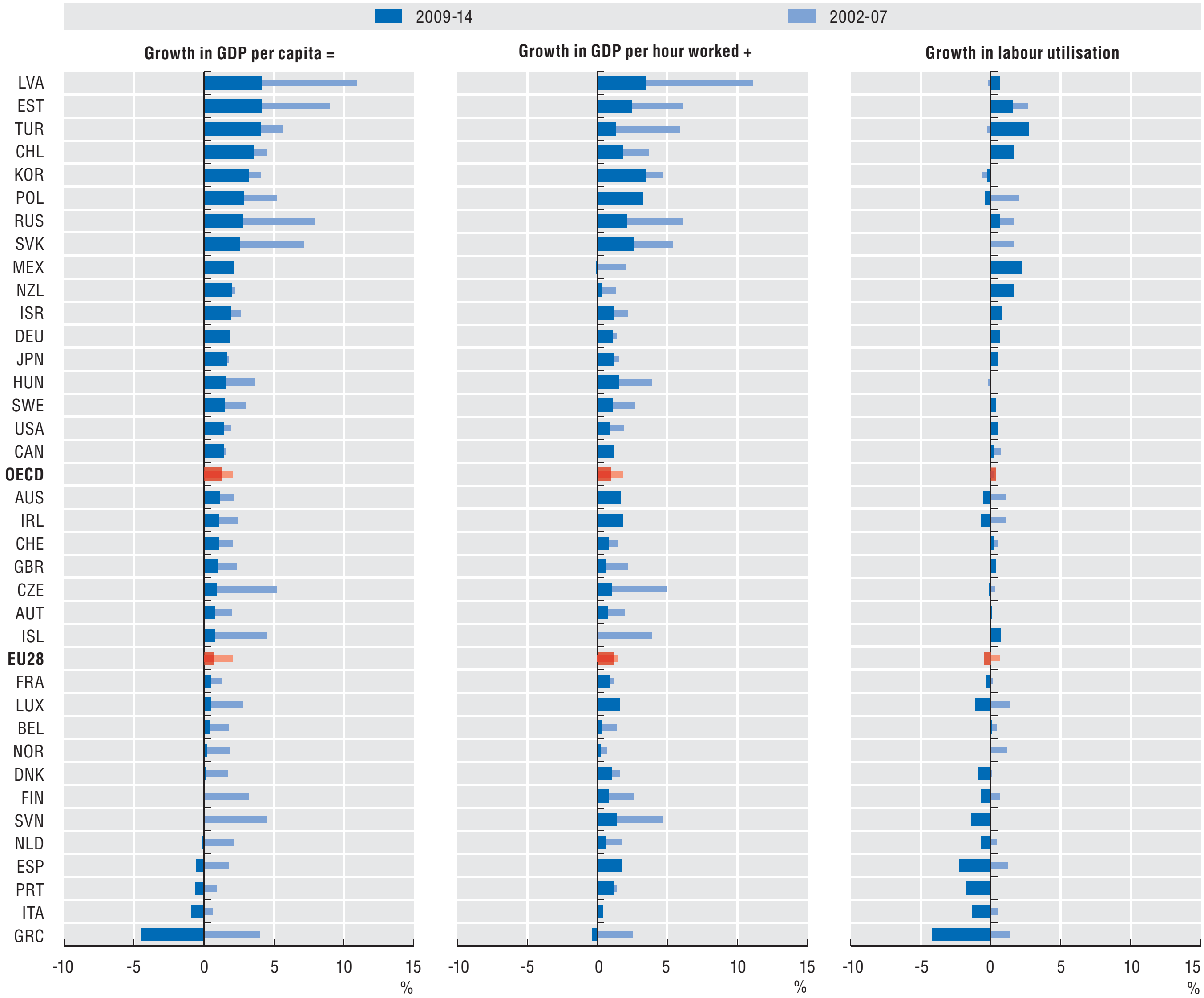
Sources of growth

Gross domestic product (GDP) per capita is a measure traditionally used to gauge a nation's welfare. Changes in this measure can result from shifts in labour productivity (GDP per hour worked) and labour utilisation (hours worked per employee and employment per capita). Differences in GDP per capita growth in OECD countries can be attributed mainly to differences in labour productivity growth, as labour utilisation has generally increased only marginally over the past 15 years. The picture changed slightly following the onset of the financial crisis. In some countries, the decline in GDP per capita resulted not only from slower productivity growth, but also from substantial declines in labour utilisation. These were due mainly to falls in employment and hours worked per person, while labour force participation remained broadly unchanged. In 2010, widespread growth signalled the start of a global recovery. However, the pace of recovery varies across the OECD and obliges countries to find new and sustainable sources of growth.

21. Decomposition of growth in GDP per capita, 2002-07 and 2009-14

Total economy, annual percentage change



Source: OECD, *Productivity Database*, *www.oecd.org/std/productivity-stats*, May 2015. See chapter notes.

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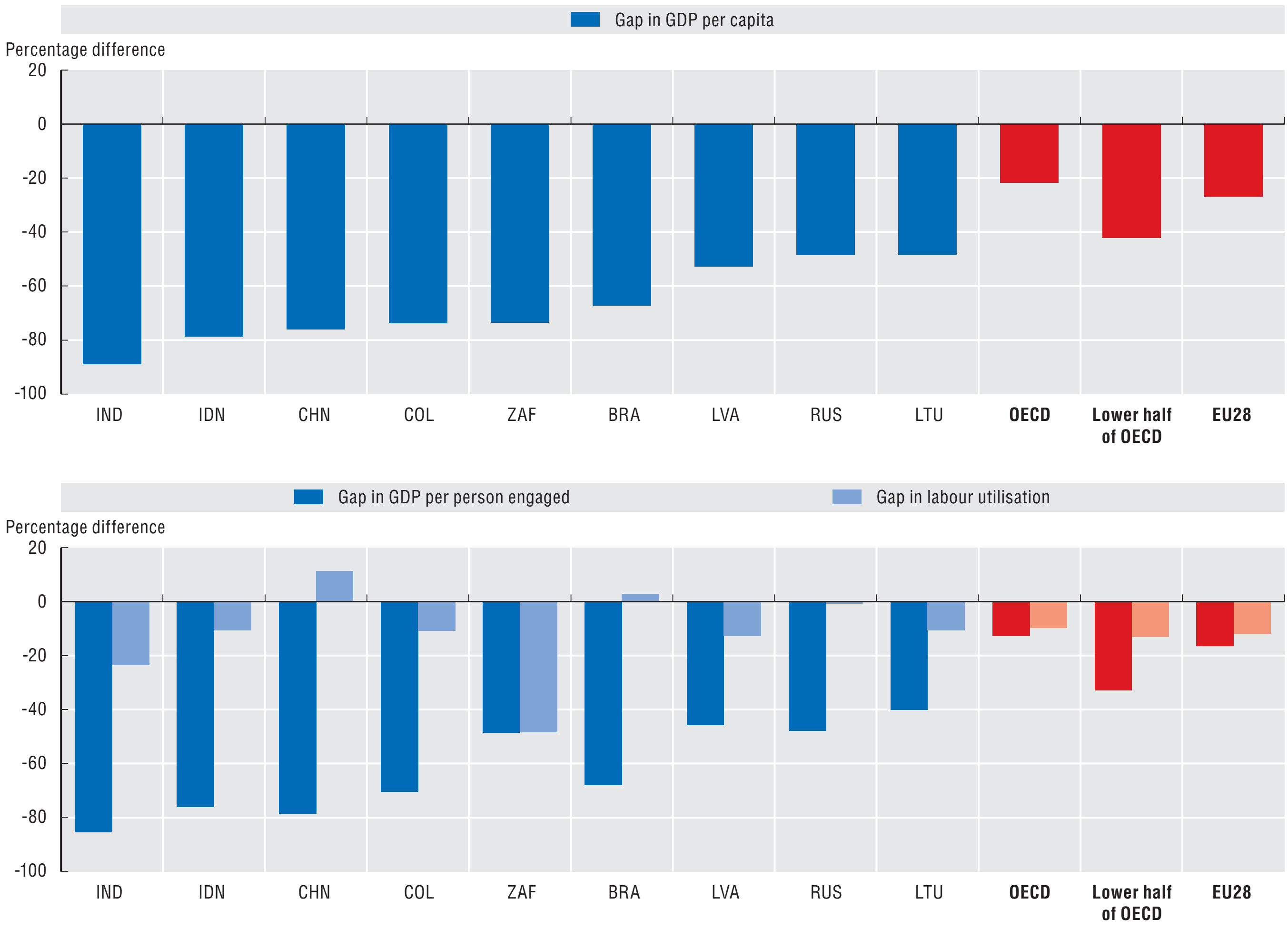
Sources of growth

Decomposition of GDP per capita highlights the importance of labour productivity in explaining the cross-country dispersion in income per capita. Despite rapid convergence among some BRIICS economies, income gaps persist with respect to the top half of OECD countries ranging from 49 and 89 percentage points (or 6 and 47 percentage points with respect to the lower half of the OECD). These gaps are due mainly to large labour productivity shortfalls compared to the United States. Among BRIICs countries, China's GDP per capita soared during the years of the crisis, drawing closer to the upper half of OECD over 2008-14, although it grew at a slower pace than in the preceding five years. The income gap is attributable to lower output per worker, as participation rates are above those in OECD countries. In Brazil, the GDP per capita gap is diminishing gradually but remains significant, due mainly to comparatively weak labour productivity performance (OECD, 2015c).

22. Gap in GDP per capita, in GDP per person employed and in labour utilisation, non-OECD economies, 2014

Percentage points differences with respect to the top half of the OECD



Source: OECD, *Productivity Database*, *www.oecd.org/std/productivity-stats*, May 2015. See chapter notes.

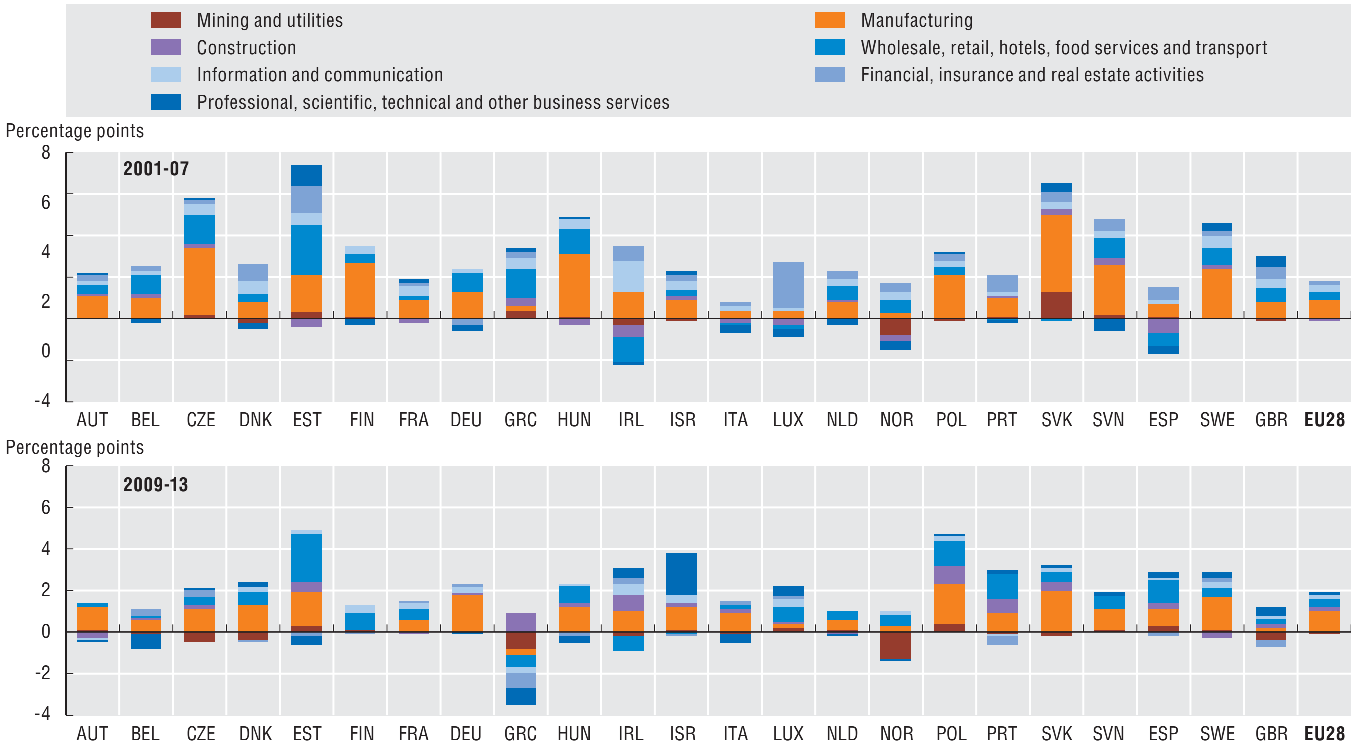
StatLink http://dx.doi.org/10.1787/888933272974

Labour productivity in sectors

Understanding the drivers of productivity growth at the total economy level requires an awareness of the contribution made by each industry. An individual sector's contribution depends not only on its productivity growth, but also on its share in total value added and employment. In the years up to the economic crisis (2001-07), productivity growth was driven almost entirely by increased productivity in manufacturing and by the increasing share of business services in overall activity. Excluding real estate, business-sector services accounted for 35% to 50% of value added across OECD countries. In European countries for which data are available, labour productivity growth decreased following the onset of the financial crisis in 2008, with this decline spread broadly across sectors. After 2008, changes in sector contributions seem to have been driven primarily by changes in sector productivity growth, rather than reallocation across sectors.

23. Decomposition of labour productivity growth by industry, 2001-07 and 2009-13

Contributions to average annual percentage change in non-agriculture business sector



Source: OECD, *Productivity Database*, *www.oecd.org/std/productivity-stats*, May 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933272986

Measuring labour productivity by sector

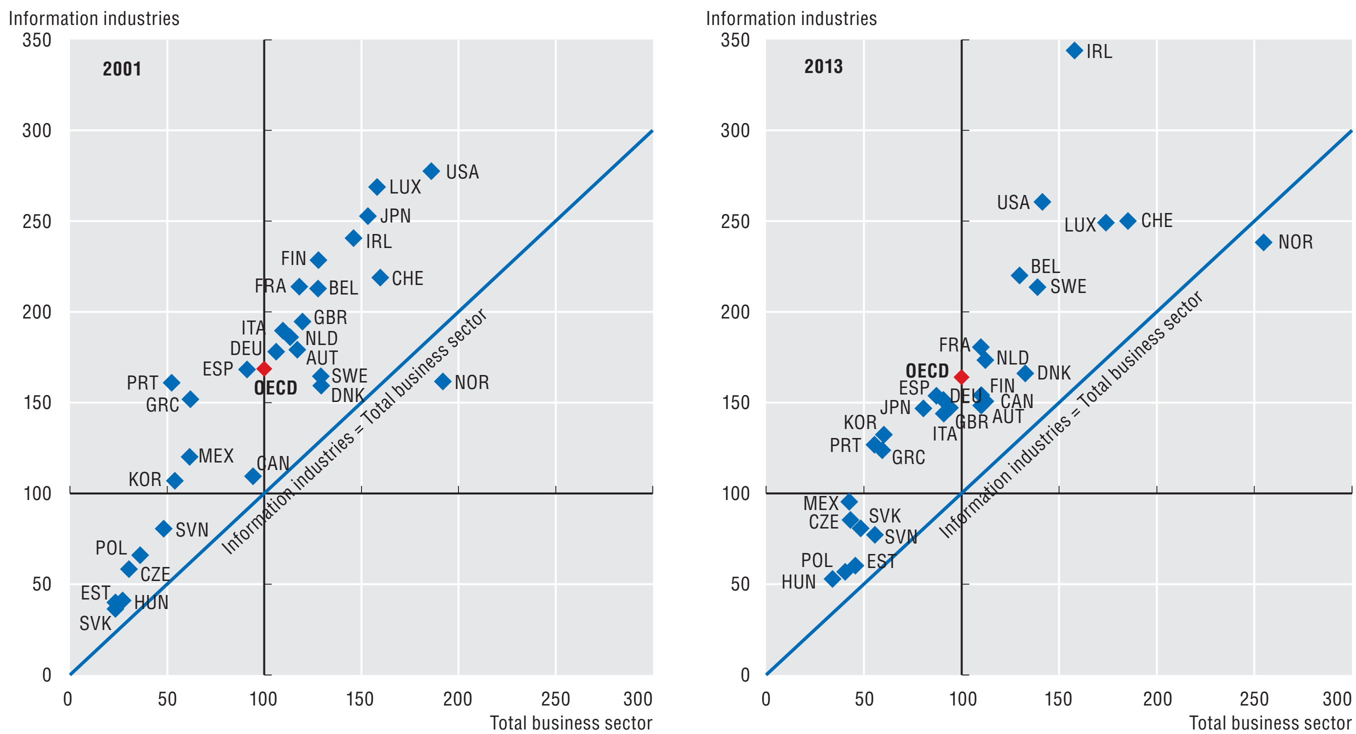
Labour productivity growth is defined as the rate of growth in real value added per hours worked. Differences in labour productivity growth across sectors may relate, for instance, to the intensity with which sectors use capital (including knowledge-based capital and skilled labour) in their production, the scope for product and process innovation, the degree of product standardisation, the scope for economies of scale, and involvement in global value chains. The comparability of productivity growth across industries and countries may be affected by problems in measuring real value added. This is particularly relevant for services, as price effects are difficult to isolate due to changes in the quality or mix of services from pure price changes. Despite the substantial progress made over the past ten years in compiling service producer price indices (SPPIs), the methods used to compute real value added still vary across OECD countries. Estimates of real value added in some industries are based on a sum-of-costs approach, which deflates, using assumptions about labour productivity growth, compensation of employees. For example, most countries assume no change in labour productivity for public administration activities; as such, this sector is not included here. Real estate services are also excluded, as the output of this sector reflects mainly the imputation made for the dwelling services provided and consumed by homeowners. In addition, sectors such as construction and several services are characterised by a high degree of part-time work and self-employment, which can affect the quality of estimates of actual hours worked. See OECD (2015), *OECD Compendium of Productivity Indicators 2015*.

Labour productivity in sectors

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, across the OECD area labour productivity in the information industries is more than 60% higher than in the total business sector, comparable to similar levels in 2001 at the height of the "new economy". This figure is higher than the total business sector average for the majority of OECD countries for which data are available. Ireland displays the highest labour productivity, driven in particular by growth in productivity of ICT services and in part by the presence of several US multinational headquarters in the ICT field, with high value added but few employees. The United States has the highest labour productivity in ICT manufacturing.

24. Labour productivity in information industries, 2001 and 2013

OECD total business sector = 100



Note: "Information industries" cover ISIC Rev. 4 Division 26, Manufacture of computer, electronic and optical products and Section J, Information and communication services, which consists of Publishing activities (Division 58), Audiovisual and broadcasting activities (59-60), Telecommunications (61), and IT and other information services (62-63). This aggregate covers both the ICT sector and the Content and Media sector as defined by the OECD, see OECD (2011).

Source: OECD, *Annual National Accounts Database* and *Structural Analysis (STAN) Database*, ISIC Rev. 4, *http://oe.cd/stan*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933272994

How to read this figure

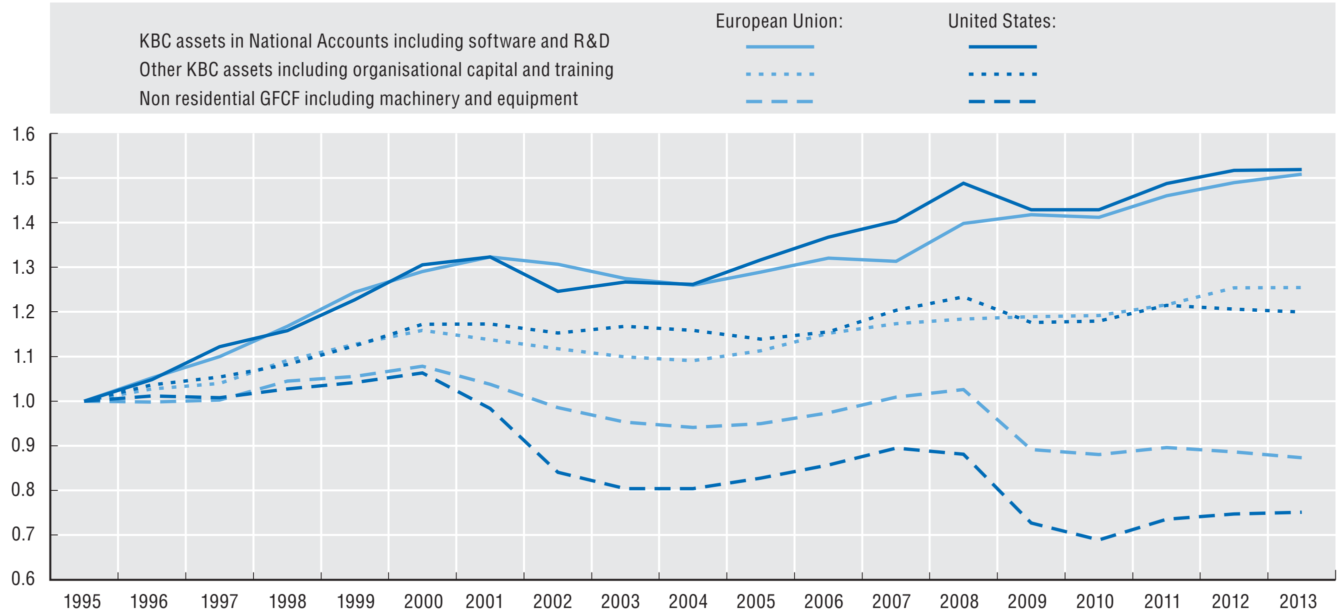
For values along the diagonal the labour productivity of information industries is equal to that of the total business sector. In all countries except for Norway, information industries have higher than average business sector labour productivity (countries are positioned above the diagonal). In 2001, labour productivity in OECD information industries was almost 69 percentage points higher than in the OECD total business sector and 64 percentage points higher than 2013 (red marks). Countries to the left (to the right) of the value 100 for the X axis have lower (higher) business sector productivity than the OECD average. In 2013, information industries in Ireland and the United States had the highest labour productivity.

Knowledge-based capital

Productivity is driven by innovation. This process relies not only on investment in research and development (R&D), but also on complementary assets such as software, design and human capital. In addition, it relies on the organisational capabilities of firms, specifically their ability to co-ordinate and manage production across global value chains, and on firm-specific training that enables workers to cope with change while improving productivity. Over the last two decades, businesses in a range of countries have increased their investment in knowledge-based assets, often at a faster pace than investment in traditional physical capital. While the latter decreased after 2000 – at a more marked pace in the United States than in Europe – business investment in KBC grew faster, or did not decline to the same extent, throughout the period. By 2011, KBC growth paths in both areas had returned to pre-crisis levels. This characteristic of aggregate investment in KBC may depend partly on the nature of the expenditures measured, primarily wages, which tend to be stickier than other forms of business expenditures.

25. Knowledge intensity of business investment, selected EU economies and the United States, 1995-2013

Business sector investment by type of asset, as a percentage of gross value added, index 1995 = 1



Source: OECD calculations based on INTAN-Invest data, *www.intan-invest.net* and OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273008

What do we mean by "knowledge-based capital"?

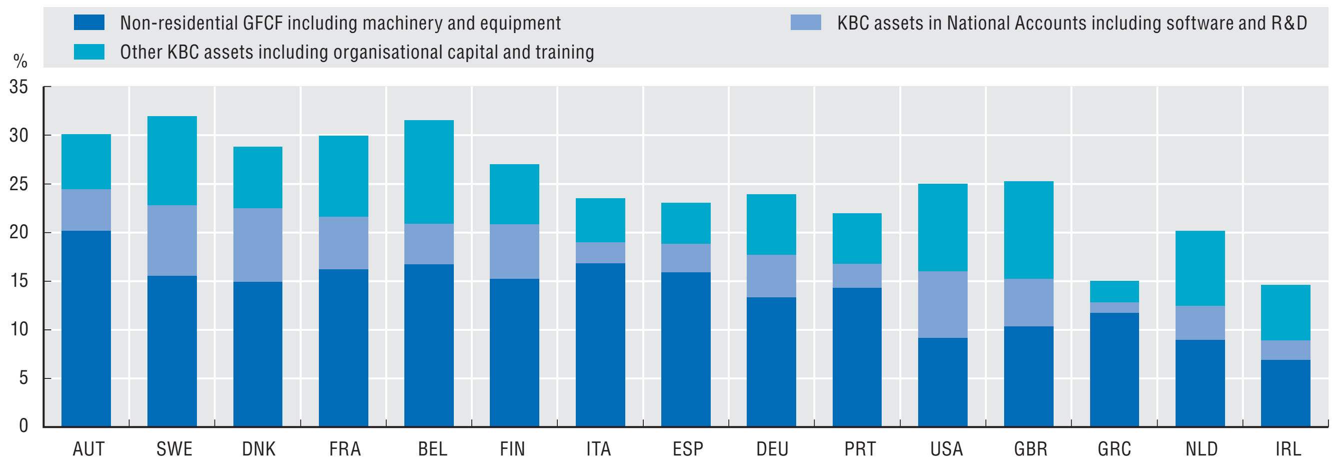
Knowledge-based capital (KBC), sometimes referred to as "intangible assets" or "intellectual capital", constitutes a long-lasting resource for companies and institutions. KBC assets are not physical in nature and their main value stems from their knowledge content and their ability to add value to other assets. The generation and accumulation of KBC result mostly from investment in human capital (i.e. people and their education, abilities, creativity and capacity for innovation). Following a widely used classification proposed by Corrado et al. (2009), investment in KBC can be subdivided into three main groups: computerised information (e.g. software and databases); innovative property (e.g. scientific and non-scientific R&D, copyrights, designs and trademarks); and economic competencies (including brand equity, aspects of advertising and marketing, firm-specific human capital, and organisational know-how and capabilities). Some KBC types have recently been recognised by the international statistical community as capital assets and are now accounted for in the *System of National Accounts* (SNA), underlining their importance. KBC assets consistent with the SNA definition include: software, R&D, entertainment, literary and artistic originals, and mineral exploration. Other KBC assets such as design, new product development in the financial industry, brands, firm-specific training and organisational capital have in recent years been at the centre of methodological work aimed at measuring these assets in an internationally comparable way. While much has been done to underpin these new sources of growth, future measurement work will need to address the pricing of these assets, the rate at which they depreciate, and the extent to which investment in different assets overlap. As firms within and across industries differ in their investment behaviours, additional work will be needed to measure and study investment patterns at the firm and industry levels. Such efforts will help to inform policy design to leverage these sources of growth, their specificities and their complementarities.

Knowledge-based capital

The importance of knowledge-based capital (KBC) for productivity and economic growth has been widely recognised, with firms in many OECD countries investing as much or more in KBC as they do in physical capital (machinery, equipment and buildings). In 2013, in the United States and the United Kingdom, investment in all types of KBC amounted to about 1.5 times investment in fixed assets. In contrast, investment in KBC in countries such as Italy and Spain amounted to less than half of investment in fixed assets. This proportion increased to about 80% in France and Germany and to about 90% or more in Denmark and Sweden. These investment patterns mirror the industrial structure of economies and differences in the knowledge intensity of sectors. Two main trends emerge when comparing 1995 and 2013 industry-specific KBC investment patterns: all sectors saw their median knowledge capital intensity increase, confirming the total business sector trends, and these increases were more heterogeneous, as indicated by the greater differences shown in the sector-specific intensities of top and bottom quartiles. This is partly explained by the crisis that hit sectors to a different extent and in particular sectors such as finance and construction. Organisational competences and design explain the relatively high knowledge intensity in the construction sector.

26. Business investment in fixed and knowledge-based capital, selected economies, 2013

As a percentage of business sectors' gross value added

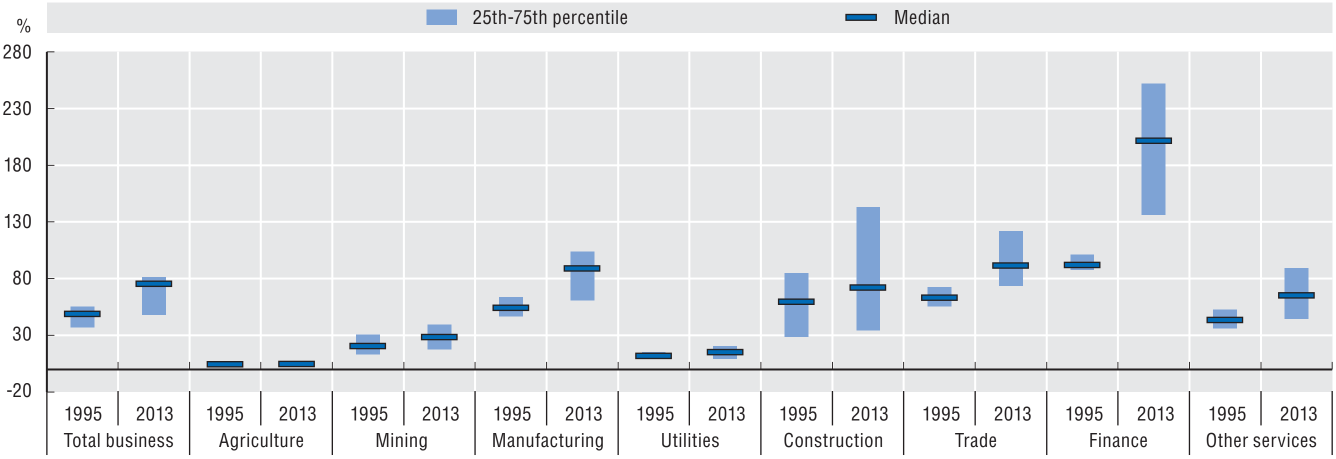


Source: OECD calculations based on INTAN-Invest data, *www.intan-invest.net* and OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273011

27. Knowledge capital intensity by sector, selected economies, 1995 and 2013

As a percentage of sectors' gross fixed capital formation



Source: OECD calculations based on INTAN-Invest data, *www.intan-invest.net* and OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan*, June 2015. See chapter notes.

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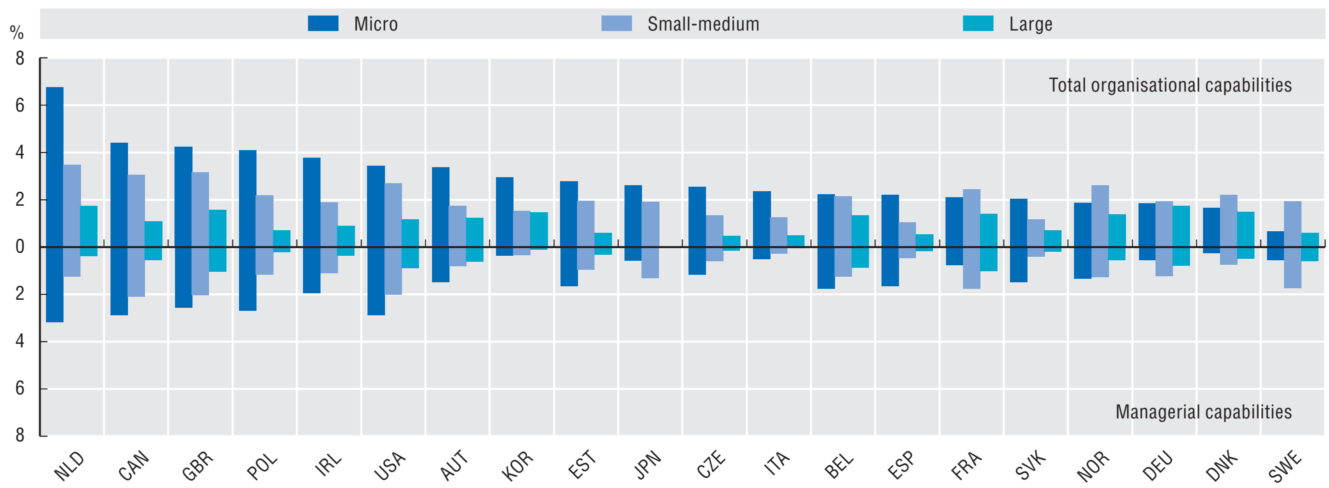
Organisational assets and training

The ways in which companies are organised, the skills of different workers and the tasks and functions they accomplish, and the extent to which knowledge is generated, codified, shared and used, are among the most important drivers of firm's performance and ability to compete and succeed on the market. Indicators based on a new OECD experimental methodology suggest that in most economies, micro and small and medium-sized enterprises (SMEs) invest a larger proportion of their value added in organisational and managerial capabilities than large firms. While seemingly counterintuitive, this result mirrors the fact that a number of organisational and strategic functions need to be accomplished regardless of company size (e.g. planning sales, identifying and comparing possible suppliers), and hence their incidence over total value added is proportionally higher the smaller the firm. In micro firms and SMEs, more than 50% of investment in organisational capabilities corresponds to managers, whereas this share decreases to 45% in large firms, where the importance of organisational profiles other than managers (e.g. production supervisors) is more pronounced.

28. Investment in organisational and managerial capabilities by size, 2011-12

As a percentage of country-wide value added in the size category



Source: OECD calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan*; OECD, *Structural and Demographic Business Statistics (SDBS) Database* and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273038

What do we mean by "organisational capital"?

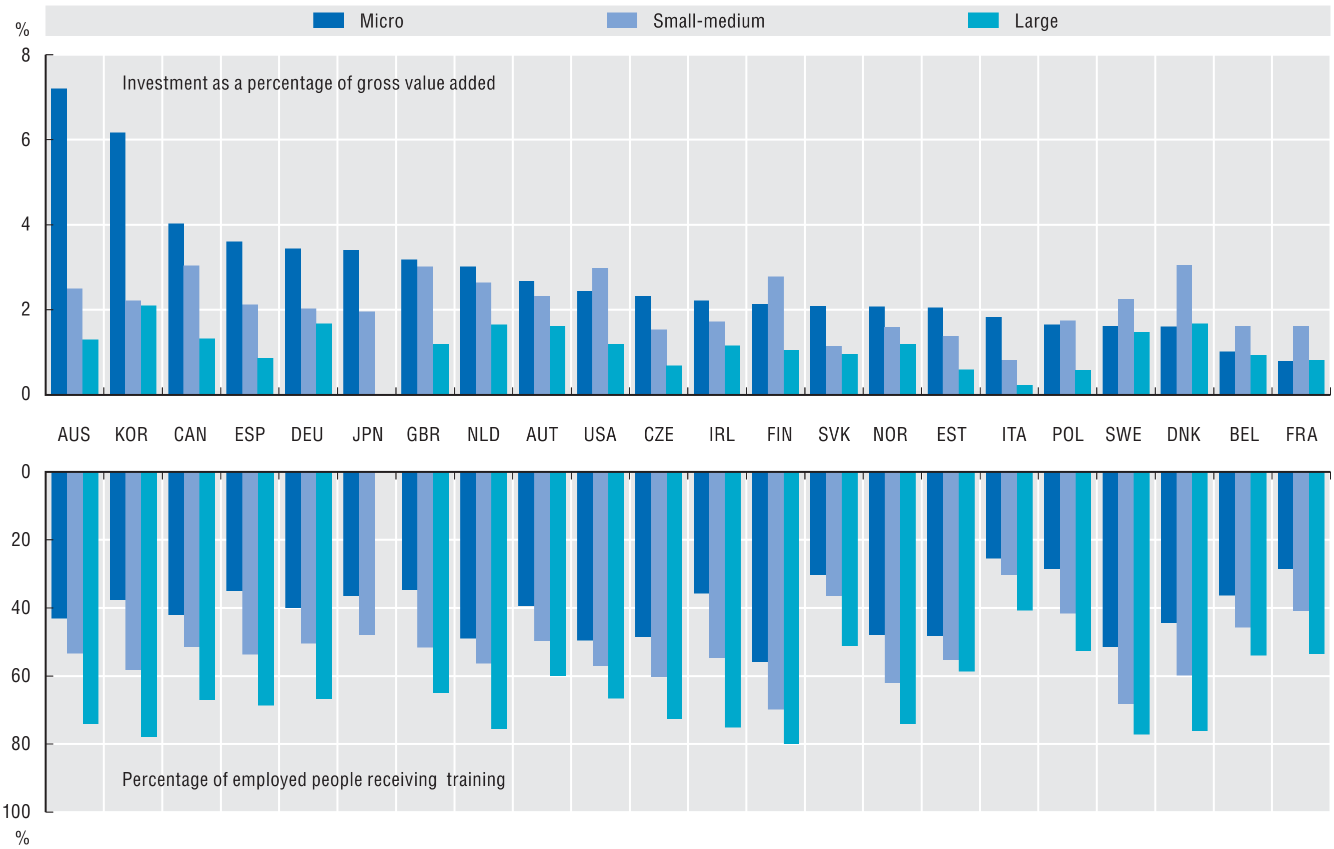
Organisational capital (OC) is firm-specific human capital, i.e. workers such as managers, supervisors and professionals who carry out tasks and activities that affect the medium and long-term functioning and performance of firms. Organisational capital workers perform tasks that involve to varying degrees: developing objectives and strategies; organising, planning and prioritising work; building teams, matching employees to tasks and providing training; supervising and co-ordinating activities; and communicating across and within groups to provide guidance and motivation. Organisational capital-related workers have been identified using information from the Programme for the International Assessment of Adult Competencies (PIAAC) regarding the frequency with which workers in different occupations perform OC-related activities. Occupations contributing to the generation and accumulation of organisational capital are those that perform such OC-related activities to the highest extent, and do so much more than workers in other occupations. Estimates of investment in organisational capital assume that OC workers on average dedicate one day a week of their work to strategic and organisation-related activities intended to shape the long-term functioning of firms. The corresponding proportions of these workers' salaries are accounted for as investment. Crucially, it is the impact of OC activities on the organisation and performance of the firm in future years, as well as in the year in which expenditures are incurred, that makes it a capital asset. The experimental methodology on which estimates rely (see Le Mouel and Squicciarini, 2015) also addresses country specificities in terms of occupational profiles generating organisational capital, and differences emerge with respect to the occupational profiles that most contribute to the generation of organisational capital within and across industries and countries. Firms' organisational capabilities are embodied in managers, albeit not exclusively, as most of the tasks traditionally carried out by managers have been progressively devolved to non-managerial occupations, due to a general move towards the decentralisation of responsibilities and less hierarchical organisational structures.

Organisational assets and training

Training helps to improve and maintain the human capital of firms by endowing workers with the skills and knowledge needed to perform on the job and adapt to change. Training also increases the productivity of workers and thus enhances the performance and productivity of firms. While the percentage of workers receiving on-the-job training is comparatively higher in large firms in all the economies considered, the percentage of value added invested in training is generally higher for micro and small and medium-sized companies than for large enterprises. In small firms, having one of few employees devoting time to training rather than work entails allocating relatively bigger shares of productive resources to it. The cases of France, Sweden and Denmark are notable, where investment in organisational capital and on-the-job training is highest for SMEs. Factors such as the industrial structure and specialisation of economies, the skill endowment of the workforce, and participation in global value chains all contribute to shaping investment patterns in training and organisational capital.

29. Investment in firm-specific on-the-job training, by firm size, 2011-12

Employees and investment in the respective size category



Source: OECD calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan*; OECD, *Structural and Demographic Business Statistics (SDBS) Database* and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273041

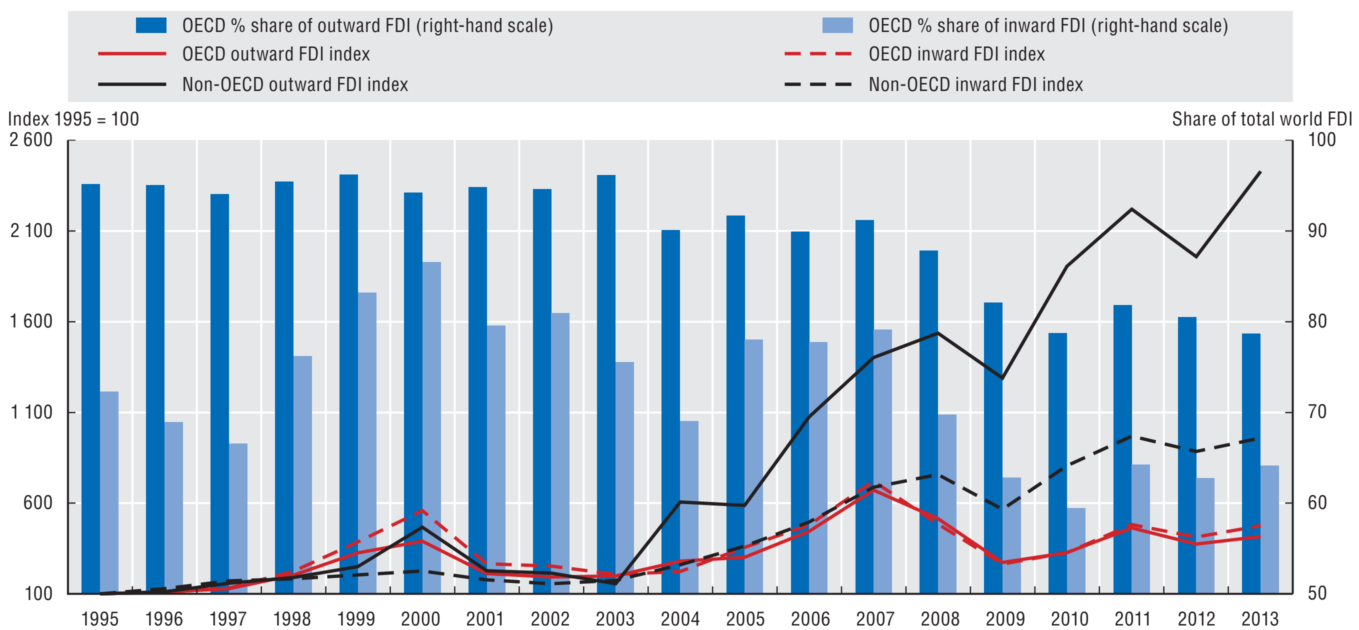
How to read this figure

The bottom panel of the figure shows that more than 40% of workers in micro firms in Australia underwent on-the-job training in 2012, as compared to more than 50% in small and medium-sized enterprises, and almost 80% in the case of large firms. However, based on estimates that take into account information regarding the length of training, the kind of workers benefitting from it and other factors, the figure in the top panel shows that micro firms invest more than 7% of their value added in training. This share is much larger than for SMEs and large companies, which invest 2% and 1%, respectively, of overall value added generated by companies in the same size class.

FDI shifting East

Foreign direct investment (FDI) may provide recipient countries with access to new technologies and generate employment opportunities and knowledge spillovers for domestic firms. Since the mid-1990s, foreign direct investment (FDI) has grown at a faster pace than international trade in goods and services. Although most flows still take place within the OECD, the landscape has changed dramatically in the past decade. Until 2003, around 95% of FDI outflows originated from OECD countries, but over the past decade their share has fallen below 80% owing to the spectacular rise in overseas investment by emerging economies. The impact of the 2008 crisis on FDI flows varied across countries. Non-OECD economies overall experienced a sharp reduction (about 20%) in inward and outward flows in 2009, followed by an immediate recovery. In the OECD area as a whole, inward and outward flows fell in 2008 and still remained short of pre-crisis levels in 2013, despite a smooth recovery in 2011. The OECD share of total world outward FDI decreased following 2011, while the share of inward flows remained relatively stable.

30. Trends in world foreign direct investment flows, 1995-2013



Source: IMF, *Balance of Payments Database*, July 2015. See chapter notes.

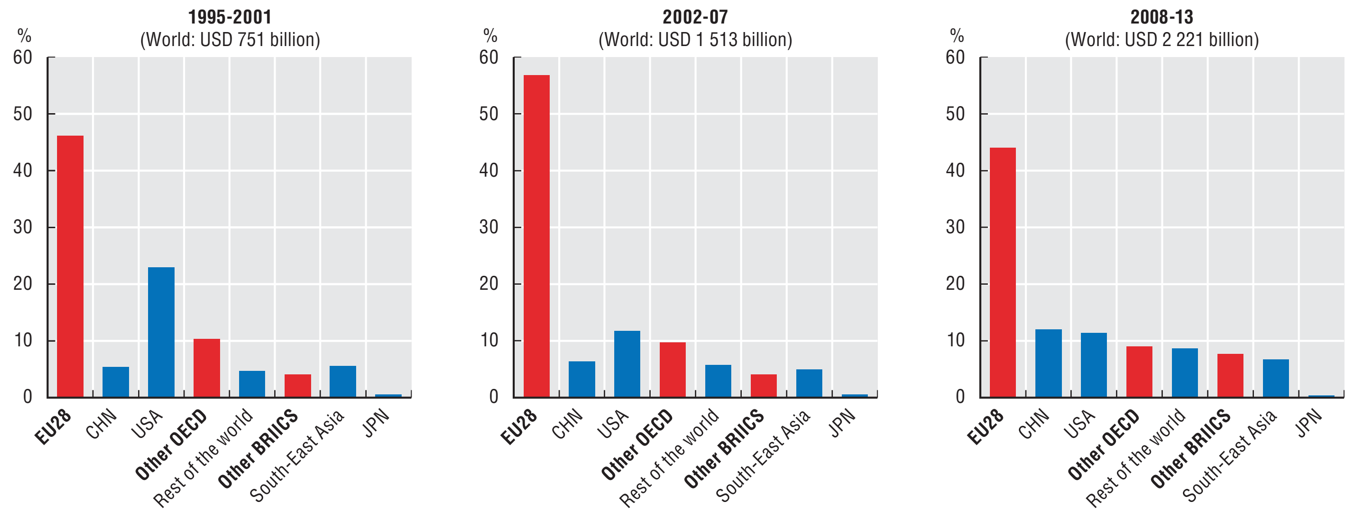
StatLink http://dx.doi.org/10.1787/888933273057

FDI shifting East

FDI flows worldwide have tripled over the past two decades. FDI inflows to Europe today still exceed those to the rest of the world, but FDI flows to China and the rest of Southeast Asia have risen from an average of about USD 83 billion a year in 1995-2001 to about USD 417 billion a year in 2008-13. China was the largest non-OECD FDI recipient in 2013, with a twofold increase in average annual inflows over 2008-13. Since 2009, the total amount of FDI inflows to China has exceeded those to the United States at about USD 350 billion against USD 300 billion in 2013. Rising global FDI outflows are still driven mostly by OECD countries, however FDI outflows from BRIICS increased substantially as they have become more integrated into the global economy. Overall, outward flows from BRIICS have more than tripled between 2002-07 and 2008-13.

31. Foreign direct investment inflows, yearly averages, 1995-2001, 2002-07 and 2008-13

As a percentage of world total FDI inflows

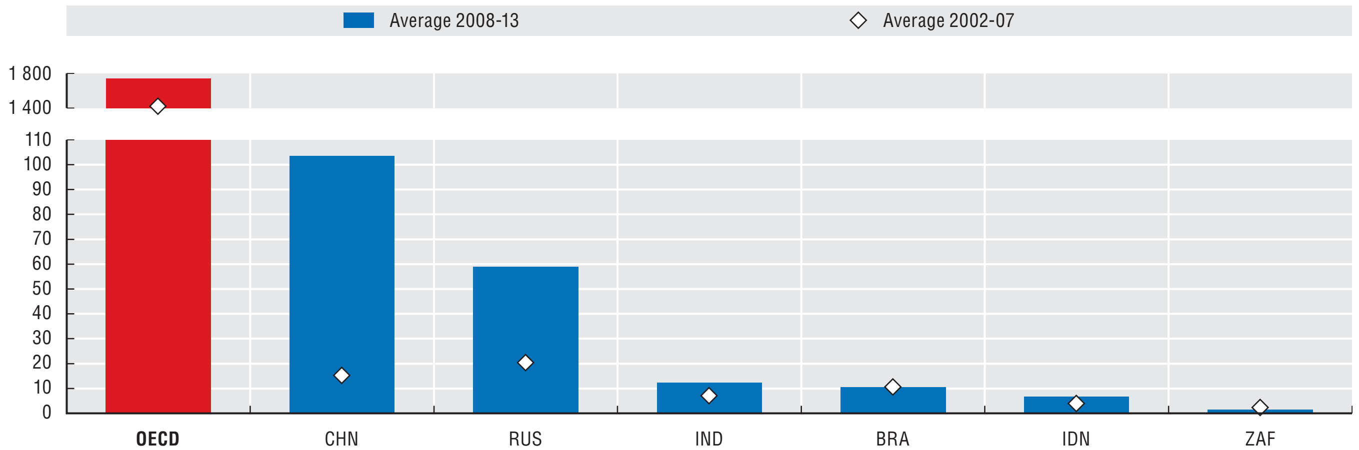


Source: IMF, *Balance of Payments Database*, July 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273065

32. Foreign direct investment, outward flows from BRIICS, 2002-07 and 2008-13

Billions of USD, current exchange rates, yearly averages



Source: IMF, *Balance of Payments Database*, July 2015. See chapter notes.

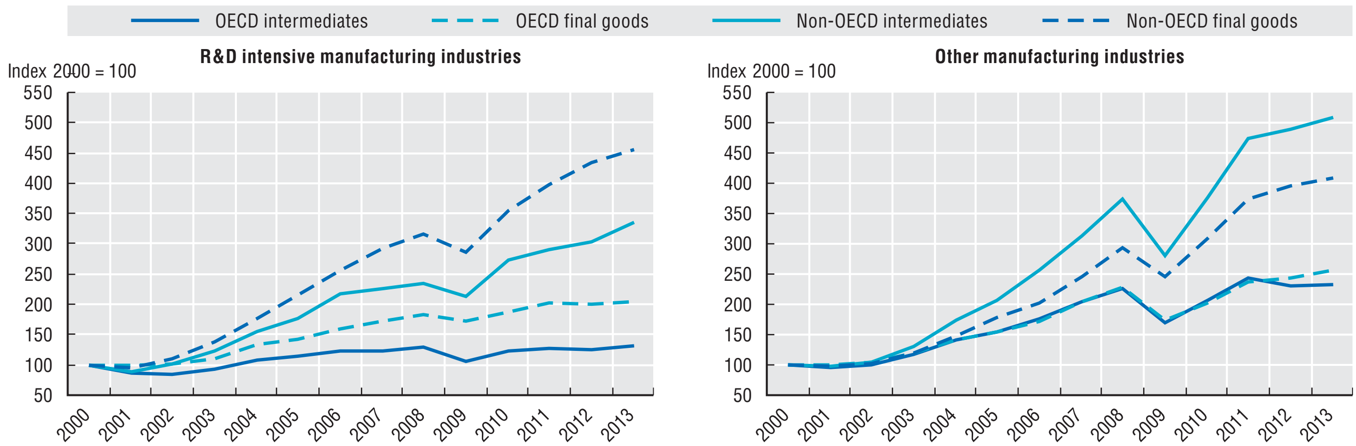
StatLink http://dx.doi.org/10.1787/888933273072

The fragmentation of production

Despite the 2009 slump in world trade triggered by the financial crisis, the value of global exports of manufactured goods increased nearly threefold between 2000 and 2013, with growth in exports from emerging economies easily outpacing that of OECD countries. This was particularly the case for R&D-intensive manufacturing industries, with the OECD member countries' share falling from 73% to 55% between 2000 and 2013, due mainly to a decline in exports of intermediate products from R&D-intensive industries. The sharp increase in global trade in intermediates since 2000 has been driven by the activities of non-OECD economies and, for R&D-intensive intermediate manufactured goods, the value of exports from non-OECD economies now outweighs exports for the total OECD area. While increasing international fragmentation of production over the last two decades has led overall to faster growth in trade for intermediates than final goods, this has not been the case for R&D-intensive manufacturing. A possible indication that, while fragmentation of production of upstream inputs has increased, R&D-intensive industries themselves tend to be more concentrated than other industries, and that the faster growth in the value of R&D-intensive final products reflects the increasing knowledge intensive services used in their production.

33. Exports of intermediate and final goods from R&D-intensive manufacturing industries, 2000-13

Index 2000 = 100



Source: OECD, *Bilateral Trade Database by Industry and End-use (BTDIxE)*, *http://oe.cd/btd*, June 2015. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888933273084*

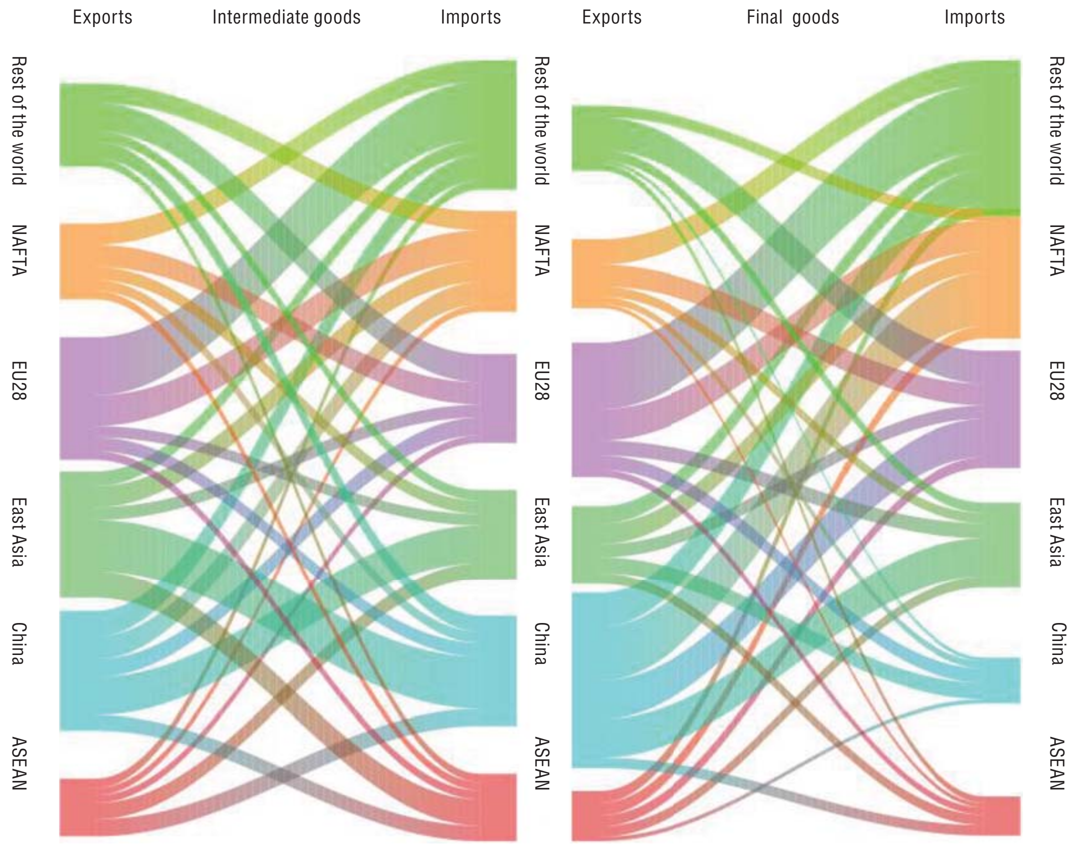
Measuring bilateral trade by industry and end use

Bilateral merchandise trade statistics are generally compiled at detailed product levels according to classifications such as the Harmonised System (HS) which are regularly revised to take account of changing technologies and other emerging needs. To estimate bilateral trade in goods by industry and end-use categories (i.e. intermediate, consumption and investment), standard conversion keys can be applied to map merchandise trade data to industry and end-use classifications. This approach is followed to generate the OECD's *Bilateral Trade Database by Industry and End-use* (BTDIxE). The conversion keys map each 6-digit HS product to the single industrial activity, defined according to the International Standard Industrial Classification of All Economic Activities (ISIC), which is considered as the typical source of the product. This approach may induce biases, as firms allocated to a particular ISIC industry according to principle activity may export a wide range of products. Furthermore, it may prove difficult to separate some final products into consumption and investment goods. For this reason, mixed end-use categories are used in BTDIxE to cover, for example, personal computers and passenger vehicles. Certain traded products allocated as final goods (e.g. shirts) may also be considered as intermediates when imported (e.g. to add brand labels). Despite these caveats, BTDIxE can provide insights into the international fragmentation of production by tracking flows of intermediate and final goods by detailed levels of industry. R&D-intensive industries are defined according to ISIC Rev. 4: Pharmaceuticals (Division 21), Computer, electronic and optical products (Division 26) and Air and spacecraft and related machinery (Group 303). For more information please refer to OECD, Bilateral Trade Database by Industry and End-use Category (BTDIxE), OECD, February 2015: *www.oecd.org/sti/ind/BTDIxE_2014.pdf*.

Fragmentation of production

International fragmentation of production has expanded rapidly over the last two decades with production processes in many economies specialising in specific tasks and activities. Tracking trade in manufactured goods separated into intermediate and final products can provide an overview of how these processes translate into inter-regional linkages. Visualisation of these networks reveals that the largest inter-regional flows of intermediate goods occur between East Asia, China and ASEAN economies, as "Factory Asia" consolidates its role in the global economy. China is the dominant supplier of manufactured final goods to East Asia, the European Union and North America. Meanwhile, the European Union and North America remain strong trading partners in both intermediate and final goods. For China and the European Union, the value of exports of final manufactured goods is greater than their intermediate imports, while for ASEAN, East Asia and North America, exports of final products are less than their imported intermediates. This reflects variations in the import content of exports to other regions and variations in imported intermediates to meet intra-regional demand for final goods. Indicators of Trade in Value Added (TiVA) provide deeper insights into these phenomena, but detailed gross bilateral trade by industry statistics can still highlight the magnitude and complexity of networks induced by global production.

34. Global manufacturing trade networks: Flows of intermediate and final manufactured goods by area, 2013



Source: OECD, *Bilateral Trade Database by Industry and End-use (BTDIxE)*, *http://oe.cd/btd*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273094

How to read this figure

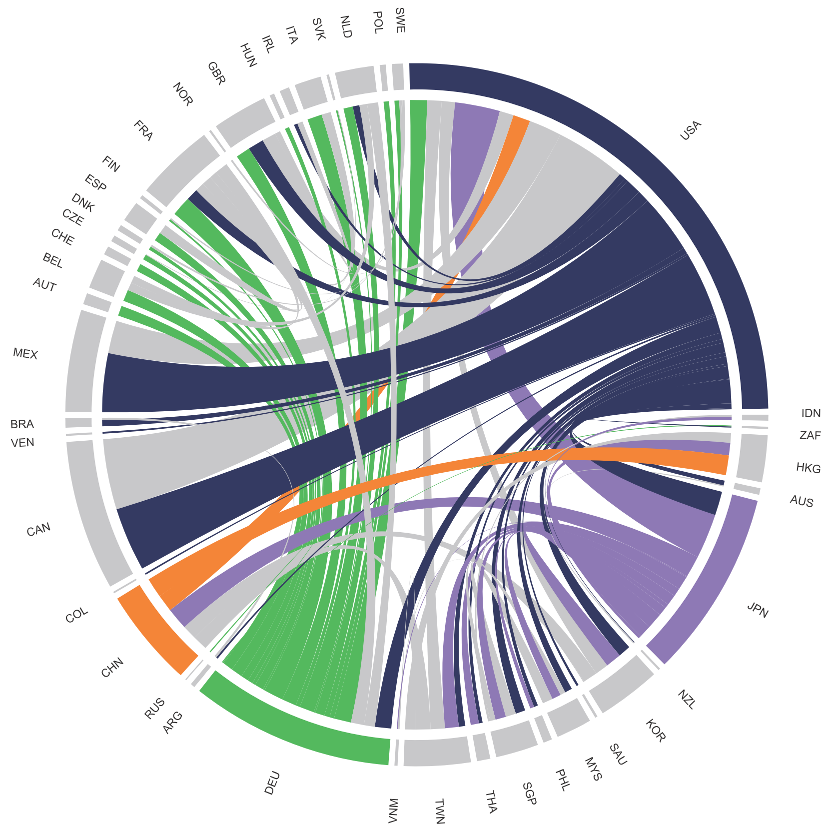
The figure is based on reported USD values for imports of manufactured goods by region. Only inter-regional flows are considered while intra-regional flows are excluded. The width of each connection is proportional to the size of the trade flow. For example, the EU28 to China connections represent about USD 100 billion, while the flow of final goods from China to NAFTA represents about USD 400 billion.

Global manufacturing networks

Comparing major bilateral flows of manufactured intermediate goods over the past 10-15 years can provide insights into the evolution of global value chains. Bilateral trade by industry and end-use data allow structural changes in international production networks to be highlighted across countries and regions. Each region has dominant suppliers providing manufactured parts and components to neighbouring economies. At the beginning of the 21st century, Germany, Japan and the United States were the major suppliers of intermediate goods. The United States reached beyond its North American partners to provide significant inputs into production in many European and East and Southeast Asian economies. Aside from being major suppliers to the United States, the main markets for intermediates produced in Germany and Japan were regional neighbours. In 2000, China was already a notable supplier of intermediates to the United States, on par with Germany but behind Japan.

35. Global manufacturing trade networks, major bilateral flows of manufactured intermediate goods, 2000

Selected flows by source country/region, USD at current prices



Source: OECD, *Bilateral Trade Database by Industry and End-use (BTDIxE)*, *http://oe.cd/btd*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273106

How to read these figure

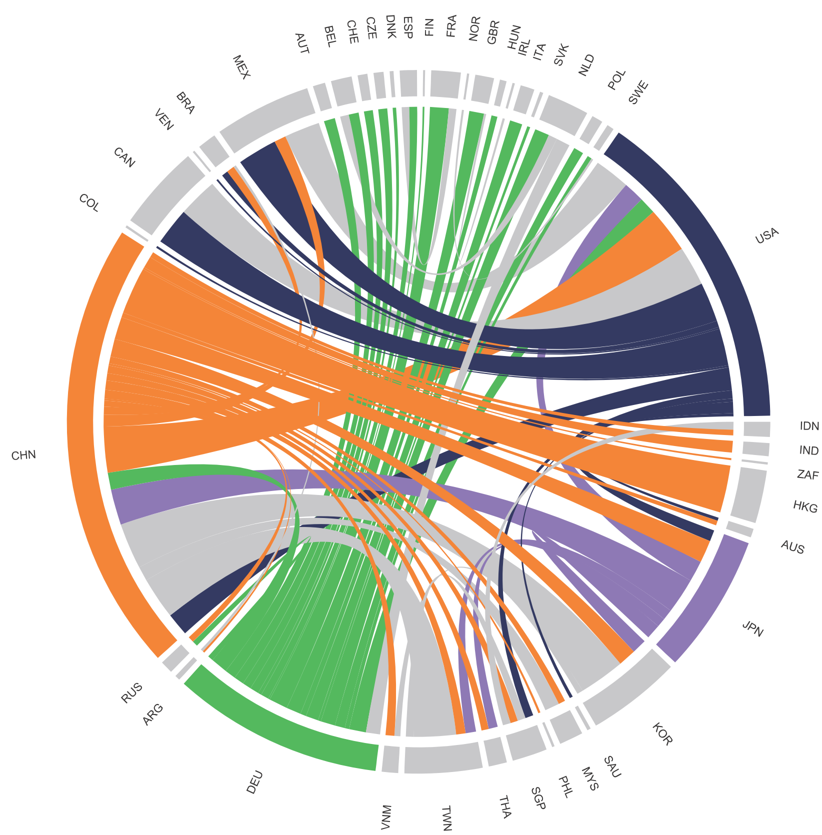
The flows are based on import data. For 2000, the flows shown represent partner country imports that are higher than USD 15 billion, or for which the partner share in a country's total imports is higher than 12%. Only significant import flows from China, Germany, Japan and the United States are highlighted with colour in these figures. For each country shown, the width of the arc on the circle is proportional to the sum of the export and import flows chosen according to the criteria.

Global manufacturing networks

By 2014, China had become a major supplier of manufactured intermediates for many countries, even surpassing Canada and Mexico to become the biggest supplier to the United States. As "Factory Asia" became more integrated and a major player in global production, China became a principal supplier of intermediates to many Southeast Asian economies further downstream in production chains, while remaining a major importer of intermediates from neighbouring economies (e.g. Japan, Korea, Chinese Taipei and Malaysia). Meanwhile, Japan and the United States have seen their relative role as global suppliers of intermediates reduced, while Germany has retained its role as the main supplier in Europe. These dynamic inter- and intra-regional movements of intermediate goods, representing about 50% of world trade in manufactures, highlight the importance of developing metrics to understand the true origins of final goods, and explain recent efforts to measure international Trade in Value Added (TiVA).

36. Global manufacturing trade networks, major bilateral flows of manufactured intermediate goods, 2014

Selected flows by source country/region, USD at current prices



Source: OECD, *Bilateral Trade Database by Industry and End-use (BTDIxE)*, *http://oe.cd/btd*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273116

How to read this figure

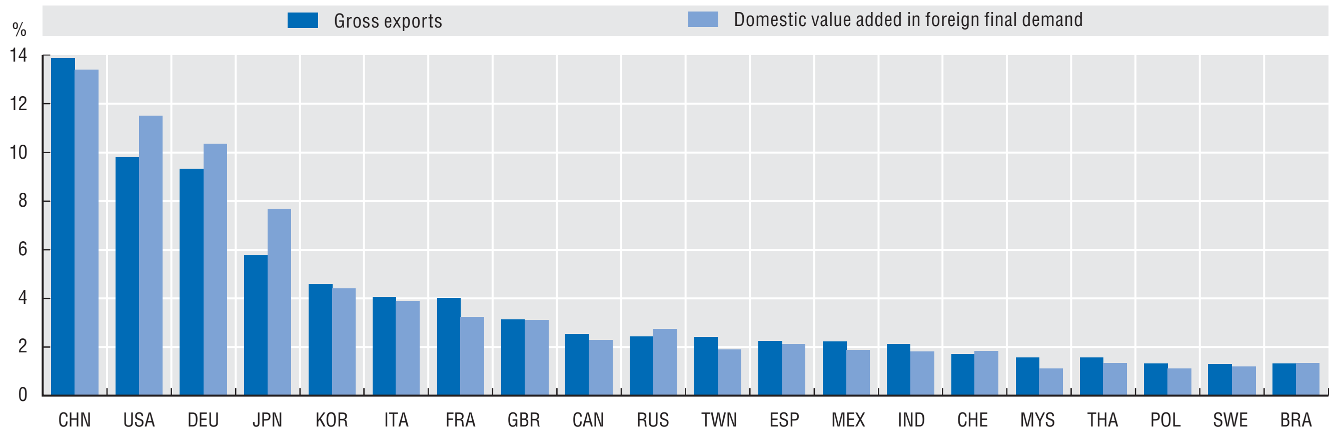
The flows are based on import data. For 2014, the flows shown represent partner country imports that are higher than USD 40 billion, or for which the partner share in a country's total imports is higher than 12%. Only significant import flows from China, Germany, Japan and the United States are highlighted with colour in these figures. For each country shown, the width of the arc on the circle is proportional to the sum of the export and import flows chosen according to the criteria.

Globalisation of manufacturing and services

The globalisation of production over the last 20 years has seen China emerge as the top exporter of manufactured goods. However, exporting firms not only import raw materials, parts and components to produce goods for export, but also purchase components from domestic producers which in turn import intermediate inputs for their production processes. It is therefore useful to supplement comparisons of gross exports with comparisons of international flows of value added. The latest release of the *Trade in Value Added (TiVA) Database* shows that China has also become the leading source of manufacturing value added for meeting foreign demand (i.e. when comparing economies' *domestic* value added from manufacturing activities embodied in *foreign* final demand). The United States, Germany and Japan have higher shares of global manufacturing exports when measured in value added terms owing to their exports of high-quality parts and components, which are subsequently embodied in other countries' exports.

37. Top 20 international suppliers of manufactured goods in gross export and value added terms, 2011

Percentage shares of total world manufactured goods



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015.

StatLink http://dx.doi.org/10.1787/888933273121

How to read this figure

The dark blue bars represent economies' shares of world gross exports of manufactured goods. Gross exports reflect traditional measures of exports which not only include value generated domestically, but also value originating from abroad embodied in imported intermediate goods and services used for production. The light blue bars represent economies' shares of domestic value added from manufacturing activities that meet foreign final demand. Often interpreted as "exports of value added" this indicator reveals the full upstream impact of final demand in foreign markets on domestic output.

What is the *Trade in Value Added (TiVA) Database?*

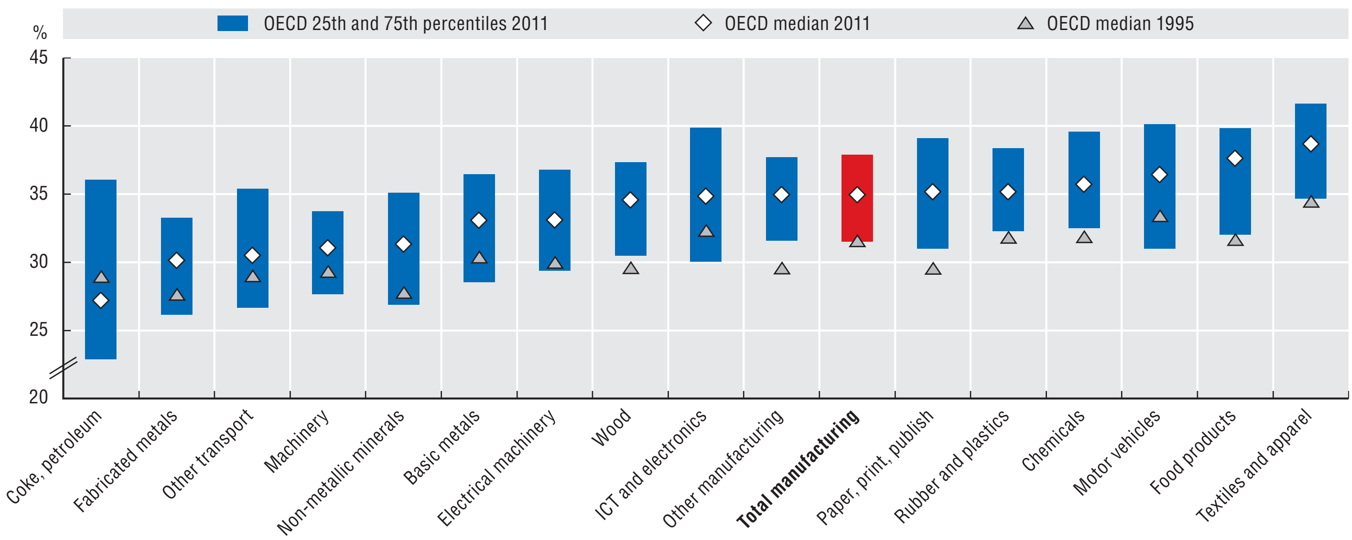
The *Trade in Value Added (TiVA) Database* facilitates analysis of global value chains by measuring trade in value added terms with a view to generating new insights about the commercial relations among economies and the process of value creation. The database is essentially a collection of indicators revealing the country and industry origins of value added embodied in exports of, and final demand for, goods and services. The calculations are based on the OECD's Inter-Country Input-Output (ICIO) tables (*http://oe.cd/icio*), which describe inter-industry and inter-country flows of goods and services for 34 industries and 61 countries, for the period 1995-2011, consistently linking production around the world to the final consumption of all countries. By applying country and industry-specific value added to output ratios it is possible to estimate value added content by industry and country along global production chains.

Globalisation of manufacturing and services

Services represent over 70% of GDP in most OECD countries, while reported exports of services account for just over one quarter of total OECD exports of goods and services. Accounting for the value added by services in the production of goods, however, shows that service sectors play a much more significant role in international trade. On average, the service value added content of total OECD gross exports is about 54% and exceeds 60% in some countries, such as France and the United Kingdom. The TiVA database provides insights into the role of services in global value chains by revealing, for example, the extent to which exports of manufactured goods depend on inputs from various service activities required to produce them. In 2011, over one third of the value of OECD exports of manufactured goods could be attributed to business sector services, having risen steadily since 1995. Business sector services content, which can be domestic or foreign in origin, varies across manufacturing industries and countries, but is generally within the range of 25% to 40% for OECD countries. Notable increases in business sector services content since 1995 are apparent across nearly all manufacturing sectors.

38. Business sector services value added in OECD manufacturing exports, by industry, 1995 and 2011

Range of values as a percentage of gross exports



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273134

How to read this figure

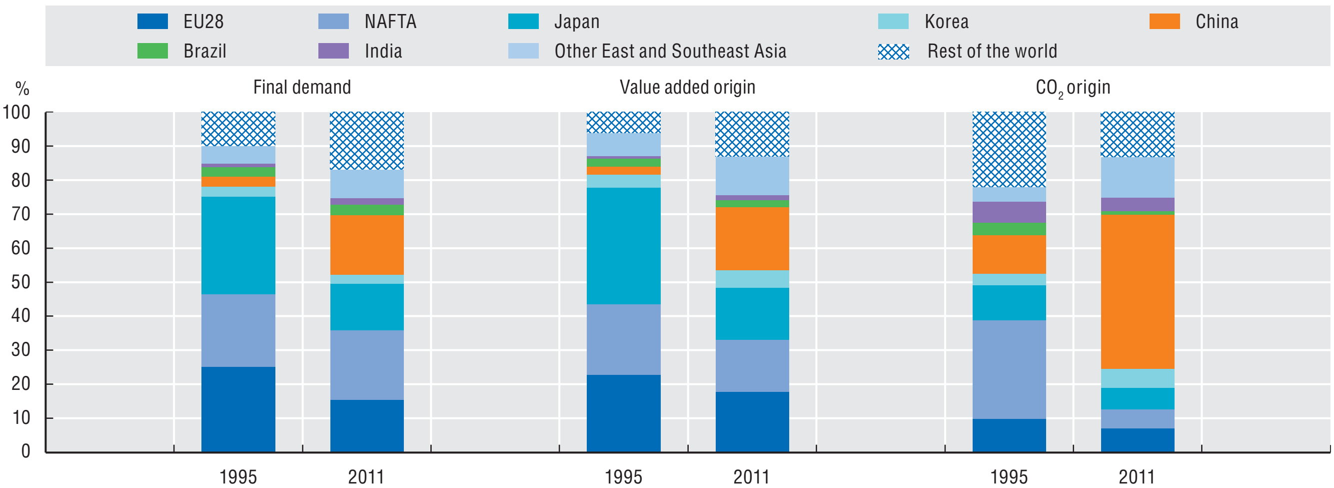
Business sector services value added content of manufacturing exports reflects the value of services, such as wholesale, transport and communications, finance and insurance, IT and other business services, that are required as inputs for the domestic production of manufactured goods. The diamonds represent the median business sector services content of manufactured exports of the 34 OECD countries and the blue bars represent the inter-quartile range (i.e. between the 25th and 75th percentiles), providing an indication of dispersion. In general, half of the OECD economies differ by only 5 to 10 percentage points. The range in shares across OECD countries is relatively narrow for manufacturing of machinery (ISIC Division 29), but relatively wide for ICT and electronic equipment (30, 32 and 33).

Sectoral value chains

A consequence of global value chains (GVCs) is that patterns of regional demand for certain products can appear very different from patterns of regional production. Comparing the locations of final demand for products with the origins of value added generated, as well as the carbon dioxide emitted, along GVCs can provide insights into global industry structures. Three sectors with high foreign value added shares in OECD final demand are *Textiles and apparel*, *Computer, electronic and optical equipment* and *Motor vehicles* (see Section 5.9). For these products the majority of global final demand comes from OECD countries, even though this share has declined significantly since 1995. Much of the value added embodied in these products is being generated by OECD countries although this share has also declined. Meanwhile, the share of carbon dioxide emitted by OECD countries has declined compared to non-OECD economies such as India, China and other East and Southeast Asian countries that experienced significant increases in shares between 1995 and 2011.

39. Global demand for Computer, electronic and optical equipment, percentage shares of total, 1995 and 2011

By country and region of final demand, origin of value added and origin of carbon emissions



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*, June 2015; and International Energy Agency (2014), *CO_2 Emissions from Fuel Combustion 2014*, *http://oe.cd/io-co2*; StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273142

How to read these figures

The figures display countries' and regions' share of global demand for three types of manufactured goods with high foreign value added content, as well as the shares of the origin of value added and CO_2 emissions generated along GVCs to produce these final goods. The value added and emissions embodied in the final products come not only from the associated industry (such as Motor vehicles), but also from any upstream industrial activity. Comparing the bars of 1995 and 2011 clearly shows a global shift towards emerging economies in all aspects of production and demand.

Extending the Trade in Value Added indicators with emissions data

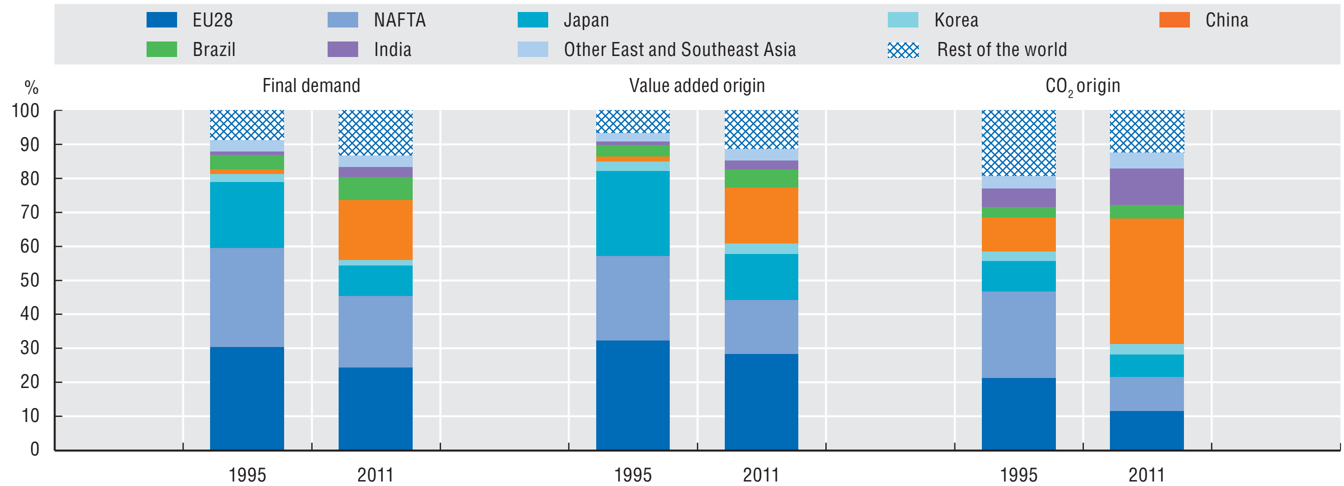
The approach for calculating pollution (CO_2 emissions) impacts along GVCs is the same as the approach underlying estimation of value added along GVCs. Instead of applying country and industry-specific value added to output ratios, country and industry-specific CO_2 emissions to output ratios are used. A key challenge in producing such estimates is allocating the International Energy Agency's CO_2 emissions from fuel combustion data (*www.iea.org/statistics/topics/co2emissions/*) to the ISIC Rev. 3-based industries used in the Inter-Country Input-Output (ICIO) tables. Some of the categories of CO_2 emitters in the reported emissions data do not correspond directly to particular ISIC activities (e.g. road emissions).

Sectoral value chains

More than half the global demand for *Computer, electronic and optical equipment* and *Motor vehicles*, came from OECD countries in 2011, while slightly more than half of global demand for *Textiles and apparel* came from non-OECD economies. When considering the origin of value added, the regional distribution for *Computer, electronic and optical equipment* is similar to that for final demand. For motor vehicles the European Union and Japan have higher shares of global value added origin compared to final demand, while for *Textiles and apparel* China is the dominant source of value added, with the OECD having very low shares of global value added compared to final demand. The emergence of China as a principal source of CO_2 emissions is evident across all three sectors shown.

40. Global demand for Motor vehicles, percentage shares of total, 1995 and 2011

By country and region of final demand, origin of value added and origin of carbon emissions

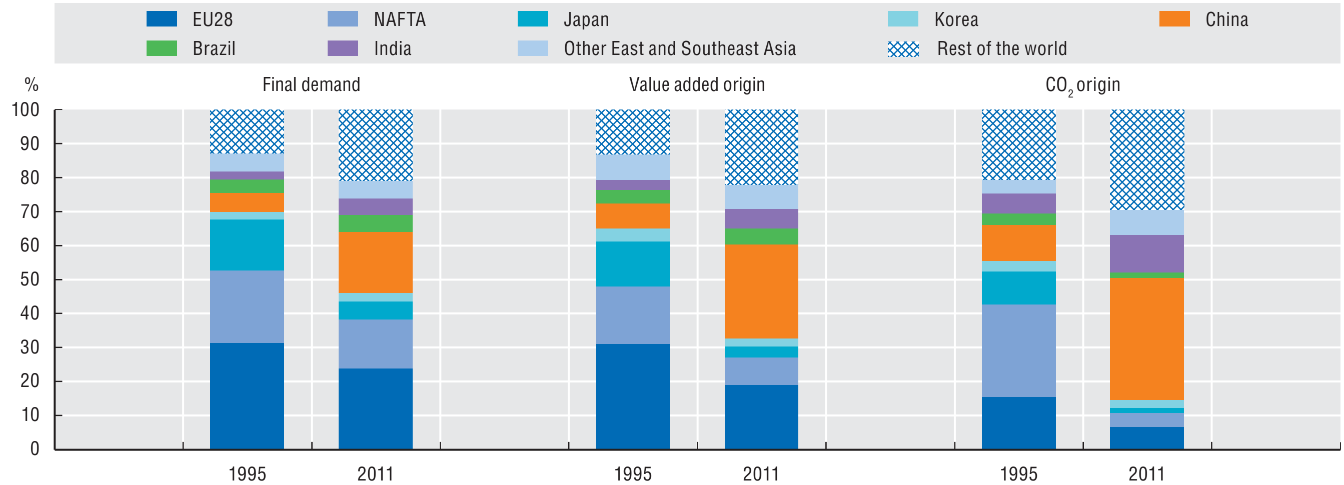


Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*, June 2015; and International Energy Agency (2014), *CO_2 Emissions from Fuel Combustion 2014*, *http://oe.cd/io-co2*. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273150

41. Global demand for Textiles and apparel, percentage shares of total, 1995 and 2011

By country and region of final demand, origin of value added and origin of carbon emissions



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*, June 2015; and International Energy Agency (2014), *CO_2 Emissions from Fuel Combustion 2014*, *http://oe.cd/io-co2*. StatLink contains more data. See chapter notes.

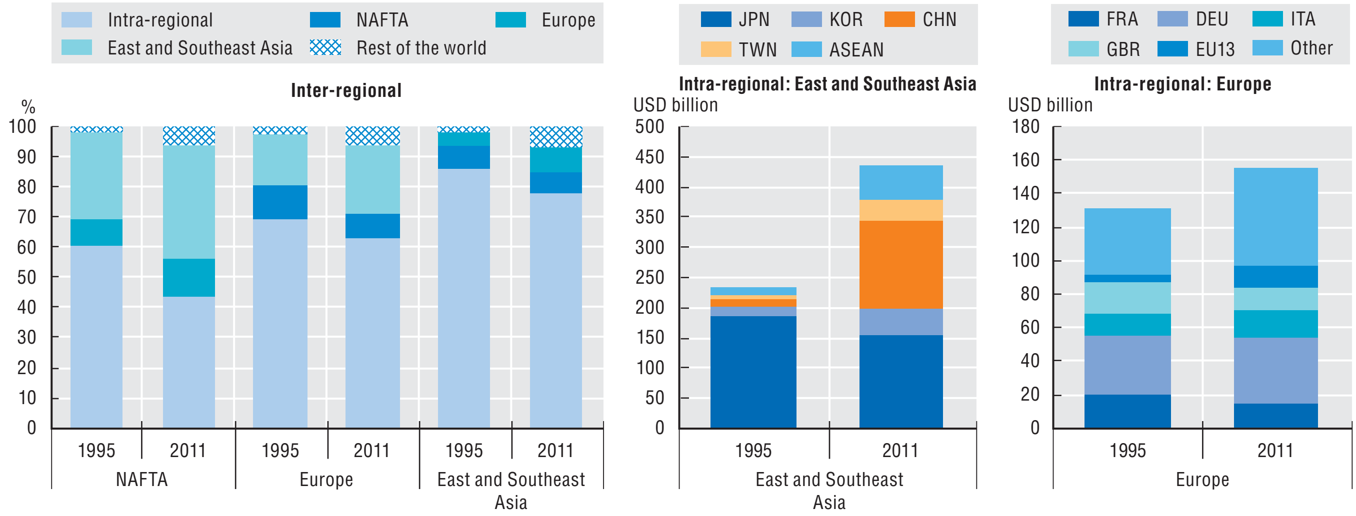
StatLink http://dx.doi.org/10.1787/888933273162

Regional value chains

Tracking the origins of value added in final demand for goods and services around the world can reveal the nature of *inter*-regional and *intra*-regional linkages and how they have changed over time. The *Trade in Value Added (TiVA) Database* allows analysis of flows of value added between and within three major regions: East and Southeast Asia, Europe and North America (NAFTA). Analysis of demand for *Computer, electronic and optical equipment*, *Motor vehicles* and *Textiles and apparel* reveals that the majority of regional final demand is met by intra-regional production. However, in general, intra-regional shares of GVCs have fallen since 1995, notably for *Computer, electronic and optical equipment*, where, for example, more than half of NAFTA demand in 2011 was met by value added generated in other regions. The intra-regional shares of GVCs are highest for East and Southeast Asia – reaching more than 80% for *Motor vehicles* and *Textiles and apparel* – due in part to high levels of domestic value added to meet domestic demand (e.g. China) and the presence of strong intra-regional production networks. NAFTA's reliance on other regions to meet demand has increased significantly in many industries. Although demand for *Motor vehicles* tends to be met mostly by intra-regional activities, East and Southeast Asia and Europe nevertheless made significant inroads in meeting NAFTA demand accounting for about one third of value added content by 2011.

42. Regional demand for Computer, electronic and optical equipment, 1995 and 2011

By country or region of value added origin



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273179

How to read these figures

The left-hand figure shows the distribution of value added origin by demand region with the Rest of the world included for completeness. The lighter bars represent intra-regional value added (i.e. the share of value added originating from the same region where the goods are eventually consumed), enabling comparisons across East and Southeast Asia, Europe and NAFTA. The two graphs on the right present intra-regional demand for East and Southeast Asia and Europe, revealing the value added contributions of selected countries within these regions. Note that intra-regional flows include domestic value added embodied in domestic demand.

Measuring final demand by origin of value added

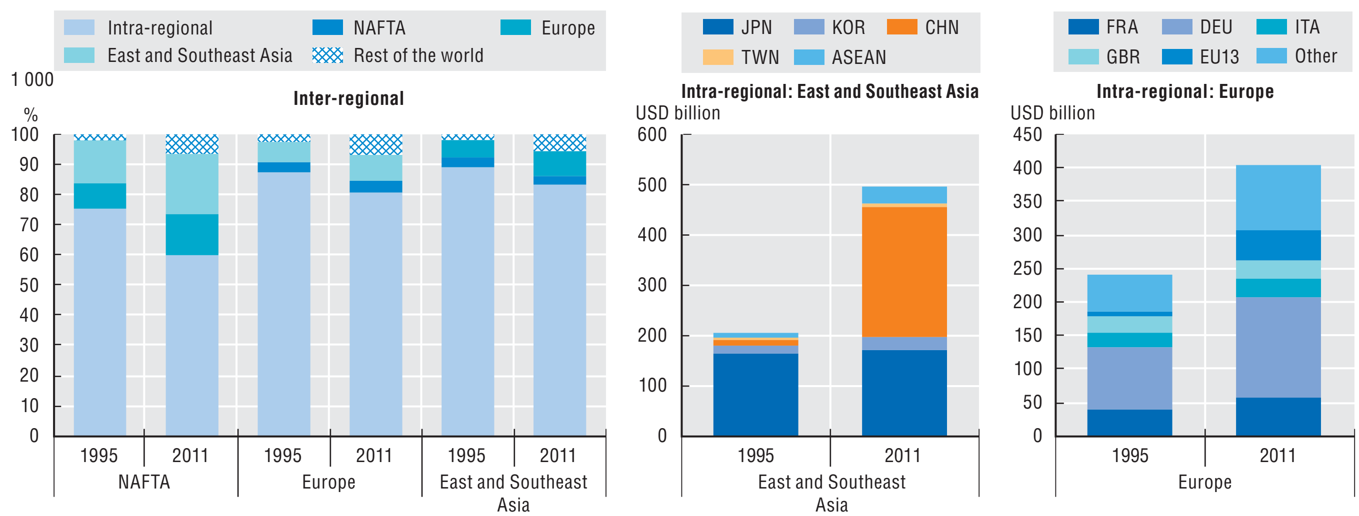
There are four factors to consider when decomposing final demand by origin of value added: the final demand country/region, the final demand industry (or product group), the country/region origin of value added and the industry origin of value added. For this analysis, the industries considered represent final demand industries with value added content originating from all industries. In other words, value added embodied in final products may also come from other upstream industries (a demand perspective). An alternative approach is to consider value added originating from a particular industry to meet final demand for all products (e.g. output from the *Computer, electronic and optical equipment industry* can be found in a range of final products). The TiVA database provides tools that allow analysis from both perspectives.

Regional value chains

Dynamics of value added flows vary within regions. Significant increases in East and Southeast Asian demand for manufactured products between 1995 and 2011 mainly embodied Chinese value added, although the share of value added from ASEAN countries also increased for *Computer, electronic and optical equipment* and *Textiles and apparel*. While domestic value added in domestic demand makes up a significant share of intra-regional flows, the proportion can vary across industries. For example, China's large share for *Motor vehicles* reflects production to meet domestic demand, while a sizeable proportion of Chinese value added for *Computer, electronic and optical equipment* and *Textiles and apparel* reflects demand from other countries within the region. Within Europe, Germany still dominates value chains in the *Motor vehicles* industry, although the younger EU members (EU13) have increased their share. Italy remains the largest source of European value added meeting European demand for *Textiles and apparel*.

43. Regional demand for Motor vehicles, 1995 and 2011

By country or region of value added origin

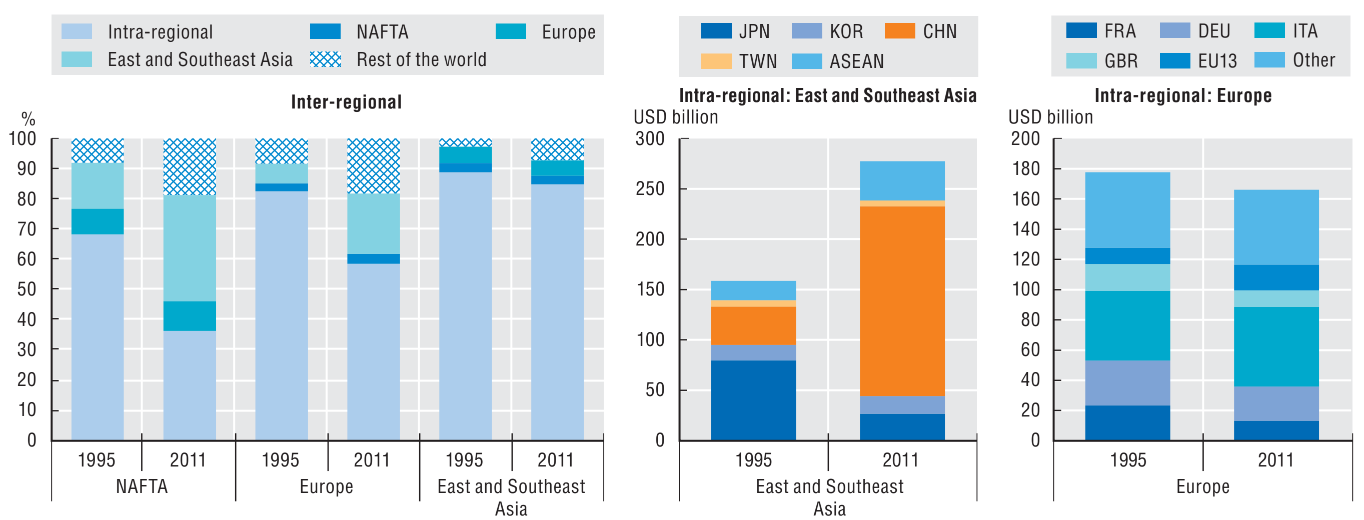


Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273187

44. Regional demand for Textiles and apparel, 1995 and 2011

By country or region of value added origin



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. See chapter notes.

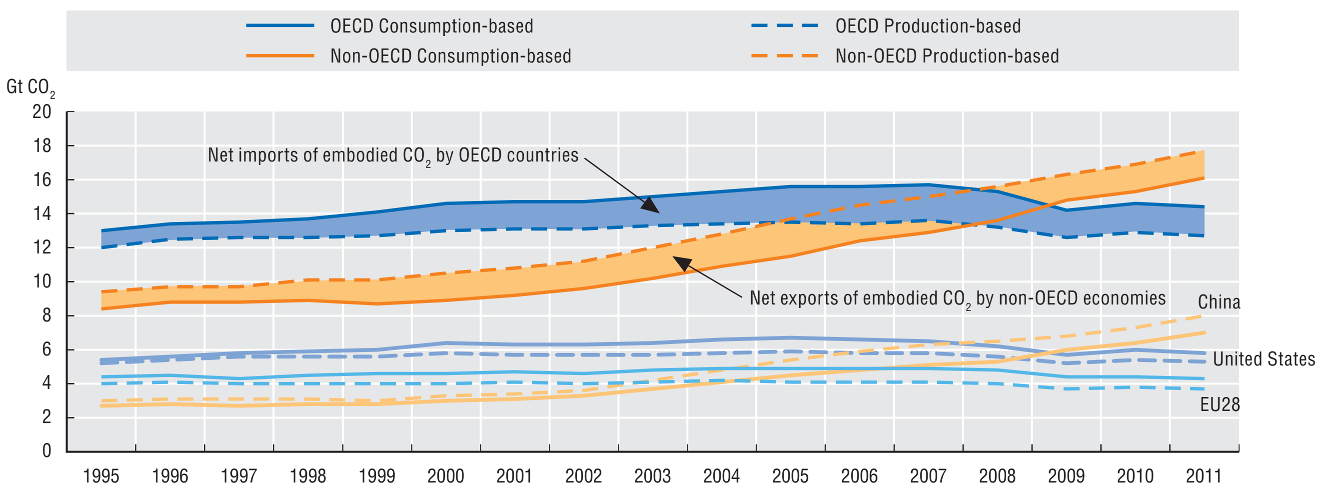
StatLink http://dx.doi.org/10.1787/888933273195

Sustainable production chains

The increasing fragmentation of global production requires the examination of CO_2 emissions from a consumption, as opposed to an exclusively production, perspective. Rather than allocating emissions to the country where they are produced, the consumption approach allocates them to the country in which the goods and services that embody the emissions are eventually consumed. In the OECD area, consumption-based emissions have been significantly higher than production-based ones, with large variations across countries. The top three countries and regions in total consumption-based as well as production-based emissions in 2011 were China, the United States and the European Union. The EU28 countries have decreased both production and consumption-based emissions since 1995, while there has been a significant (2.5 times) increase in China and a slight increase in consumption-based emissions in the United States. China is now the country with the single highest absolute emissions from a consumption and production perspective. In per capita terms, however, although Chinese per capita emissions have doubled since 1995, US consumption-based emissions remain almost four times higher.

45. Trends in production- and consumption-based CO_2 emissions, 1995-2011

CO_2 emissions from fuel combustion, Gigatonnes (Gt)



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*, June 2015; and International Energy Agency (2014), *CO_2 Emissions from Fuel Combustion 2014*, *http://oe.cd/io-co2*.

StatLink http://dx.doi.org/10.1787/888933273201

How to estimate imports and exports of CO_2 and embodied energy

The OECD's Inter-country Input-Output (ICIO) tables can be combined with the IEA's emission and energy statistics (CO_2 emissions from fuel-combustion and energy balances) to estimate international transfers of embodied CO_2 emissions as well as embodied energy. Energy technologies analysed here are selected low-carbon renewables (geothermal, solar thermal, solar photovoltaics, tide, wave and ocean technologies, and wind power), as well as total energy used for electricity and heat generation. The results highlight differences among countries in production-based and consumption-based emissions, as well as in the share of low-carbon renewables used for electricity and heat generation from a production and a consumption perspective. The methodology used to estimate the consumption-based indicators is equivalent to the methodology used to estimate the final demand-related TiVA indicators.

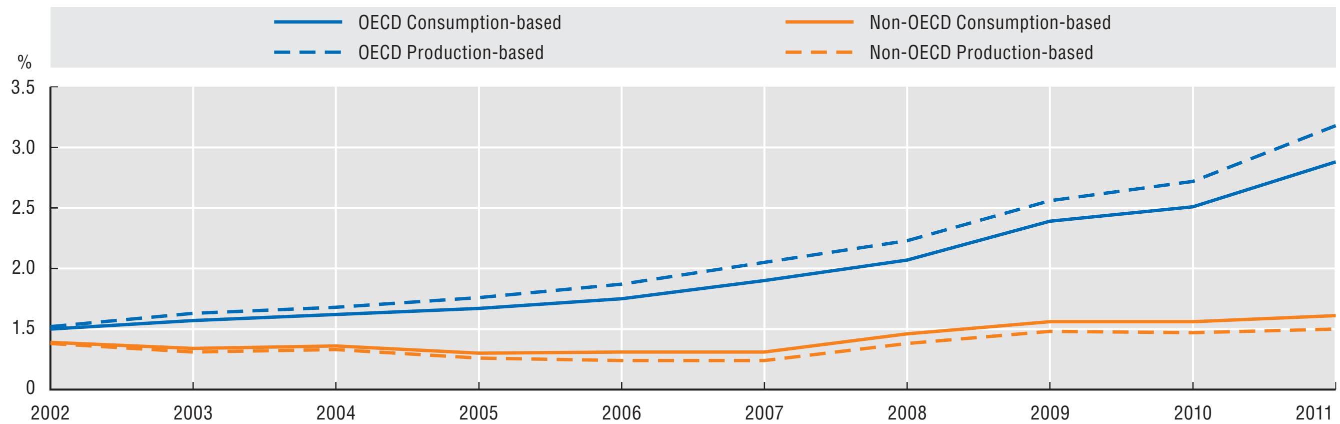
Consumption-based CO_2 emissions of OECD countries were, on average, about 10% to 15% higher over the time period than conventional measures of production-based emissions would suggest. CO_2 emissions embodied in imports can, to a large extent, be traced back to the electricity industry in other countries. Thus, part of the difference between consumption and production-based emissions can be explained by the differences in the CO_2 emission intensity of electricity production. Some countries with large differences between production and consumption-based emissions have relatively low emission intensities of electricity production due to the use of low-carbon renewables. Net exports of embodied renewables used for electricity/heat production are close to zero for many countries, with some exceptions. For example, Indonesia and Iceland, which export energy-intensive manufacturing goods (e.g. aluminium exports of Iceland) and have a high share of geothermal power in electricity production, are among the top net-exporters of embodied selected renewables used for electricity and heat production. The United States, while having the highest absolute electricity and heat production from the selected renewables, also has by far the highest consumption of embodied selected renewables.

Sustainable production chains

All products consumed in daily life require electricity at various stages of the production process. The rise in the use of renewable energy technologies in electricity production over the last decade has contributed to more sustainable production chains. In the OECD area, the percentage of low-carbon renewables in total energy used for electricity and heat production doubled over the decade from 2002-11 to reach 3%, while it remained stable at less than 1.5% in non-OECD economies. Nevertheless, because of the increase of trade with non-OECD economies, the electricity mix embodied in the consumption of OECD countries has included increasingly less renewable energy than the production-based electricity mix. This is one of the underlying reasons for the higher carbon content of consumption compared to production for many OECD countries. OECD economies can be found both among top net-exporters and top net-importers of embodied low-carbon renewables used for electricity generation. This reflects a large cross-country variation in the propensity to use such technologies.

46. Embodied low-carbon renewable energy used for electricity production, 2002-11

As a percentage of total embodied energy used for electricity production

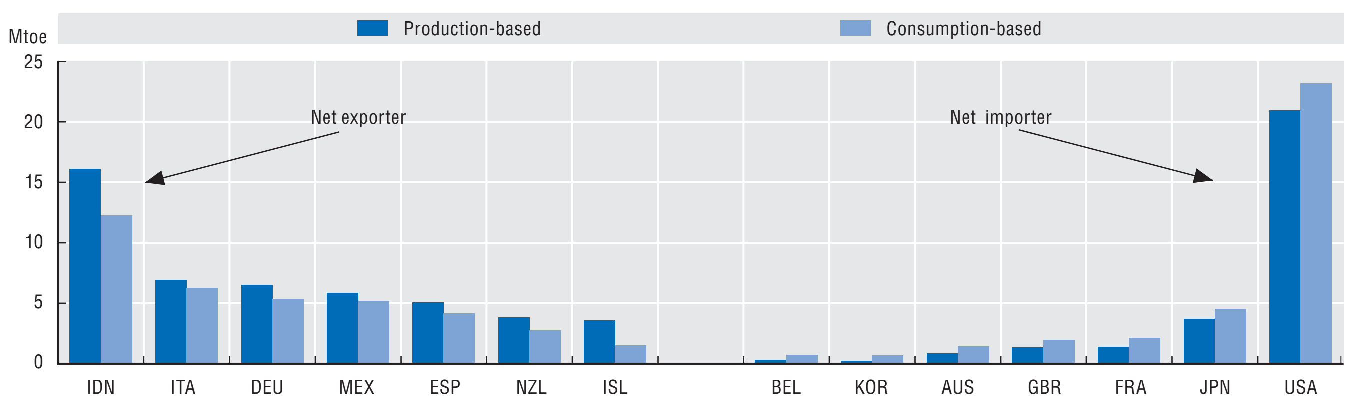


Source: OECD, *Inter-Country Input-Output (ICIO) Database*, http://oe.cd/icio, June 2015; and International Energy Agency (IEA), *World Energy Balances Database*, 2014. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273212

47. Top net exporters and net importers of embodied low-carbon renewables used for electricity production, 2011

Millions of tonnes oil equivalent (Mtoe)



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, http://oe.cd/icio, June 2015; and International Energy Agency (IEA), *World Energy Balances Database*, 2014. StatLink contains more data. See chapter notes.

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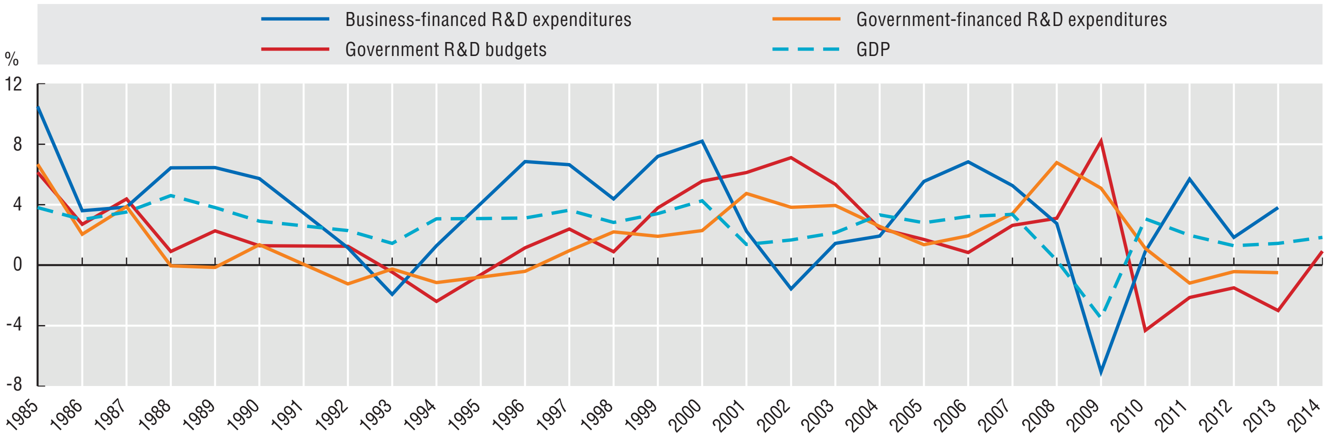
Science and innovation today

R&D trends

As with other types of investment, expenditures in R&D and innovation are pro-cyclical – they are positively related to an economy's level of activity. R&D financed by the business sector is particularly affected by the business cycle and reflects changes in financing constraints and aggregate demand. The major drop in GDP and business R&D in 2008-09 was partly balanced by a boost in government-funded R&D. From 2010, business-funded R&D has recovered, while in turn direct government funding of R&D has declined, reflecting budget consolidation policies. Since 1985, the components of R&D have evolved differently. Across all sectors, applied research and experimental development have more than doubled in real terms since 1985. These account for most of R&D expenditures (21% and 62% of GERD, respectively in 2013, but more so in China at 11% and 85%). Basic research (17%) has nearly quadrupled over the period, driven by sustained growth in R&D within higher education. Behind these general trends lie diverse sectoral patterns, suggesting increasing sectoral specialisation in the types of R&D performed. This picture may hint at an increasing gap between basic research and the development of new products and processes.

48. R&D growth over the business cycle by source of financing, OECD area, 1985-2014

Average annual real growth rate, percentage

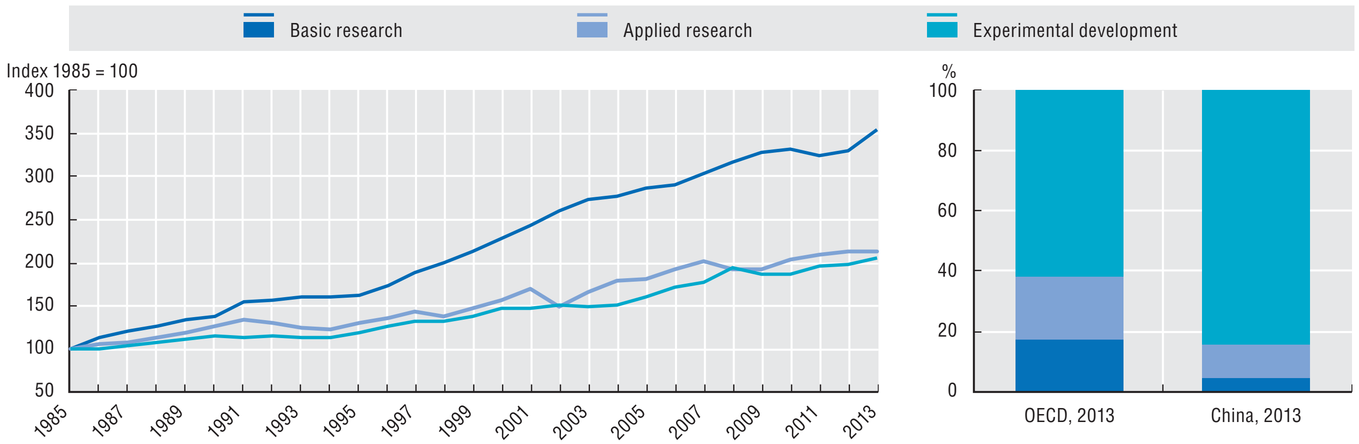


Source: OECD, *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273234

49. Trends in basic and applied research and experimental development in the OECD area, 1985-2013

Constant price index (USD PPPs 1985 = 100) and share of GERD in 2013 as percentages



Note: The index has been estimated by chain-linking year-on-year growth rates that are calculated on a variable pool of countries for which balanced data are available in consecutive years and no breaks in series apply.

Source: OECD, calculations based on *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm* and *Research and Development Statistics Database*, *www.oecd.org/rds*, June 2015. See chapter notes.

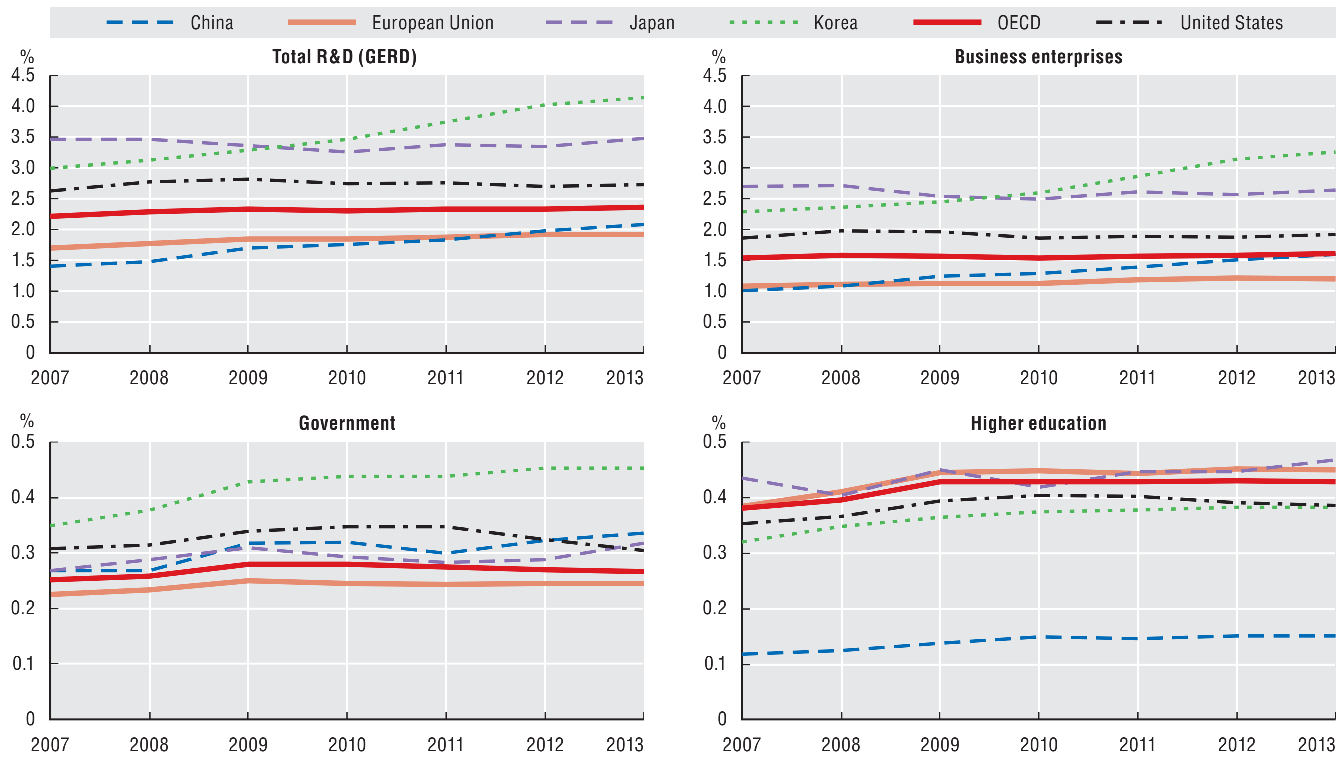
StatLink http://dx.doi.org/10.1787/888933273241

R&D trends

Gross domestic expenditure on R&D (GERD) in the OECD area grew 2.7% in real terms from 2012, to reach USD 1.1 trillion in 2013, thus consolidating the recovery after the decline triggered by the global economic and financial crisis of 2008-09. As a percentage of GDP, GERD in the OECD area remained unchanged with respect to 2012 at 2.4%. This recent growth was been driven by a strong increase in business R&D, while R&D expenditures in government institutions fell in 2013. China's reported expenditure on R&D continued to converge with the OECD average. Among countries covered in the OECD Main Science and Technology Indicators publication, R&D intensity was highest in Korea following a period of fast growth. The fast growth witnessed in China and Korea was driven principally by their business sector, while the R&D intensity in this sector in the OECD has barely changed over the period. The growth in higher education R&D has been accompanied by a slight reduction in the role of the government sector. China's investment in Higher education R&D still lags behind that of the OECD.

50. Recent trends in R&D performance, OECD and selected economies, 2007-13

Totals and sector estimates, as a percentage of GDP



Source: OECD, *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273253

Measuring R&D and its components

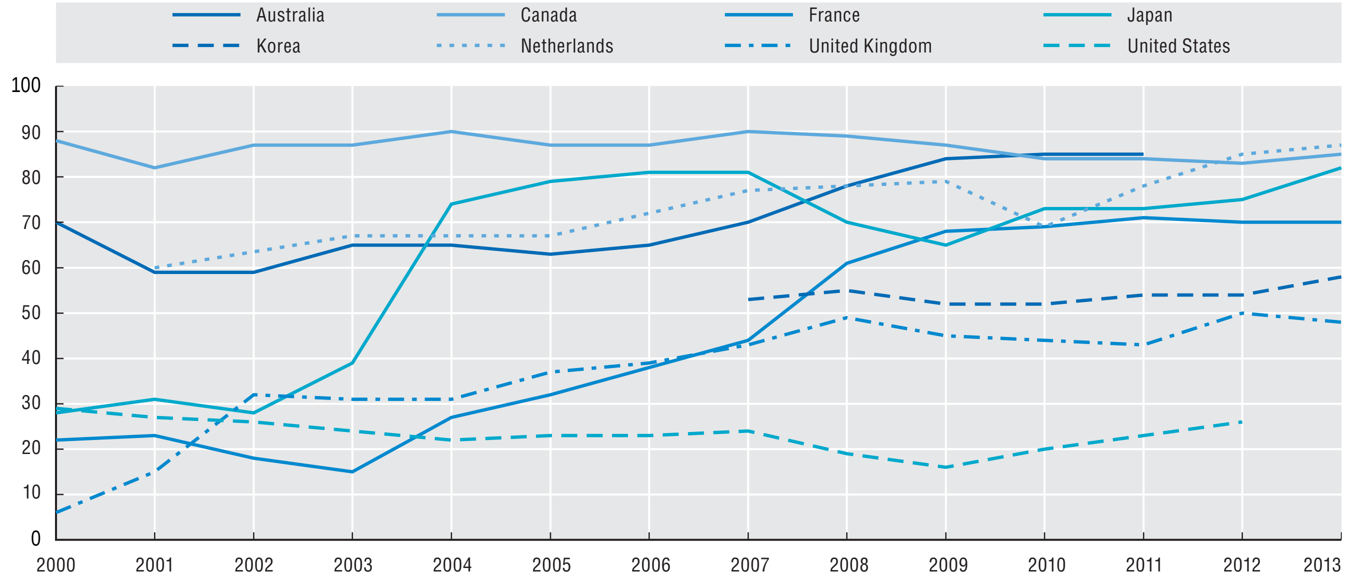
As defined in the *Frascati Manual* (OECD, 2015e), R&D comprises basic research (aimed at creating new knowledge with no specific application in view), applied research (new knowledge towards a specific practical aim) and experimental development (to develop new products or processes). For some countries it is difficult to report these components separately for all performing sectors, leading to coverage gaps. Financial incentives, especially government funding decisions and priorities, may also impact the likelihood of respondents reporting R&D projects as basic or applied research, as well as the extent of sectoral specialisation in different types of R&D.

The policy mix for R&D

Governments can adopt various support instruments to promote business R&D. In addition to providing grants and buying R&D services ("direct" support), many also provide fiscal incentives. In 2015, 28 of the 34 OECD countries and a number of non-OECD economies give preferential tax treatment to R&D expenditures. Since 2000, several OECD countries such as France, Japan, the Netherlands and the United Kingdom have increased their reliance on R&D tax incentives as a mechanism for supporting business R&D, sometimes displacing direct forms of support. However, this trend has not been uniform. The relative importance of tax incentives declined briefly during the crisis in many economies, reflecting the demand-led nature of tax relief and its dependence on profits. For this reason, some governments opted for direct funding to mitigate the impacts of the crisis on business R&D. In the United States, federal tax support for R&D remained fairly stable. In Canada, a review of federal R&D support led to a small rebalancing of central government support. However, Canada continues to place significant emphasis on tax support, surpassed only by the Netherlands in 2013.

51. Trends in government tax incentive and direct support for business R&D, 2000-13

Tax support as a percentage of total (direct and tax) government support for business R&D, selected countries



Source: OECD, R&D Tax Incentive Indicators, *www.oecd.org/sti/rd-tax-stats.htm* and *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273262

How to measure R&D tax incentives

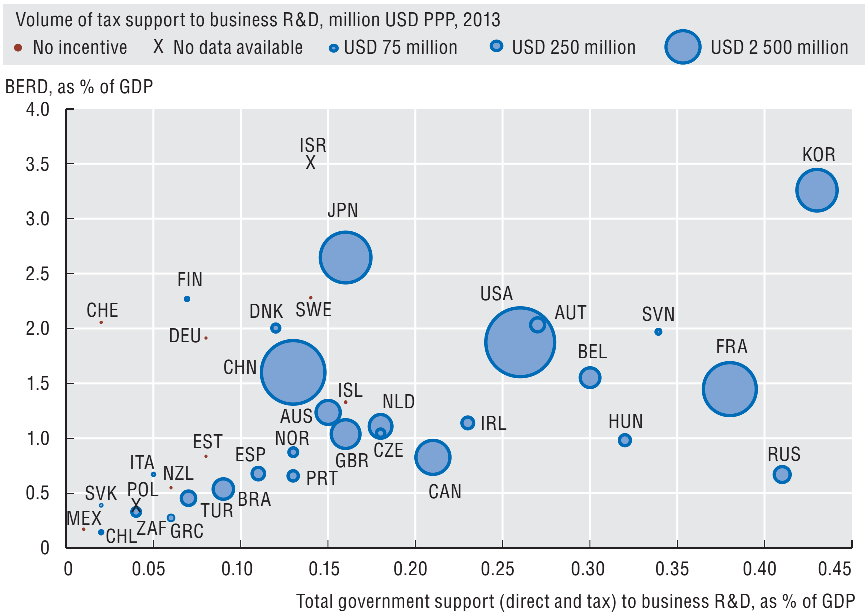
OECD estimates of the cost of R&D tax incentives are combined with data on direct R&D funding, as reported by firms through R&D surveys, to provide a more complete picture of government efforts to promote business R&D. These efforts can now be mapped over time. The OECD data collection on R&D tax incentives, now in its fifth edition, attempts to identify and address subtle differences in the tax treatment of R&D, the relevant tax benchmark and measurement approaches. National experts on science and technology indicators have collaborated with public finance and tax authorities to provide the most up-to-date and internationally comparable figures possible. The estimated cost of provisions for the treatment of R&D expenditures by firms is presented relative to a common benchmark (full deductibility of current R&D) whenever possible. Estimates reflect the sum of foregone tax revenues – on an accruals basis – and refunds where applicable. The new edition of the OECD *Frascati Manual* incorporates a new chapter dedicated to the measurement of R&D tax incentives (OECD, 2015e), see *http://oe.cd/frascati*.

The policy mix for R&D

Across countries, R&D intensity in the business sector has a positive correlation (0.4) with the level of government funding of business R&D. Germany and Korea present relatively high business R&D intensities compared to their degree of measured government support, while France, Hungary and the Russian Federation have high rates of support relative to countries with similar business R&D-to-GDP ratios. In 2013, Germany, Switzerland and Sweden did not offer tax incentives, but had very R&D-intensive business sectors. Israel provides a limited form of R&D tax relief but no estimates are available. In 2013, Finland temporarily introduced a tax allowance although its volume was rather modest. Sweden introduced an R&D tax incentive in January 2014. Correlations do not necessarily imply the existence of a causal relationship between R&D support and performance.

52. Business R&D intensity and government support to business R&D, 2013

As a percentage of GDP



Source: OECD, R&D Tax Incentive Indicators, *www.oecd.org/sti/rd-tax-stats.htm*; OECD, *Annual National Accounts Database* and *Main Science and Technology Indicators Database*, June 2015. Direct funding estimates for Brazil based on national sources. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273275

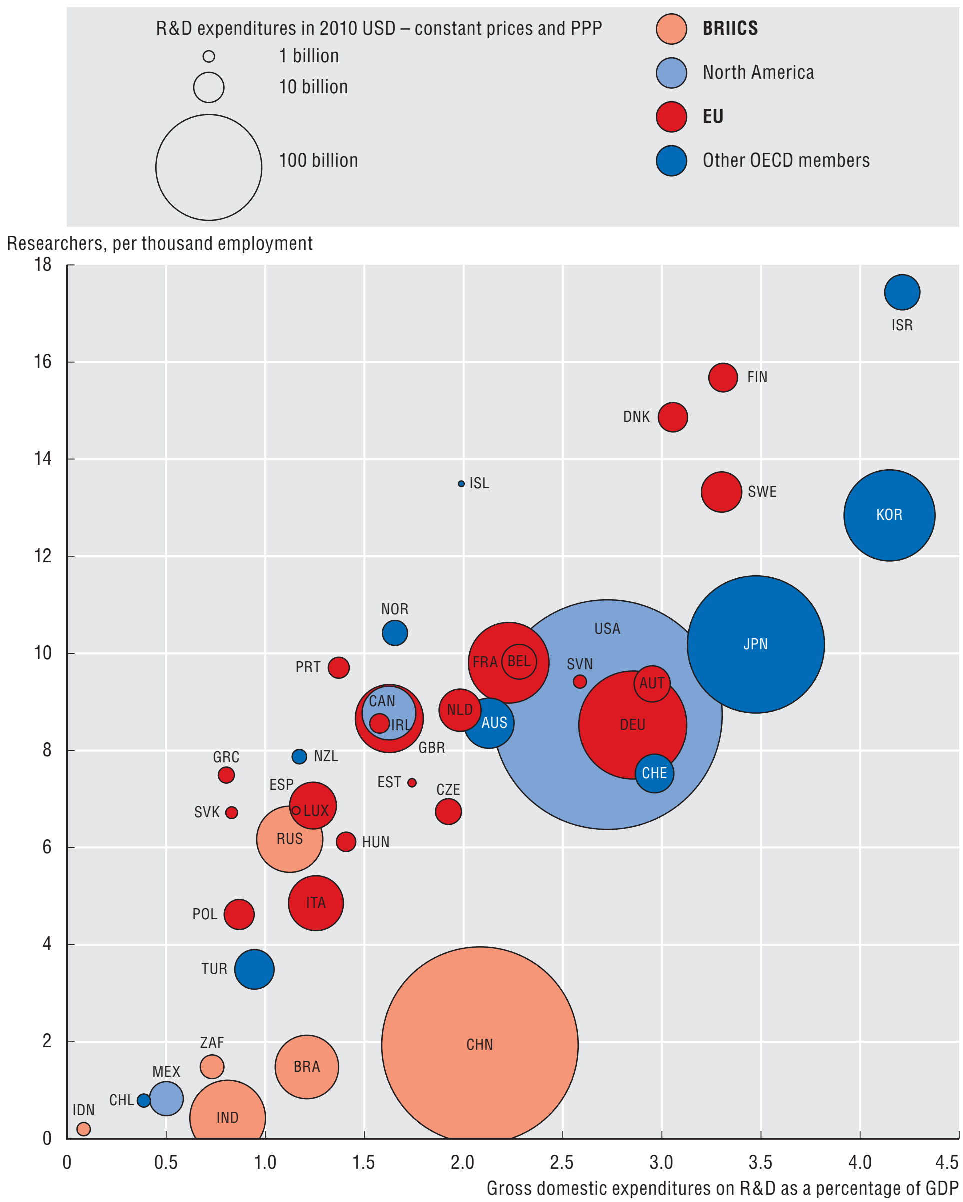
How to read this figure

Bubble sizes represent the total amount of support provided through expenditure-based R&D tax incentives in USD PPP. For example, in the Netherlands, tax support for R&D is just above USD 1 billion. Total government funding of business R&D is close to 0.2% of GDP and business R&D is about 1% of GDP. Some countries have no mass because no R&D tax incentives are provided (red dots). For two OECD countries (marked as "x") estimates of R&D tax incentives are not available.

R&D and top science

The United States is the world's largest R&D performer, with nearly USD 433 billion of domestic R&D expenditures in 2013. This exceeds by about one-third the amount of R&D performed in China, the second-largest performer, which is broadly on par with the combined EU28 area. Israel and Korea have the highest ratio of R&D expenditures to GDP owing to rapid increases in recent years. Non-OECD economies account for a growing share of the world's R&D, measured in terms of total researchers and R&D expenditures. Personnel costs, which include researcher costs, account in most economies for the bulk of R&D expenditures. This explains the close relationship between R&D as a percentage of GDP and the number of researchers as a percentage of total employment. Variations can be related to differences in the price of R&D inputs, such as researcher costs, the pattern of R&D specialisation and R&D capital expenditures, as some countries may be developing their research infrastructure for the future.

53. R&D in OECD and key partner countries, 2013



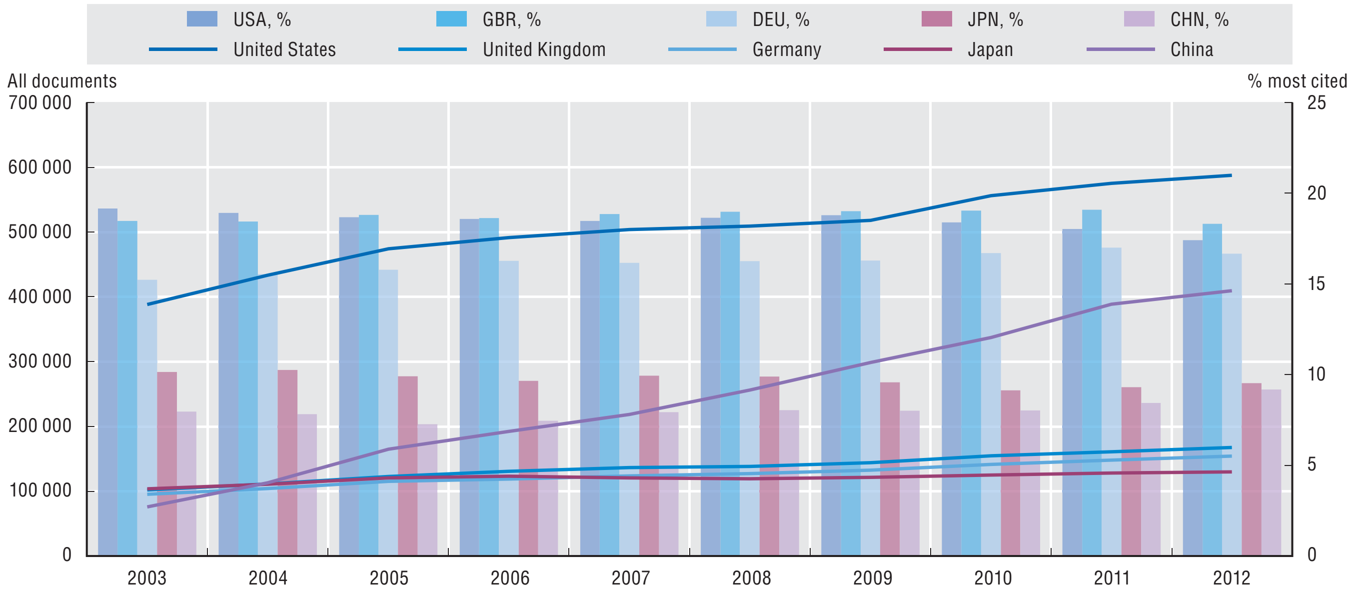
Note: Owing to methodological differences, data for some non-OECD economies may not be fully comparable with figures for other countries.
Source: OECD, *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*; and UNESCO Institute for Statistics, June 2015. See chapter notes.
StatLink *http://dx.doi.org/10.1787/888933273287*

R&D and top science

The global volume of scientific production, as indexed in Scopus, a private bibliometric database, increased over the 2003-12 period by nearly 8% per year. In the United States, total publications rose by 50% over this period, while total output quadrupled (300%) in China. Top-cited publications provide a measure of "quality-adjusted" research output. While China is converging towards the United States in terms of volume, the same does not hold true in terms of "excellence", defined as the percentage of domestic documents in the top-10% most-cited publications. On this metric, "catching-up" is significantly slower. On the other hand, China has almost caught up with Japan in terms of measured "excellence" of scientific production. In the United Kingdom, the excellence rate has remained stable and the proportion of US-based publications among the 10% most-cited has declined slightly over the last ten years.

54. Trends in scientific publication output and excellence, selected countries, 2003-12

Number of all documents (line) and percentage within 10% most cited (bar), by author affiliation



Source: OECD and SCImago Research Group (CSIC) (2015), *Compendium of Bibliometric Science Indicators 2014*, *http://oe.cd/scientometrics*. StatLink contains more data. See chapter notes.

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How to read this figure

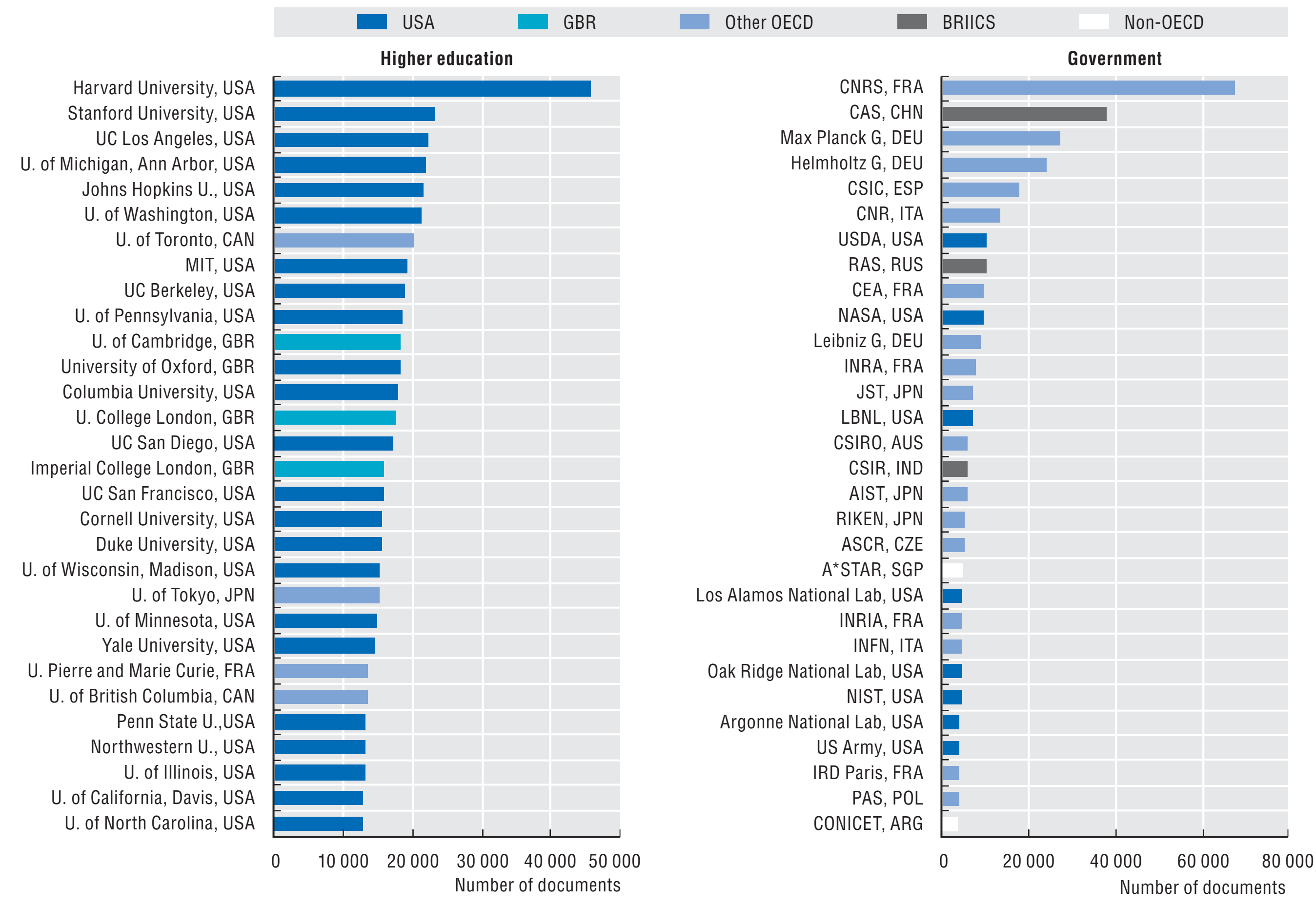
Lines depict absolute scientific publication output levels, but are not adjusted on a quality basis. *Excellence rates* – the proportion of publications within a country that feature within the global 10% most-cited publications – are represented by the bars and the values feature on the right hand scale. China's *excellence rate* reached nearly 9% in 2012 over nearly 409 000 publications. In the United Kingdom, the excellence rate is close to 18% over nearly 167 000 publications, indicating that China has nearly 7 000 more top-cited publications than the United Kingdom.

Scientific excellence

Individual institutions that attain a critical scale and level of excellence can have a major impact on the science and innovation performance of sectors and countries. A new indicator reveals which institutions account for the largest number of highly cited publications within the higher education (HE) and government sectors. The results confirm the widespread presence of US-based institutions among the top HE institutions, well above this country's share of highly cited documents for this sector. This reflects significant heterogeneity across institutions within this country in terms of size and average publication outcomes. Institutions based in the United Kingdom and Canada also play a prominent role within HE. The list of high impact government institutions is more geographically diversified. Several are large multi-subject research institutions with activities in different locations within their countries. Their average performance is not always as high as that of smaller institutions. The list includes several institutions from non-OECD economies.

55. Institutions with the largest number of top-cited publications, by sector, 2003-12

Identity and location of 30 largest producers of top 10%-most-cited documents



Source: OECD and SCImago Research Group (CSIC) (2015), *Compendium of Bibliometric Science Indicators 2014*, *http://oe.cd/scientometrics*. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273306

Analysing publications by sector

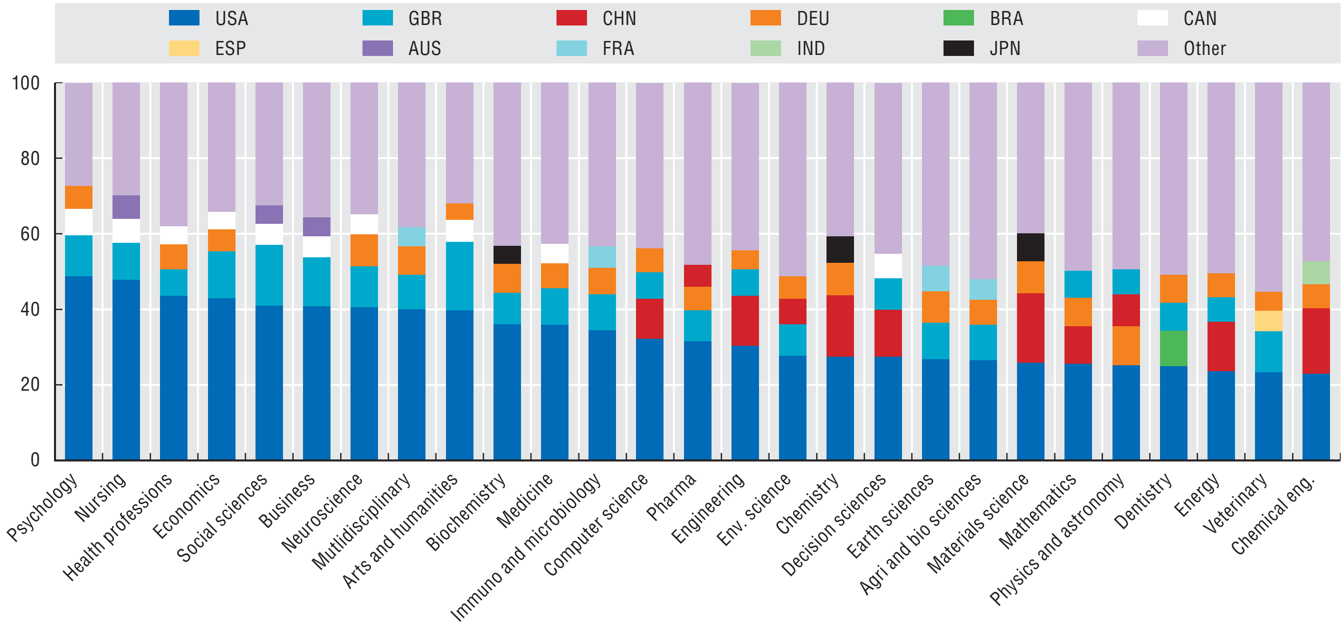
The analysis of top-cited publications is normalised by science domains, but the aggregation of these publications within institutions may give a larger weight to institutions that excel in specific fields. The definition of HE and government sectors used in this bibliometric analysis does not fully match the OECD *Frascati Manual* definitions used for R&D statistics. SCImago defines a separate "health sector" in which it includes government institutions such as the US National Institutes of Health, with nearly as many high impact publications as the Max Planck Society.

Scientific excellence

Among OECD and BRIICS countries, the distribution of top cited publications, i.e. the 10% most-cited publications within each field, provides an indicator of aggregate scientific excellence across fields. The United States accounts for the largest number of top-cited or high impact publications across all disciplines. This pre-eminent role is particularly marked in the life sciences and most health-related and social science fields. US-authored publications account for a relatively lower percentage of high-impact publications in a number of basic science domains outside the life sciences and engineering. The United Kingdom is the second largest producer of top-cited publications, especially in the fields where the United States accounts for a large share, but also excels in the Earth, Environmental, Agricultural and Veterinary sciences. China is the second largest producer of top-cited publications in Materials science, Chemistry, Engineering, Computer science and Chemical engineering, Energy and mathematics. Germany has the second largest share in Physics and astronomy, and is the third largest producer of high-impact publications across most fields. Other countries in the top 4 include Japan – a significant player in Materials science, Chemistry and Biochemistry – Australia, Brazil, France, India and Spain. Canada is present in several fields, often those where the United States has the most prominent position.

56. Top 4 countries with the largest number of 10% top-cited publications, by field, 2003-12

As a percentage of all top-cited publications by authors in OECD and BRIICS economies, whole counts



Source: OECD and SCImago Research Group (CSIC) (2015), *Compendium of Bibliometric Science Indicators 2014*, *http://oe.cd/scientometrics*. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273312

Interpreting these indicators

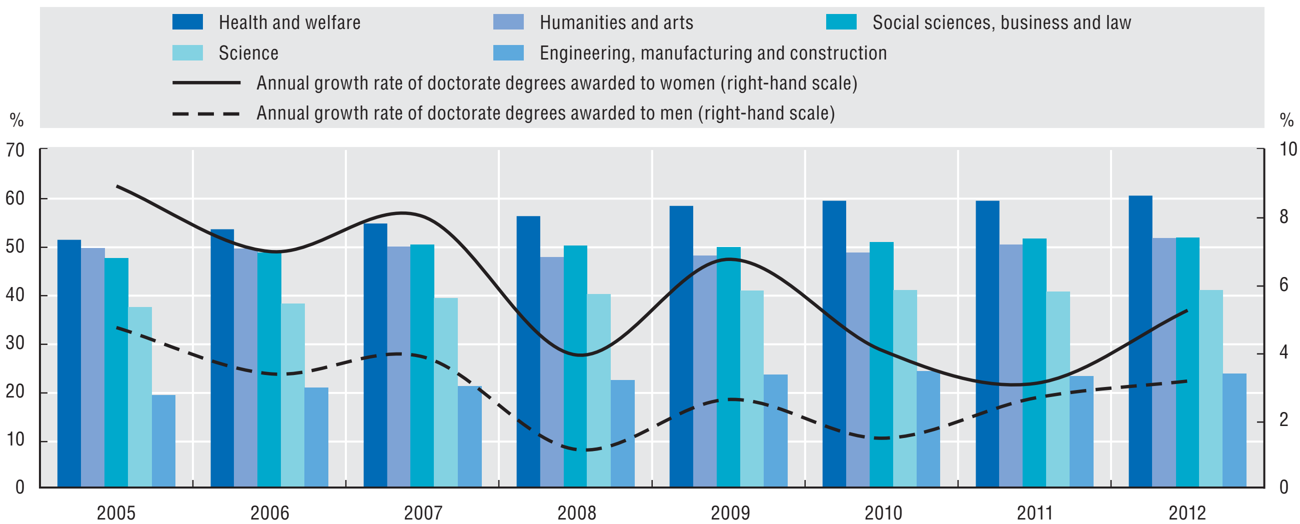
The top-10% most-cited publications are defined by reference to a subject-based norm, so as to take into account different citation patterns by field. The indicators show which institutions or countries account for the largest number of publications in the field-normalised 10% "high impact" group. They do not represent a measure of average performance for these institutions or countries. The results are not intended as league tables, but help illustrate the extent to which high impact publications are concentrated in a number of major institutions or countries, and how this pattern compares or differs across sectors or fields.

Women in science

Gender equality forms part of research and in-novation policy in many countries and organisations. It aims to promote equal participation and opportunities for women and men in research careers, encompassing issues ranging from compulsory education to gender balance in scientific decision-making. It also aims to integrate the gender dimension in research content (i.e. taking into consideration the biological characteristics and the social and cultural features of women and men). Achieving parity in participation in tertiary education is of particular importance, especially in research degrees, as this provides an increasingly important entry mechanism into research careers and senior roles across the science and innovation system. Since 2005, OECD countries have witnessed considerable convergence towards gender parity across most domains. The flow of new doctorates awarded to women has grown at a higher annual rate than for those awarded to men. However, the gender gap remains very large in the field of engineering, with men accounting for nearly 80% of all doctoral degrees. Women hold 40% of doctoral degrees in science, and are on par with men in the social sciences and humanities. In health-related disciplines, the share of degrees awarded to women has increased from 50% in 2005 to 60% in 2012.

57. New doctoral degrees awarded to women in OECD countries, by field of education, 2005-12

Percentage shares of all doctoral degrees and annual growth rates



Source: OECD, based on OECD, *Education Database* and national sources, July 2015. See chapter notes.

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How to read this figure

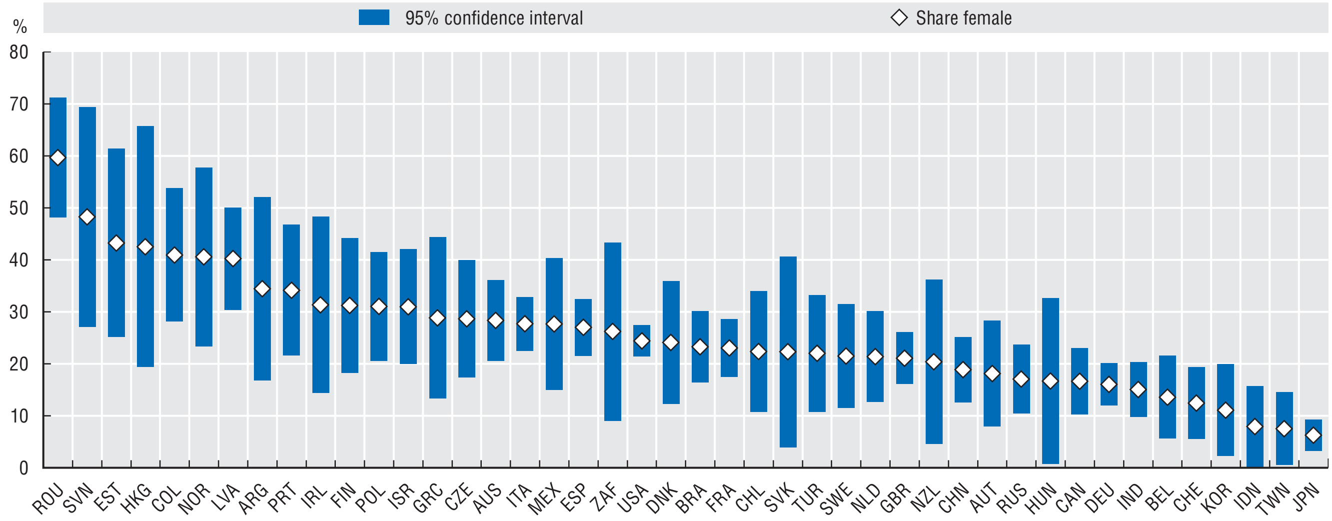
In 2012, women accounted for 60% (left-hand scale) of new doctoral degrees in Health and welfare disciplines were awarded to women, but only 20% of new doctoral degrees in Engineering, manufacturing and construction. The growth rate in the number of female new doctorates (right-hand scale) was larger than for men over the 2005-12 period. In 2012, it stood at nearly 6% for women and nearly 4% for men.

Women in science

A new indicator, based on an experimental global survey of scientific publication authors, finds considerable differences across countries in the share of women among authors who are designated as corresponding authors, a proxy for leadership in the context of research collaboration. These figures reflect patterns found in OECD statistics on the gender composition of the R&D personnel workforce and doctorate holders, but present a slightly more male centric gender distribution. This may signal additional challenges for women researchers to feature as leading authors. Despite the non-linear nature of many research careers and the time taken for convergence in doctorate graduation numbers to be reflected at more senior levels, the data suggest that gender equality in scientific publishing and team leadership is not occurring as rapidly as in careers. Data from this survey reveal that representation of women is highest in the social sciences, especially in the arts and humanities (slightly above 30% of corresponding authors), and lowest in physics, followed by materials science and chemical engineering at 15% or less.

58. Female scientific authors in selected fields, by country, 2011

As a percentage of corresponding authors, estimated shares



Note: This is an experimental indicator, based on a stratified random sample of scientific authors.
Source: OECD, based on preliminary analysis of the OECD Pilot Survey of Scientific Authors, July 2015. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888933273335*

How were these estimates derived?

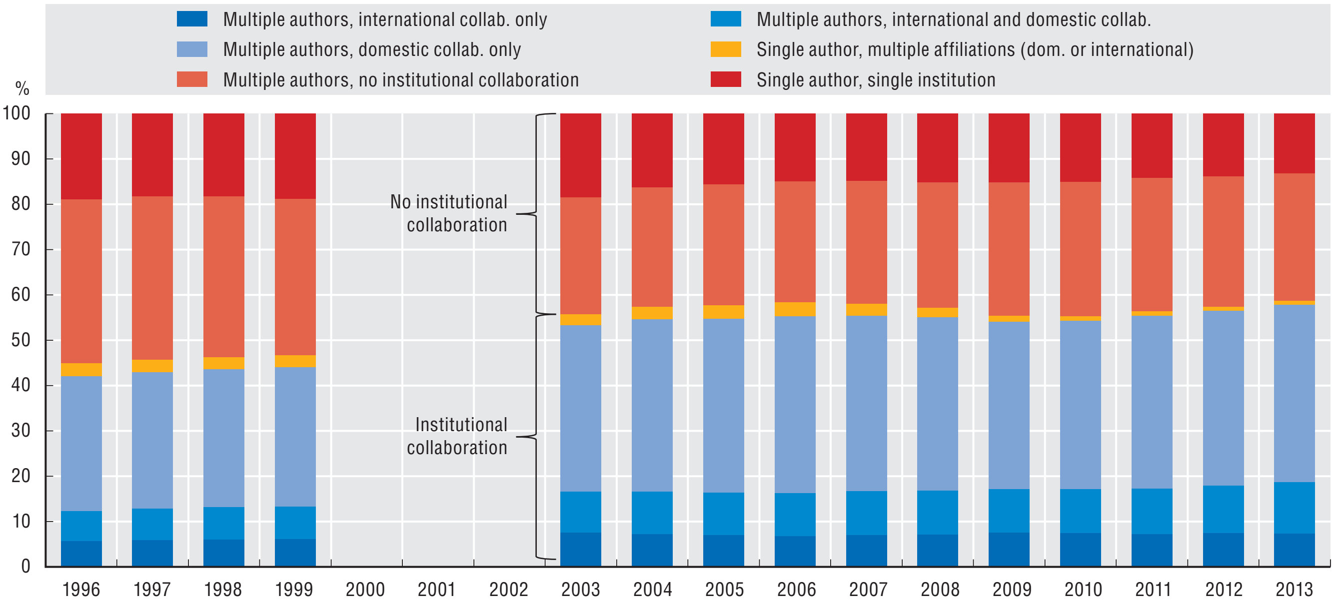
Estimates were based on the authors' self-reported gender in the OECD Pilot Survey of Scientific Authors carried out in January 2015 (*www.oecd.org/science/survey-of-scientific-authors.htm*). Samples were drawn from documents published in 2011 and indexed in the Scopus database, focusing on the document's author designated as "corresponding author". The fields covered in this survey include Arts and Humanities, Business, Chemical Engineering, Immunology and Microbiology, Materials Science, Neuroscience and Physics and Astronomy. Weighted averages take into account sampling design and non-response patterns by fields, country and journal status. No gender information about the population is available, so this factor does not enter the calculations of sampling weights and non-response analysis. A number of researchers and organisations are exploring how to use information on names to identify the statistically most likely gender with a view to enabling more detailed gender-based analyses.

Knowledge flows and collaboration in science

Production of scientific knowledge has shifted progressively from individuals to groups, from single to multiple institutions, and from the national domain to the international arena. Scientific researchers increasingly network across national and organisational borders. Single authors affiliated to a single institution currently account for less than 15% of scientific publications. The proportion of documents involving international collaboration in some form has nearly doubled since 1996, reaching close to 20% in 2013, although most scientific collaborations are still of a domestic nature. Almost 60% of documents involve collaborations across different institutions, up from nearly 45% in 1996. Scientific collaboration is of particular importance for scientific specialisation and knowledge diffusion, with recent evidence showing that collaboration is strongly associated with higher levels of citation impact (see Chapter 3).

59. Global scientific collaboration trends, 1996-2013

As a percentage of all publications, fractional counts



Note: Results for 2000-02 not displayed because of incomplete indexation in the Scopus database of authors for publications in those years. Estimates based on available data would understate the true extent of scientific collaboration.

Source: OECD calculations based on *Scopus Custom Data*, Elsevier, Version 4.2015, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273347

How to measure scientific collaboration?

Scientific collaboration can be measured from an individual or institutional perspective. Scientists within the same institution may co-author a publication, however such cases do not entail inter-institutional collaboration. Collaboration across different institutions is often deemed a stronger form of collaboration and it is typically a preferred approach to presenting data. Some forms of institutional collaboration may not involve collaboration among different individuals, for example, when a single author is affiliated to two different institutions possibly located in different countries. In such situation, institutional-based measures assume that a formal collaboration arrangement is in place between organisations, although in some instances, affiliations may just represent loose linkages with institutions potentially operating as virtual networks.

Knowledge flows and collaboration in science

Flows of scientific knowledge are partly reflected by the network of citations contained within scientific publication repositories. These networks represent the flow of knowledge from the economies in which authors hold affiliations to those of authors who reference these publications in their own work. When a citation is made and recorded in a publication index, this provides a mechanism to ascertain one dimension of the relevance of a given publication – i.e. its citation impact. The United States is firmly placed at the centre of the international citation network, with a larger number of works in any country citing publications with US-based corresponding authors than vice versa. Citation networks are closely linked to scientific collaboration and mobility networks but the citation network exhibits a more skewed pattern. For example, many China or Germany-based authors cite US-based authors whereas few US-based authors cite authors based in China or Germany. This network shows that China has a much smaller size in terms of citations received from abroad than would be implied by its overall publication volume. Over the 1996-2013 period, China-based authors received approximately as many foreign citations as Sweden, although this figure has increased rapidly.

60. International citation network, 1996-2013

Citation counts, by country of main affiliation of citing and cited corresponding author

Source: OECD calculations based on *Scopus Custom Data*, Elsevier, Version 4.2015, May 2015. StatLink contains more data.

StatLink http://dx.doi.org/10.1787/888933273353

How to read this figure

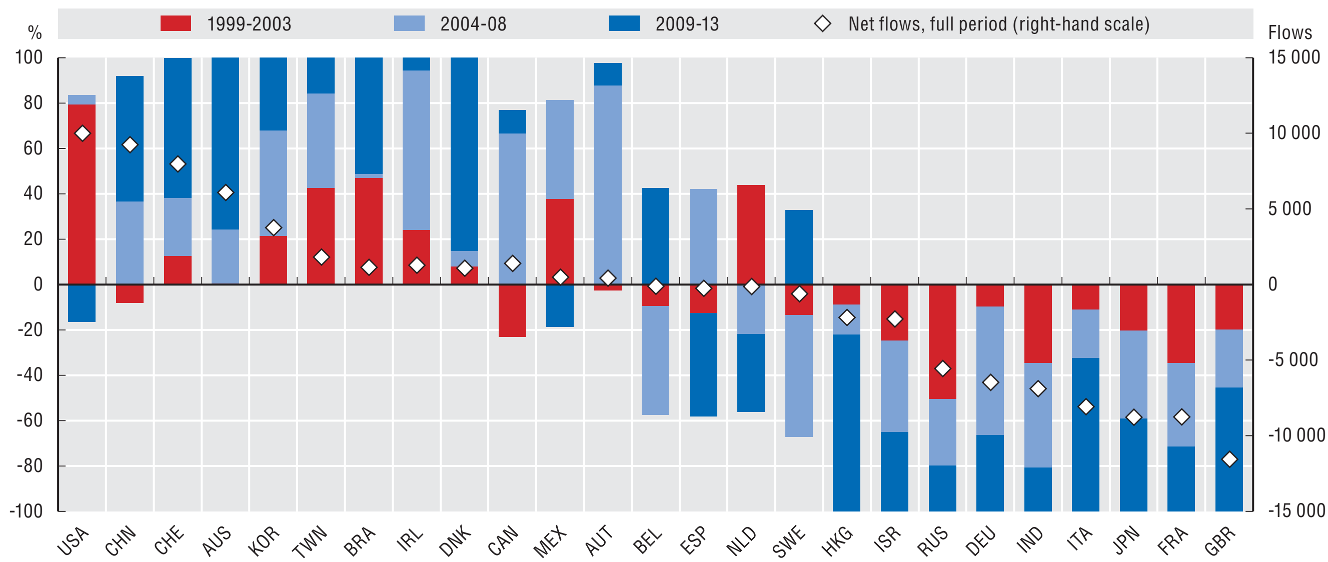
The position of selected economies (nodes) exceeding a minimum number threshold of 200 000 citations received has been determined by the total number of citations across economies from 1996 to 2013. For the arrows (citation flows) a minimum threshold of 100 000 citations was applied. A visualisation algorithm (Sci2 Team, 2009) has been applied to the international citation network to represent the linkages in a two-dimensional layout where distances reflect the combined strength of citation forces between economies. Bubble sizes are proportional to the number of citations received by a given economy from all other economies, excluding citations from within the economy itself. The thickness of the arrows linking the nodes and the intensity of the colour represents the number of citations. These arrows are oriented from the citing to the cited economy. Differences in the size and colour of the arrow tip denote a marked variation in the volume of citations in opposite directions.

Researchers on the move

Indicators of international mobility based on changes in author affiliations can be used to investigate the net entry or exit flow of scientific authors over time. The timing and intensity of these flows can be related to relevant policies adopted by countries, for example concerning the funding of scientific research, support for international mobility, or the role played by migration policies. Analysis of the economies involved in the largest cumulative absolute number of flows from 1999 to 2013 reveals that countries such as Australia, China and Switzerland owe most of their overall positive net inflow to recent trends. China reversed what were net outflows experienced in the late-1990s into a significant net inflow of authors in the last few years, while India experienced persistent net outflows until 2013 when a net inflow was first recorded. In the United States, a positive balance involves substantial net inflows in the early part of the 1999-2013 period, combined with a net outflow in more recent years. Spain has recently witnessed a return to the net outflows experienced in the beginning of the late 1990s. While the scientist population in the United Kingdom is among the most mobile, it also has the largest net outflow over the period.

61. International net flows of scientific authors, selected economies, 1999-2013

Difference between annual inflows and outflows, as percentage of cumulative net flows



Note: Detailed yearly flows available as "More data" provide a more accurate description of trends.

Source: OECD calculations based on *Scopus Custom Data*, Elsevier, Version 4.2015, *http://oe.cd/scientometrics*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273360

How to read this figure

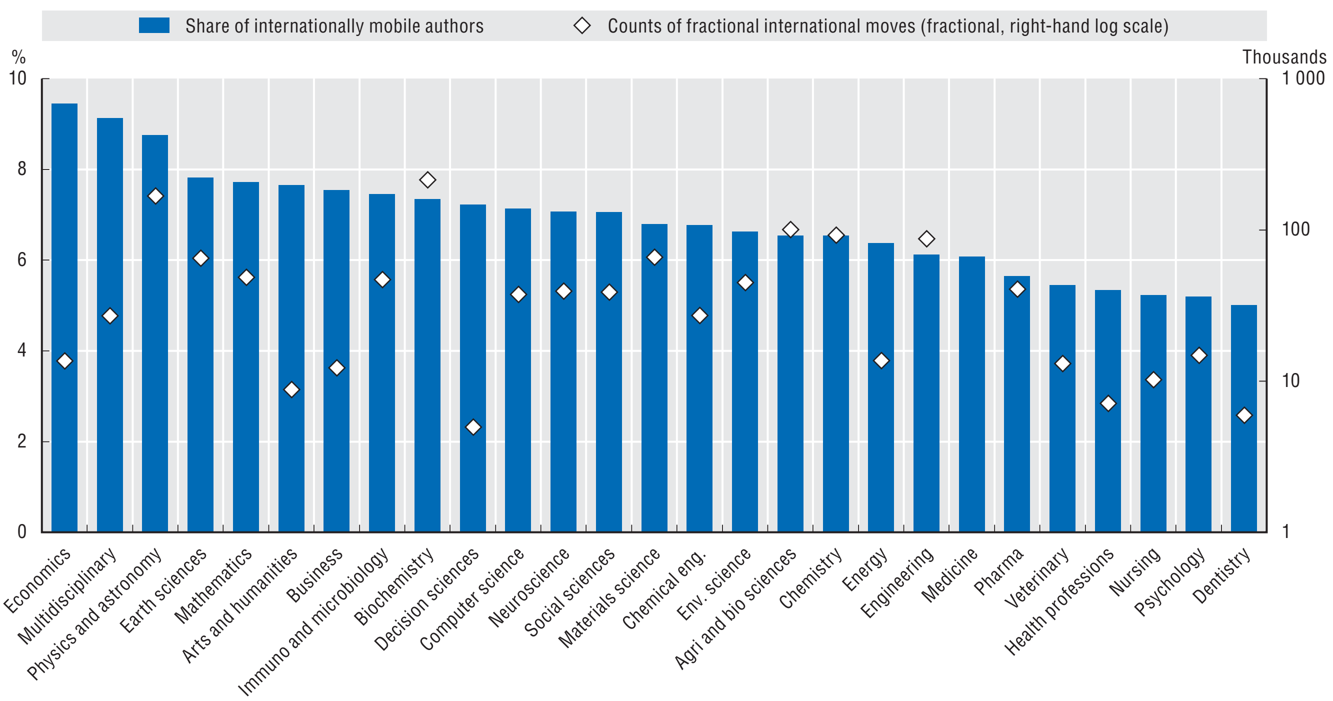
This figure decomposes the overall net flow of scientific authors across different years for economies experiencing the largest flows over the period 1998-2013, expressed in relative terms. This helps to identify the timing and intensity of different phases of net entry and net exit from the perspective of a given country. For example, Belgium and Spain experienced no net gain or loss over the period (see diamond value on the right-hand scale). In the case of Spain, this is the result of a phase of net outflow in the late 1990s, followed by a significant net inflow of scientific authors in the 2000s. Spain subsequently experienced a significant net exit of scientific authors in recent years. This mirrors the opposite of Belgium's record, which experienced net gains in recent years offsetting previous net exits.

Researchers on the move

Aggregate patterns of scientist mobility hide important variations by scientific domain. The highest mobility rates are found in Economics and Physics and Astronomy. Authors publishing in multidisciplinary journals are also more mobile than the average. The fields experiencing the largest number of mobility episodes are Medicine, Biochemistry and Physics and Astronomy. These volumes are related to the overall publication volumes in those fields. The lowest mobility rates are found in Medicine and several other health-related domains. This may reflect more limited scope for mobility for individuals with professions combining a research and healthcare component. Mobility is also relatively limited in engineering-related domains. The data also point to a wide heterogeneity of mobility patterns by field and country. For example, analysis of bilateral flows between the United States and China point to a net outflow from the United States for authors in Engineering while the opposite holds for Biochemistry.

62. International mobility of scientific authors by field, 1996-2013

Based on authors with publications in more than two years



Source: OECD calculations based on *Scopus Custom Data*, Elsevier, Version 4.2015, *http://oe.cd/scientometrics*, June 2015. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888933273378*

How to measure scientific author mobility

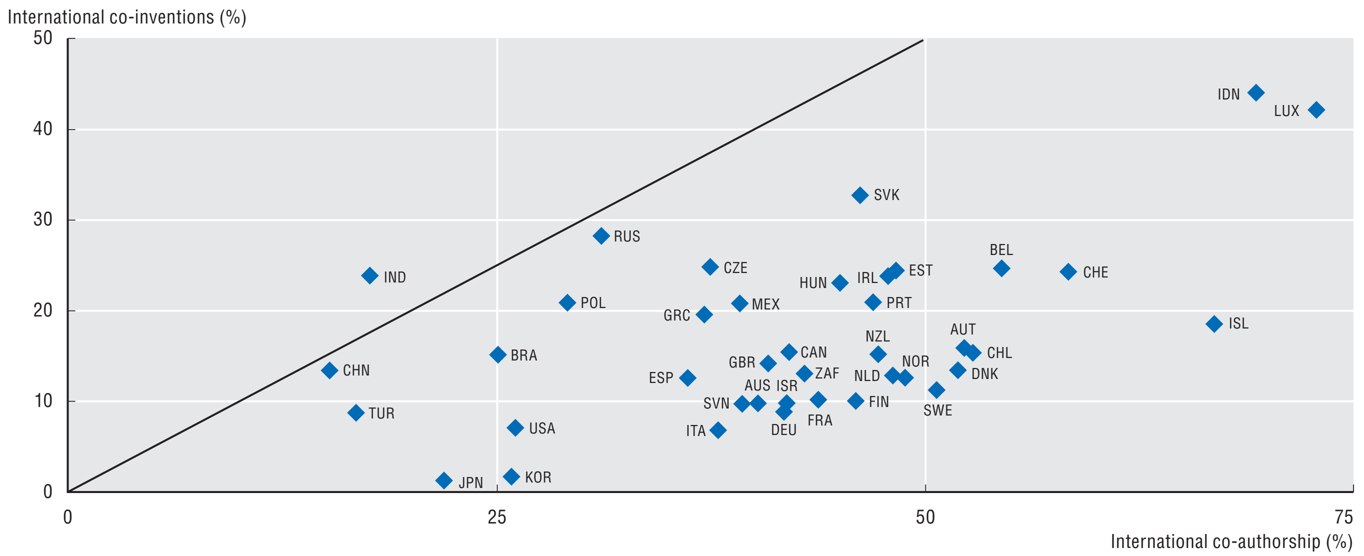
It is difficult to capture consistently the movement of scientists through statistical surveys which are national in scope. Monitoring changes in scientist affiliations in global repositories of publications provides a complementary source of detailed information but these are limited to authors who publish and do so regularly: otherwise their affiliations cannot be detected and timed in a sufficiently accurate way. Mobility can only be computed among authors with at least two publications. These indicators are likely to understate flows involving moves to industry or organisations within which scholarly publication is not the norm. Furthermore, measurement of mobility can be hard to disentangle from that of collaboration in the case of authors with multiple affiliations in different countries. For example, significantly higher volumes of flows are detected when working with a dominant country affiliation than by applying a fractional affiliation criterion for each author.

Collaboration and competition

Collaboration within and across countries is a pervasive feature of research and innovation activities worldwide. This can be seen by looking at the affiliation and geographic location of co-authors of scientific publications and co-inventors of patented inventions. With the exception of India, international collaboration appears to be more frequent in scientific production than in inventive activities. While exhibiting similar levels of engagement in international co-authorships, highly innovative economies such as Japan, Korea and the United States present different levels of co-patenting, with Asian inventors being relatively more engaged in within-country collaboration. Small open economies generally seem very active in international co-authorships (about 45% or more), whereas engagement in international co-inventions varies: Nordic countries exhibit values of about 10-15%, while economies such as Ireland, Belgium and Switzerland collaborate in about 25% of cases. Factors such as scientific and technological specialisation, collaboration opportunities, and geographical and institutional proximity may contribute to explain these patterns.

63. International collaboration in science and innovation, 2003-12

Co-authorship and co-invention as a percentage of scientific publications and IP5 patent families



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015; and OECD and SCImago Research Group (CSIC), *Compendium of Bibliometric Science Indicators 2014*, *http://oe.cd/scientometrics*. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273385

How to read this figure

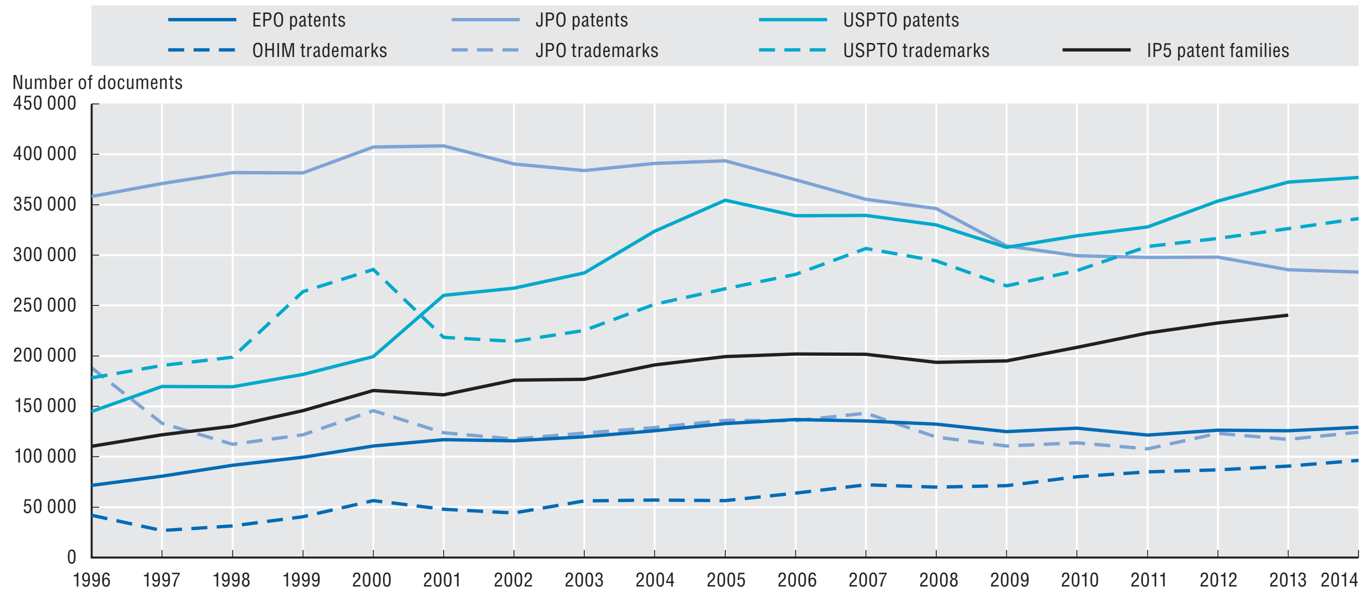
International co-authorship of scientific publications is measured in terms of the share of articles featuring authors affiliated with foreign institutions (from a different country or economy) in total articles produced by domestic institutions. International co-inventions are measured as the share of patents with at least one co-inventor located abroad in total patents invented domestically. Most countries fall below the 45-degree line, indicating a larger share of international scientific co-authorships than patented co-inventions. For Sweden, 50% of publications featuring Swedish institutions involved co-authorship with institutions based abroad. For Japan, scientific co-authorship just exceeds 20%; however this is higher than the level of international patent co-invention, which stands at less than 2%.

Collaboration and competition

Recent decades have witnessed an overall surge in intellectual property rights (IPR) applications worldwide. Firms rely not only on patents but also increasingly on other types of IPR, such as trademarks, to protect their product and process innovations on the markets. This reflects the growing centrality of knowledge-based assets such as R&D, design or brands to firms' business models and their competitiveness. It also reflects the complexity and modularity of many new products and technologies (e.g. computers, mobile phones and electric cars) and the fact that new products often embed features that require protection through IPR bundles. Trademark-related activities appear more sensitive to economic cycles than patents, as shown by the marked drops in trademark applications in the United States, Japanese and European markets in the early 2000s and in 2008-09 (although this drop was less marked in Europe). Overall, a strong increase has been observed in both patent and trademark-related activities at USPTO since the 2000s (a more than 40% increase between 2001 and 2013). The steady growth of IP5 patent families over the last two decades has been driven mainly by the surge in IPR activities in Chinese and Korean markets, which more than counterbalanced the slowdowns observed to different extents in Europe and Japan.

64. Trends in the IP bundle, 1996-2014

Patent and trademarks applications in selected IP offices



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*; EPO, JPO and USPTO annual reports 2012-14; and WIPO, IP Statistics Data Center, *http://ipstats.wipo.int*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273392

The geographical scope of IP protection

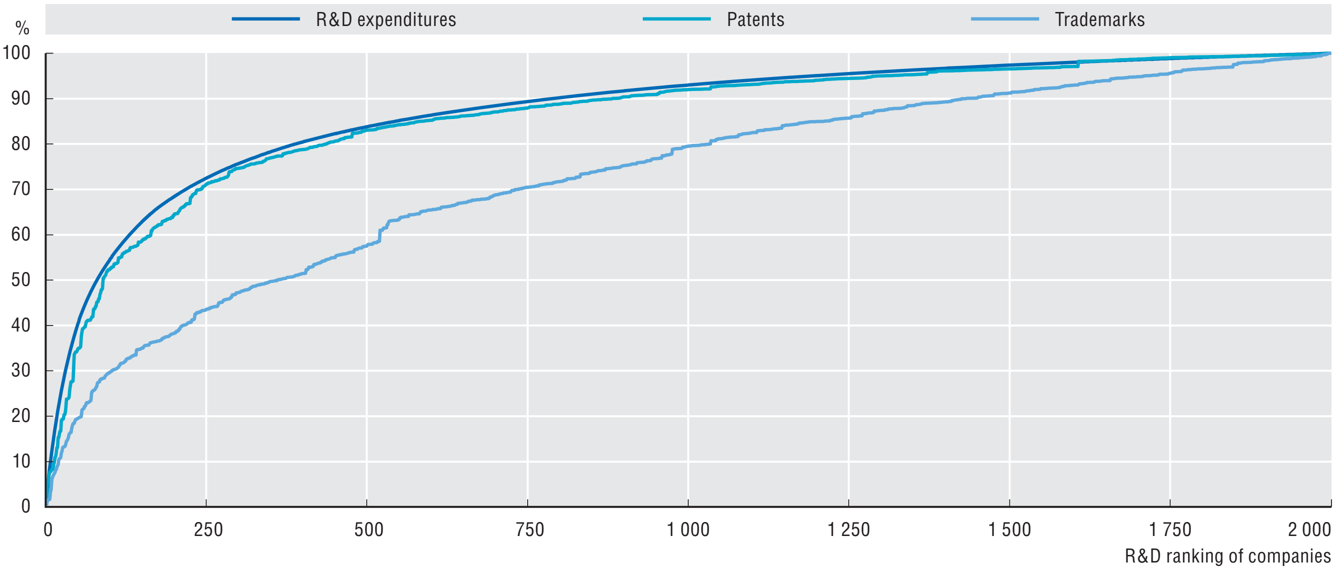
The data series mirror the number of new patent and trademark applications in the various IP offices by filing date. IP5 patent families correspond to patent families filed within the Five IP offices (IP5, i.e. the European Patent Office, EPO; the Japan Patent Office, JPO; the Korean Intellectual Property Office, KIPO; the State Intellectual Property Office of the People's Republic of China, SIPO; and the US Patent and Trademark Office, USPTO) and are attributed to the different IP authorities depending on the office where they were first filed. The IP bundle in the European market refers to patent applications at the EPO and trademark applications at the Office for Harmonization in the Internal Market (OHIM). The Japanese market refers to patent and trademark applications filed at the JPO, and the US market refers to patents and trademarks filed at the USPTO. Differences in factors such as requirements, administrative procedures and costs across offices may affect the extent to which IP systems are used. In Europe, European IP offices coexist with national offices. IP users may seek Europe-wide protection and file applications at the EPO and the OHIM, or protect their IP rights in each European country. EPO patents may be requested for one or more contracting states (38 since 2010), whereas OHIM trademarks have a unitary European character that precludes restrictions on their geographic scope.

Top R&D corporate players

Top corporate R&D investors are companies at the technology frontier which account for a substantial amount of innovation-related investment and output. The headquarters of these companies are concentrated in relatively few economies – mainly OECD and BRIICS countries – and have affiliates in 202 economies worldwide, although more than 60% are located in the United States, Japan, France and the United Kingdom. R&D expenditure, as well as innovative output in the form of patents and trademarks, also appears to be highly concentrated. In 2012, the top 5% of these corporate R&D investors (i.e. the top 100 companies) accounted for 55% of R&D expenditure, 53% of patents and 30% of trademarks. The top 250 corporate R&D investors accounted for more than 70% of R&D and patents and 44% of trademarks. Out of the total number of patents held by the top 250 R&D players, 55% relate to information and communication technologies (ICTs), corresponding to almost 80% of all ICT-related patents owned by the top 2 000 corporate R&D investors. Factors such as industry-specific dynamics, product complexity and market differentiation strategies help to explain emerging differences between patent and trademark patterns.

65. R&D expenditures and the IP bundle of top R&D companies, 2012

Cumulative percentage shares within the top 2 000 R&D companies



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273408

Who are the world top corporate R&D investors?

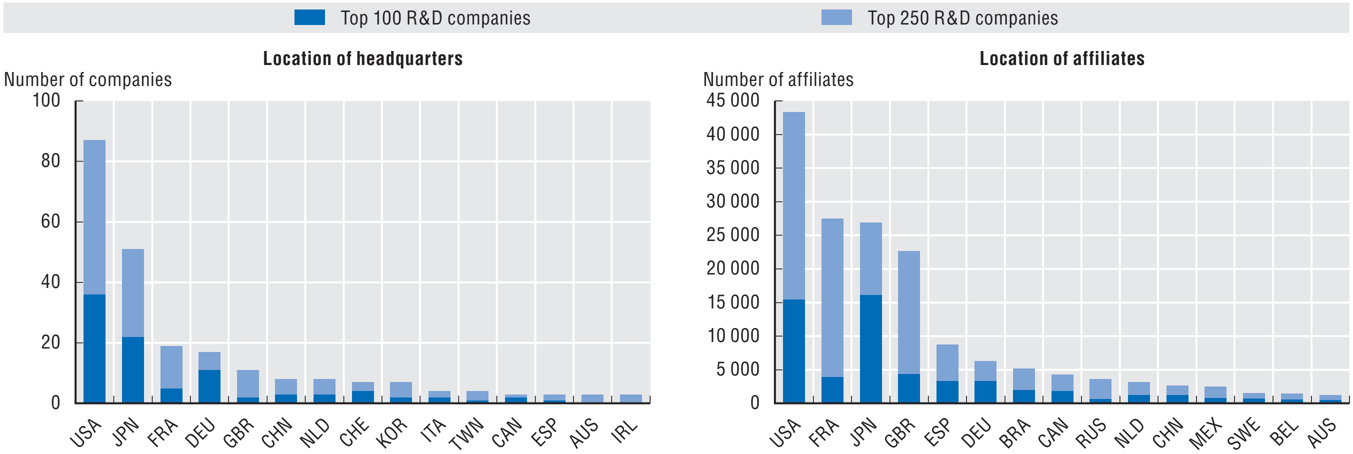
Top R&D investors worldwide are companies that are either parents of (a number of) subsidiaries or independent entities. In the former case, the R&D spending figure used for the ranking is that which appears in consolidated accounts and includes spending made by subsidiaries. In 2012, the top R&D investors had more than 500 000 "controlled" subsidiaries (defined as firms owned for more than 50% by the parent company) and accounted for EUR 539 billion in total annual R&D investment. This figure corresponds to more than 90% of total business R&D expenditure of OECD countries plus Argentina, China, Romania, the Russian Federation, Singapore, South Africa and Chinese Taipei. Nine of the top 10 patenting companies among top R&D investors were headquartered in Asia, and eight belonged to the ICT sector. Overall, their patent families' portfolio accounted for one quarter of total patents owned by top R&D investors. Top corporate R&D investors used patents and trademarks as complementary means of protection and the majority of companies in the US and European markets favoured the combined use of these IP rights. More information about these companies and their patenting and trademarking activities can be found in Dernis, Dosso et al. (2015).

Top R&D corporate players

In 2012, about 60% (55%) of the headquarters of the top 100 (250) R&D corporate investors and 50% (40%) of their affiliates were based in the United States and Japan. Most of the remaining headquarters and affiliates of the top 250 corporations were located in France, the United Kingdom and Germany. The industry that saw the highest number of top R&D investors was computers and electronics, which alone accounted for about 30% of both the top 100 and the top 250 R&D corporate investors. Companies in the fields of computers and electronics, transport equipment and pharmaceuticals together accounted for 70% (55%) of the top 100 (250) corporate R&D investors. However, all R&D corporations, taken individually, tend to diversify their subsidiaries' structure both in terms of industrial activity and location of affiliates.

66. Top 100 and 250 corporate R&D players by location of headquarters and affiliates, 2012

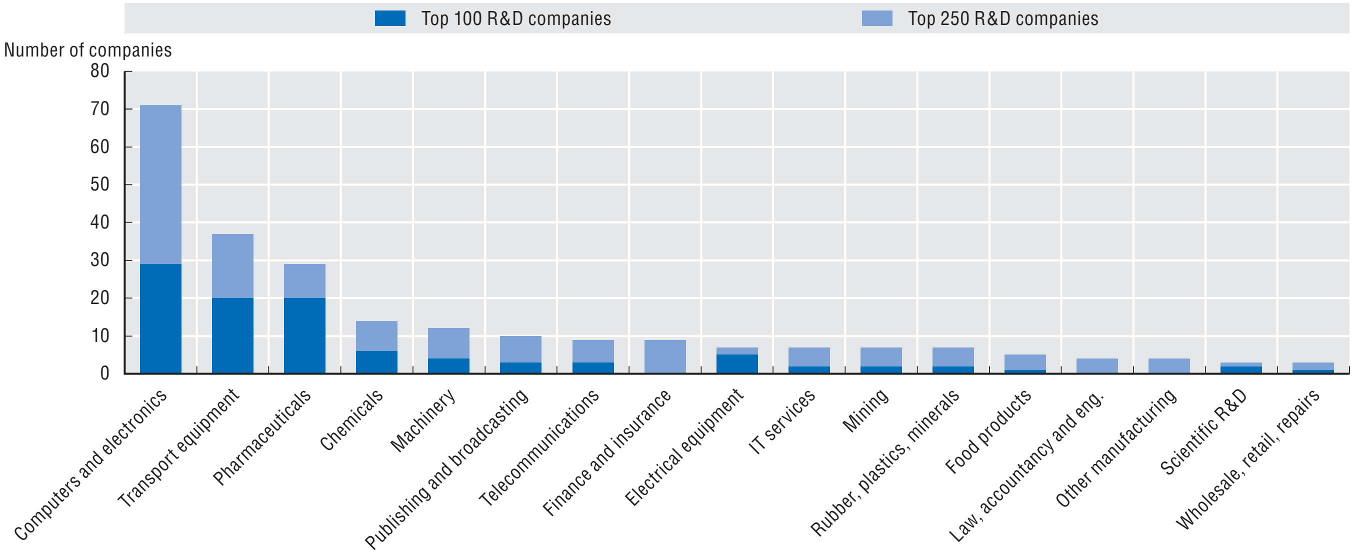
Number of companies and affiliates in the top 100 and top 250 R&D companies



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888933273413*

67. Top 100 and 250 corporate R&D players by industry, 2012



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888933273426*

IP bundle of top R&D players

The top corporate R&D investors are technology and market leaders. Their technological profile and IP portfolios can provide leads on current and future innovation and about the dynamics of competition. In 2012 the 2000 leading R&D companies, together with their over 500 000 "controlled" subsidiaries, accounted for more than 90% of global business R&D and 66% of patent families covering the largest five IP offices worldwide (IP5). More than 60% of these companies were headquartered in the United States, Japan, Germany and the United Kingdom and about 9% in China and Chinese Taipei. Top-R&D corporations located in Korea specialise in all ICT-related technology areas, as well as associated fields, such as semiconductors and optics. US-headquartered corporations lead in IT methods, whereas Chinese corporations are extremely specialised in digital communications and telecommunications. More generally, top corporate R&D investors headquartered in Europe and the United States tend to specialise in a wider array of technologies, including those targeting societal challenges such as health, energy and the environment.

68. Technological specialisation of top R&D investors by headquarters' location, 2010-12

Revealed technology advantage of companies' patent portfolio

Low specialisation | Average | High specialisation

	EU28	United States	Japan	Korea	China	Rest of the world
Electrical machinery	1.0	0.7	1.1	1.3	0.5	1.1
Audio-visual tech.	0.4	0.5	1.2	1.6	0.6	2.1
Telecommunications	0.7	0.7	1.0	1.4	3.1	1.3
Digital communication	1.1	1.1	0.6	1.3	8.0	1.2
Basic communication	0.8	1.0	1.0	1.0	1.1	1.7
Computer technology	0.5	1.3	0.8	1.4	1.4	1.8
IT methods	0.8	1.8	0.7	1.0	0.6	1.2
Semiconductors	0.4	0.7	1.1	2.0	0.1	1.5
Optics	0.3	0.4	1.6	1.1	0.2	1.0
Measurement	1.4	1.1	0.9	0.5	0.3	0.8
Control	1.7	1.9	0.4	0.1	0.7	1.3
Micro- and nano-tech.	1.2	1.0	0.7	1.3	0.0	1.7
Bio materials	1.6	1.6	0.7	0.6	0.0	0.1
Medical technology	1.5	1.6	0.9	0.3	0.0	0.2
Organic chemistry	2.0	1.4	0.6	0.3	0.5	0.3
Biotechnology	1.8	1.6	0.6	0.6	0.1	0.2
Pharmaceuticals	2.0	1.8	0.5	0.2	0.1	0.6
Polymers	1.2	0.9	1.1	0.7	0.3	0.5
Food chemistry	2.1	1.8	0.5	0.2	0.0	0.1
Basic chemistry	1.4	1.3	1.0	0.5	0.2	0.3
Chemical eng.	1.6	1.4	0.8	0.6	0.3	0.3
Materials, metallurgy	1.2	0.7	1.3	0.5	0.3	0.3
Surface and coating	0.8	1.1	1.1	0.7	0.1	1.2
Civil eng.	1.9	1.8	0.5	0.1	0.5	0.4
Environmental tech.	1.4	1.4	1.0	0.4	0.3	0.1
Thermal devices	1.5	0.8	0.9	0.9	0.3	0.6
Engines, pumps, turbines	1.5	1.7	0.8	0.4	0.1	0.2
Machine tools	1.4	1.1	1.0	0.2	0.6	0.7
Other special machines	1.4	1.0	1.1	0.3	0.1	0.4
Mechanical elements	1.6	1.2	0.8	0.5	0.2	0.5
Transport	1.5	1.1	1.0	0.7	0.1	0.2
Handling and logistics	1.2	0.8	1.3	0.2	0.3	0.7
Textile and paper machines	0.5	0.6	1.8	0.2	0.2	0.1
Furniture, games	1.7	0.8	0.9	0.5	0.7	0.7
Other consumer goods	1.9	0.8	0.7	1.4	0.2	0.4

Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273438

How to read this figure

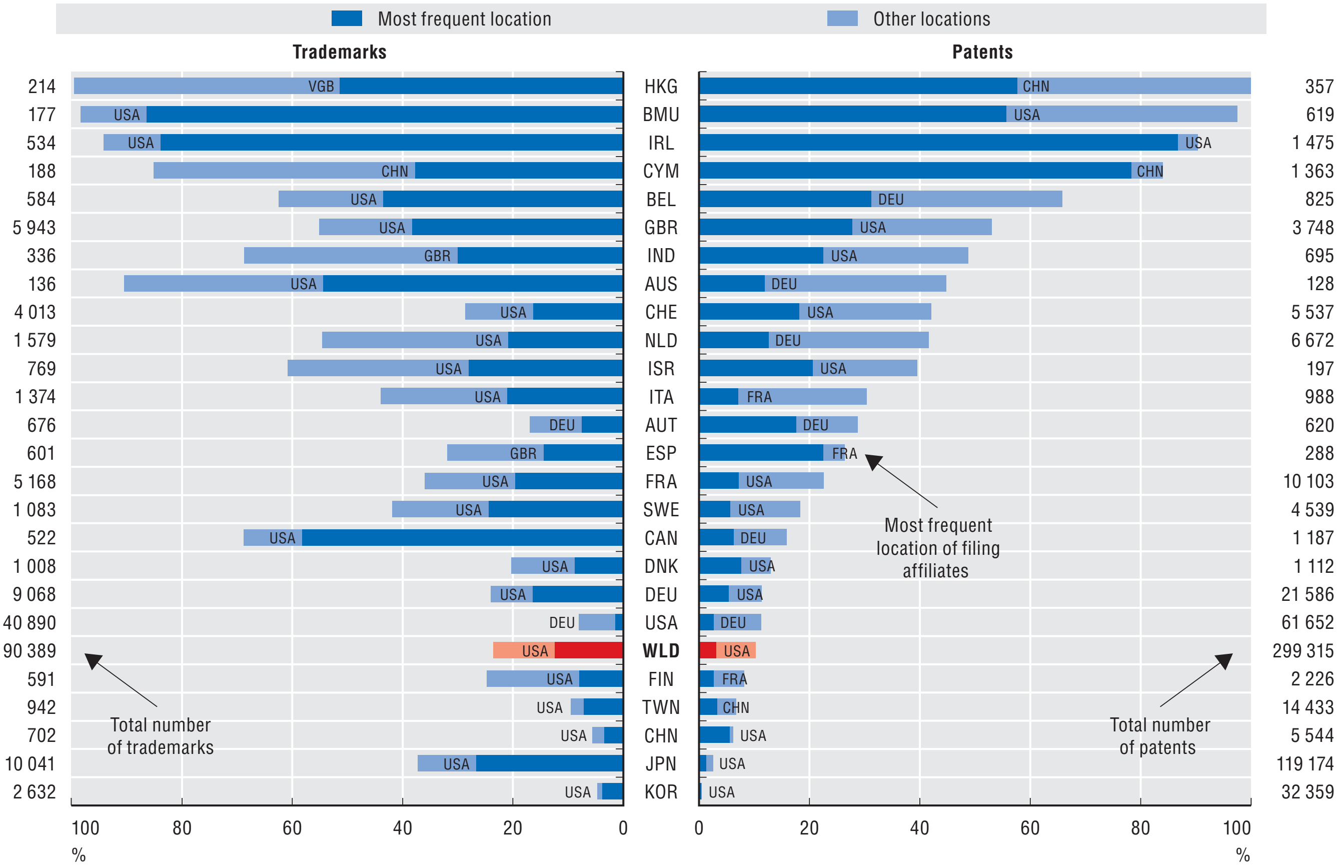
Patent families are sets of patents taken in multiple countries to protect a single invention obtained by means of extending the priority filing, i.e. the first application, to other offices. The revealed technological advantage (RTA) index uses data contained in patent families to provide an indication of companies' relative specialisation in different technologies. The index is equal to zero when the companies in a considered economy have no patents in a given field; equals 1 when the share in a considered technology field equals the share in all fields (no specialisation); and above 1 when a positive specialisation in a certain field is observed. Food chemistry is the technology field in which Europe-based top R&D inventors are relatively more specialised (with an RTA value of 2.1) whereas China's top specialisation field is digital communication (with an RTA value of 8). Top R&D investors located in the United States and Korea feature opposite specialisation patterns in the case of control-related technologies: in the case of US based corporations it is the field featuring the highest RTA index (1.9), whereas Korea based R&D investors barely exhibit any inventive activity in the field (their RTA is 0.1).

IP bundle of top R&D players

Information contained in intellectual property (IP) rights such as patents and trademarks can be used to trace the origin of value creation (the geographical location of innovators) and the site of value appropriation (the geographical location of the ultimate owners of innovations). Patents proxy technological innovations, whereas trademarks provide information about new product and service innovations. More than 80% of the technological and product innovations protected in Europe and the United States by top-global R&D investors headquartered in Hong Kong, China; Bermuda; Ireland and the Cayman Islands are generated by foreign affiliates. The United States and China stand out as the dominant location of these affiliates. In general, while top-R&D performers rely differently on innovators located abroad, the location of innovative affiliates generating technological, product and service innovations in the United States and Europe are often the same: the United States is the top location, followed by Germany, China and France.

69. IP filings by foreign affiliates of top R&D corporations, by location of the headquarters, 2010-12

Share of total patents and trademarks filed in Europe and the United States, and most frequent location of foreign filing affiliates



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cld/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273440

How to read this figure

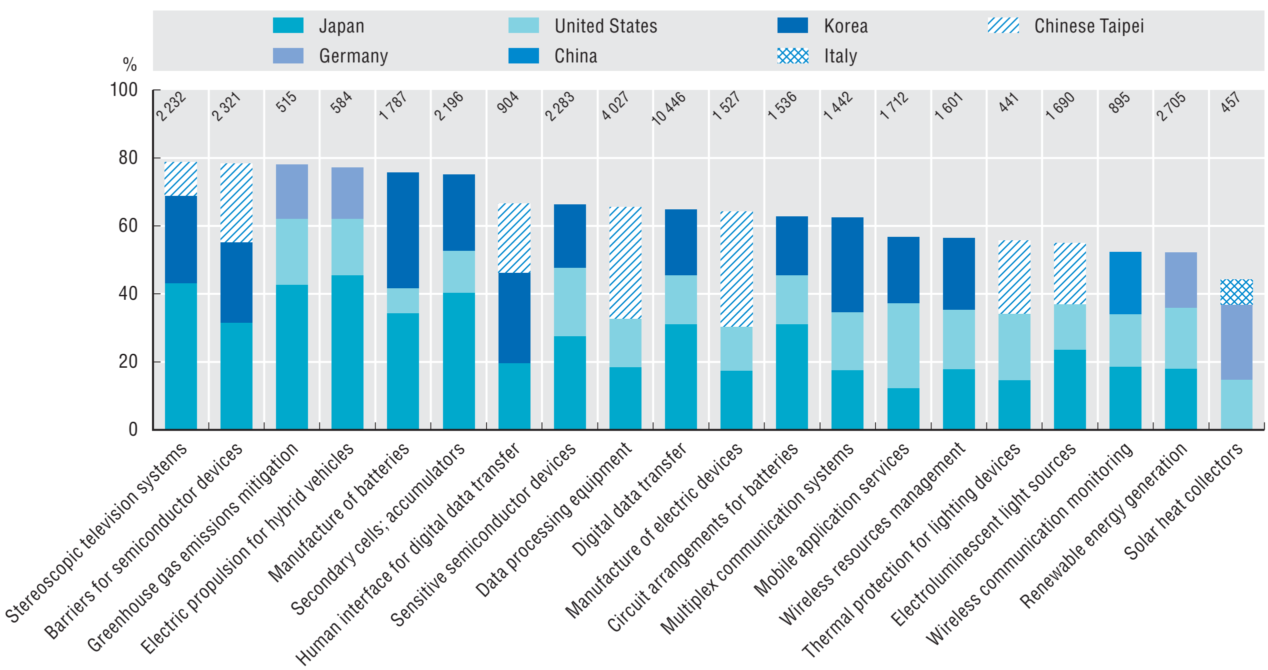
The figure refers only to IP (patents and trademarks) filed by affiliates at USPTO and EPO/OHIM. The bars show the percentage of IP accounted for by foreign affiliates of R&D corporations by location of the headquarters. The dark portion of the bar represents the percentage of IP accounted for by the dominant location of the foreign affiliates and the name of the location is indicated with the country ISO code. Almost 100% of IP (patents and trademarks) owned by R&D corporations headquartered in Bermuda rely on innovations developed by foreign affiliates, with almost 60% of patents and more than 80% of trademarks that are generated by affiliates located in the United States. Japanese and Korean top R&D corporations that file IP on US and EU markets mostly rely on innovations generated by their domestic affiliates.

Bursting technological developments

Technologies emerge, develop and mature at different paces. Some technologies stabilise while other find a wide array of applications that accelerate their development. These technologies are said to "burst". An experimental data-mining approach enables monitoring of the extent to which technologies emerge, develop, stabilise or abate. Since 2005, booming technological developments have been observed in fields related to information and communication technologies (ICT), energy and the environment, and enabling technologies such as those related to semiconductors. Over the period 2010-12, the top three economies contributing to the rapid development of these "bursting" technologies were Japan, Korea and the United States, which together accounted for 40% to 80% of all patenting activities in these fields. China and Chinese Taipei were among the top three economies developing technologies in the fields of digital data and lighting, while Germany contributed to accelerated advances in environment-related technologies.

70. Top players in emerging technologies, 2010-12

Share of top three economies' patents in top 20 technologies bursting from 2005 onwards



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273458

Identifying acceleration in technological development

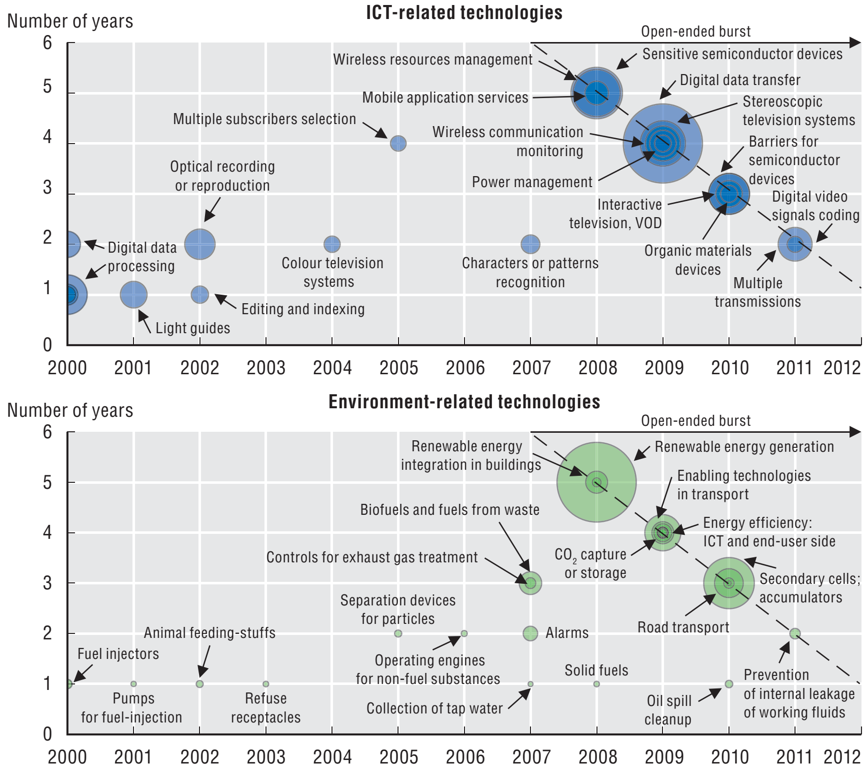
Patents protect novel inventions and technologies and patent data can help investigate the extent to which inventions occur in different technology areas, and the pace at which technologies develop, mature or are abandoned. A new data mining approach, called "DETECTS" (see Dernis, Squicciarini et al., 2015) exploits information contained in patents to identify innovative activities whose intensity increases sharply (i.e. "bursts"), compared to previous levels and to the development of innovations in other technology fields. It also maps the time it takes for such dynamics to unfold. A good comparison is the performance of marathon runners: some runners (technologies) run consistently (develop) at the same pace, others may at times accelerate ("burst") and then continue to run at this faster pace until the end of the competition ("open-ended burst"), and some accelerate and then slow down ("completed burst") or even abandon the competition. A technology field is said to "burst" or accelerate when a substantial increase in the number of patents filed in the field is observed. DETECTS monitors such acceleration in relative terms (i.e. compared to past development patterns in the field and relative to the pace of development in other fields). Monitoring fields in which accelerations occur is vital for policy making, as developments are likely to persist in these areas over the short and medium term. Furthermore, information contained in patents about the location of patent owners and the technology fields to which inventions belong allows identification of economies leading such technology developments, and can shed light on the generation of new fields arising from the cross-fertilisation of different technologies (e.g. ICT and environmental technologies).

Bursting technological developments

ICT products such as mobile phones and computers are well known for their complexity and modularity, their rapid obsolescence, and their reliance on a wide array of continuously evolving technologies. Examination of ICT technologies which have burst over the last decade enables closer observation of these features. At the start of the 2000s, activities burgeoned in the field of digital data processing and editing; however, since 2008 technologies related to wireless communications and improved performance of ICT devices (e.g. power management, data transfer) have accelerated with unprecedented intensity. Over the period 2000-12, a continuum of bursts in different areas characterised the development of environment-related technologies, including acceleration in the development of biofuels and fuels from waste (2007-09), and the series of open-ended bursts underway in transport-related technologies, the generation of renewable energy, and energy accumulation and efficiency. In comparison to the start of this period, recent bursts seem to last longer and consist of a higher number of inventions.

71. Intensity and development speed in ICT and environment-related technologies, 2000-12

Intensity of bursts (bubble size) and duration over time



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

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How to read this figure

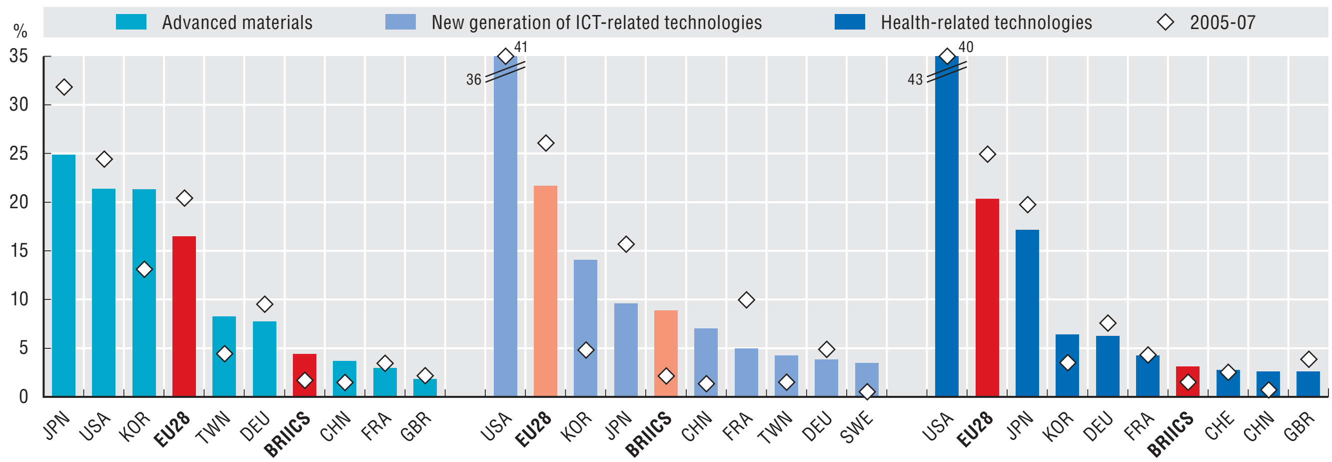
The size of the bubble indicates the "burst" intensity, and different shades indicate the different technologies that burst. The technology bursts in the year are indicated on the X axis and the acceleration of its development ends in t years after the burst, indicated on the Y axis. For example, acceleration in the development of patented technologies related to biofuels and fuels from waste was first observed in 2007, and lasted for three years, until the end of 2009. Bubbles located along the diagonal line on the right hand side of the figure represent "open-ended" burst technologies (i.e. technologies still developing at an accelerated pace at the end of the sample period) . For example, a number of technologies began to burst in 2009, including technologies related to CO_2 capture or storage, enabling technologies in transport, and energy efficiency. While developments in these fields were characterised by varying number of patents – with enabling technologies in transport accounting for the highest number – inventive activities in all fields continued to occur at an accelerated pace up to the end of the 2012.

A new generation of disruptive technologies

Disruptive technologies displace established ones and affect production processes, the entry of new firms, and the launch of ground-breaking products and applications. Examples of such technologies include sensors, computers and experimental gene therapies. Many of the most exciting or useful products available today owe their existence performance, efficacy and accessibility to the recent development of disruptive technologies in fields such as advanced materials, information and communication technologies, and health-related technologies. In 2010-12, the United States, Japan and Korea led inventive activities in these domains, together accounting for more than 65% of patent families filed in Europe and the United States, followed by Germany, France and China. The United States alone contributed 36% of all inventions patented. In the case of a new generation of ICTs (i.e. technologies related to the Internet of Things (IoT), big data and *quantum* computing and telecommunication) and 43% of health-related technology patents, whereas BRIICS economies, and China in particular, contributed about 3% and 8% of inventions in health-related and ICT-related technologies, respectively.

72. Top players in selected disruptive technologies, 2005-07 and 2010-12

Economies' share of IP5 patent families filed at USPTO and EPO, selected technologies



Source: OECD calculations based on IPO (2014), *Eight Great Technologies: the Patent Landscapes*, United Kingdom; and *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273474

Methodology

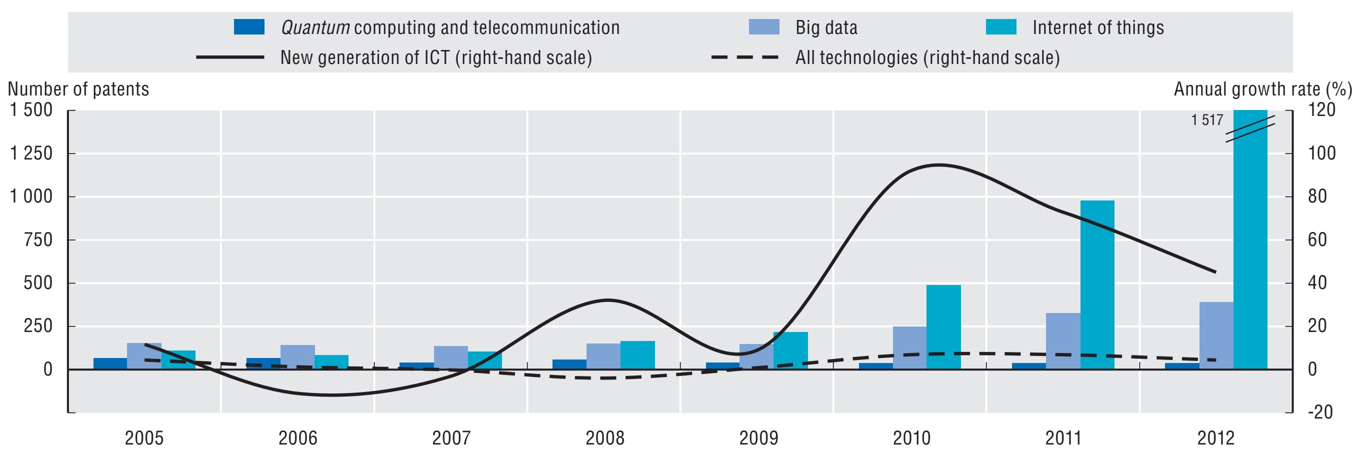
The UK Government has identified a number of technologies as potential sources of future growth. Experts from the UK Intellectual Property Office (IPO) mapped inventive activity in these technologies over the period 2004-13 through examination of patent documents published worldwide. Among the identified technologies were a number of enabling technologies that form the basis of the new generation of ICTs, as well as advanced materials and health-related technologies. The new generation of ICT technologies includes *quantum* computing and telecommunication, the Internet of Things, and big data and energy efficient computing. *Quantum* technologies harness *quantum* physics to acquire functionalities or improve the performance of existing technologies (e.g. microprocessors). *Quantum* computation technologies are information-processing methods that promote more effective computation. *Quantum* telecommunications technologies offer secure communication channels and lead to patents related to encryption, as well as transmission systems and components. Big data and energy-efficient computing relates to data having such magnitude (typically several petabytes) and high processing speed requirements that require innovative approaches to handling and manipulation. The Internet of Things (IoT) refers to networks of everyday physical objects that can be accessed through the Internet and are able to automatically identify themselves to other devices. Examples include remote control appliances, traffic congestion optimisation, e-health and industrial auto-diagnosis. Advanced materials and nanotechnologies in conjunction with ICT technologies are likely to engender the next production revolution. They encompass new forms of carbon (e.g. graphene and nanostructures), metamaterials, renewable energy enabling materials and wearable technologies. Health-related technologies encompass developments in life sciences, genomics and synthetic biology. The indicators presented here rely on patent families within the Five IP offices (IP5) with patent family members filed at the EPO or USPTO. The distribution of economies reflects the location of patent assignees. Further insights about these technologies can be found in IPO (2014).

A new generation of disruptive technologies

Technologies often develop in a wave-like fashion. Rapid growth is sometimes followed by periods of slower activity and subsequent phases of rapid development. Such behaviour is visible for 2005-12 in the new generation of ICT-related technologies. Inventive activities related to big data exploded around 2010, while developments related to the Internet of Things (IoT) grew throughout 2006-12, ranging from rates of 23% to 126% a year, reaching a peak in 2010. Activities in *quantum* computing and telecommunications seemingly established the basis for the development of other ICT-related technologies: patenting in the field peaked around 2006 and slowed down thereafter before stabilising. EU countries, especially the United Kingdom, led developments in *quantum* computing, whereas the United States led developments in both IoT and big data-related technologies. While European economies have played an increasingly important role in *quantum* technologies, both the European Union and the United States saw their relative share of IoT inventions diminish as Asian countries, in particular China, gained ground.

73. Patents in new generation of ICT-related technologies, 2005-12

Number of IP5 patent families and annual growth rates

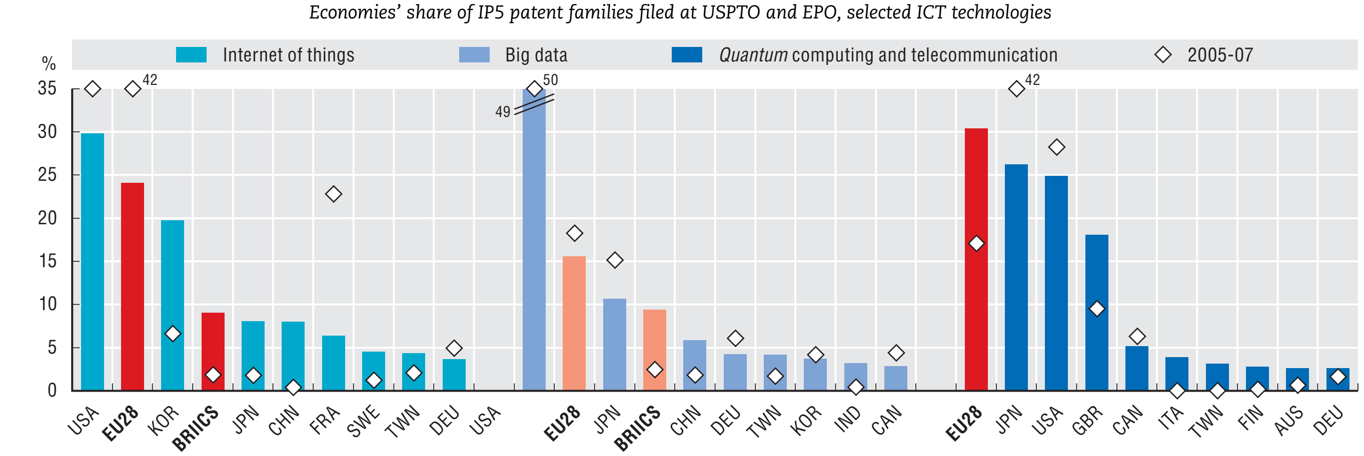


Source: OECD calculations based on IPO (2014), *Eight Great Technologies: the Patent Landscapes*, United Kingdom; and *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273482

74. Top players in IoT, big data and *quantum* computing technologies, 2005-07 and 2010-12

Economies' share of IP5 patent families filed at USPTO and EPO, selected ICT technologies



Source: OECD calculations based on IPO (2014), *Eight Great Technologies: the Patent Landscapes*, United Kingdom; and *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

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Notes and references

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 recognises 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 of the European Union Member States of the OECD and the European Union:

"The Republic of Cyprus is recognised 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."

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

1. Labour productivity growth based on hours worked, total economy level, 2001-14

Data for 2014 are provisional.

2. GDP per capita growth and GDP per person employed growth in the BRIICS and the OECD, 2002-07 and 2009-14

Calculations are based on GDP at constant prices, converted to USD using 2005 purchasing power parities.

Employment estimates for Brazil, China, India and Indonesia are based on Gröningen Growth Development Center (GGDC), *Total Economy Database*, January 2013; while series for South Africa are from OECD, Annual National Accounts database.

4. Harmonised unemployment rates in the OECD, European Union, United States and Japan, July 2008-April 2015

The OECD harmonised unemployment rates, compiled for all 34 OECD member countries, are based on the International Labour Office (ILO) guidelines. The unemployed are persons of working age (in the reference period) who are without work, are available for work and have taken specific steps to find work.

Rates are seasonally adjusted.

5. Job creation, job destruction and churning rate, 2001-11

General notes:

The following countries are covered: Austria, Belgium, Brazil, Denmark, Finland, Hungary, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden and Turkey.

The churning rate is calculated as the sum of the job creation rate and job destruction rate.

Owing to methodological differences, figures may differ from those officially published by national statistical offices.

Mergers and acquisitions are not taken into account in determining firm age, firm entry and firm exit.

Data for Japan are limited to the manufacturing sector only.

Data for the following countries are limited to the period indicated in brackets: Italy (2001-10), Spain (2003-11), Portugal and Turkey (2006-11), and Japan and Norway (2001-09). Data for the Netherlands in 2006 are excluded due to the redesign of the business register.

Additional note:

Gross job creation is defined as the sum of all positive unit-level job variations over the biennium. Gross job destruction is defined as the sum of all negative unit-level job variations over the biennium. For each of the two measures, the rate is calculated as the ratio of the value over the average employment in the biennium. The churning rate is calculated as the sum of job creation rate and job destruction rate.

6. Contribution to net job creation rate by group of firms, 2001-11

See general notes under 5.

Contribution to the net job creation rate is calculated as the ratio of net job creation (the difference between gross job creation and gross job destruction) of the reference group over average total employment in the biennium.

7. Contribution to net job creation rate by group of firms and macro sector, 2001-11

See general notes under 5.

Contribution to the net job creation rate is calculated as the ratio of net job creation (the difference between gross job creation and gross job destruction) of each macro sector over average total employment in the biennium.

8. Where people lost and gained jobs, 2010-14 and 2010-13

Sectoral changes in levels of employment can be "normalised" to highlight their relative contributions, within each country, to the total change in employment between 2010 and 2014. This is achieved, for each country, by expressing the sectoral changes as a percentage of the sum of absolute changes.

Aggregate industrial activities are defined according to ISIC Rev. 4: Agriculture, forestry and fishing (Divisions 01-03); Mining and utilities (05-09 and 35-39); Manufacturing (10-33); Construction (41-43); Wholesale, retail trade, hotels, food services, transportation (45-56); Information and communication (58-63); Finance and insurance (64-68); Professional, scientific and technical and other business services (69-82); and Public administration, education, health and other services (84-99).

The gains and losses, in thousands, represent the sum of those aggregate sectors with positive changes and the sum of those aggregate sectors with negative changes, respectively. A finer activity breakdown (e.g. 2-digit ISIC Rev. 4) would produce different estimates for total gains and losses.

For Japan, Professional, scientific, technical and other business services are combined with Public administration, education, health and other services.

For Chile, Information and communication, Financial, insurance and real estate activities and Professional, scientific, technical and other business services are grouped together.

The employment data are drawn mostly from National Accounts (SNA) sources and are measured in terms of persons, except for Canada, which is measured in terms of jobs.

9. Employment growth in information industries, OECD, 1995-2013

Information industries are defined according to ISIC Rev. 4 Divisions 26 (Computer, electronic and optical products), 58 to 60 (Publishing, audiovisual and broadcasting activities), 61 (Telecommunications) and 62 to 63 (IT and other information services).

OECD consists of OECD countries excluding Chile, Iceland and Turkey.

10. The Great Recession hit routine intensive occupations harder, 2001-13

3-digit occupations are ranked in terms of their routine intensity following an experimental methodology detailed in Marcolin et al. (2015), which exploits information from the OECD, Programme for International Assessment of Adult Competencies (PIAAC) database. Routine-intensive occupations rank above the median in terms of routine intensity of tasks performed on the job; non-routine occupations score below the median.

Employment data are sourced from the European Labour Force Surveys. Armed forces are excluded. Figures are based on data from: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Iceland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom. The change in the ISCO occupational classification used (from ISCO 1988 to ISCO 2008) imposes a break in the series between 2010 and 2011. Data for Italy exclude ISCO 1988 occupation 13 (general managers) due to a country-specific break in the series.

11. Contribution of routine-intensive and non-routine occupations to employment growth, 2000-13

3-digit occupations are ranked in terms of their routine intensity following an experimental methodology detailed in Marcolin et al. (2015), which exploits information from the OECD, Programme for International Assessment of Adult Competencies (PIAAC) database. Routine-intensive occupations rank above the median in terms of routine intensity of tasks performed on the job; non-routine occupations score below the median.

Employment data for Selected European countries are sourced from the European Labour Force Surveys. Armed forces are excluded. Figures are based on data from: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Iceland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom. The change in the ISCO occupational classification used (from ISCO 1988 to ISCO 2008) imposes a break in the series between 2010 and 2011. Employment data for the United States are sourced from the Current Population Survey. The conversion table for the occupational classification from SOC and Census to ISCO 2008 classifications is described in Eckardt and Squicciarini (2015).

Yearly figures for the United States are calculated as simple averages over monthly data. Figures for Europe are based on annualised quarterly data. 2012 figures for the United States are based on a simple eight-month average (i.e. May to December 2012), to avoid possible biases due to changes in the occupational codes used by the US Census to address confidentiality issues. See Eckardt and Squicciarini (2015) for details.

12. Long-term decline in manufacturing jobs, 1970-2013

G7 consists of Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

Estimates for Germany prior to 1991 are based on manufacturing employment shares for western Germany.

OECD refers to the unweighted mean of manufacturing shares of employment for 16 countries (i.e. the G7 and Australia, Belgium, Denmark, Finland, Ireland, Korea, the Netherlands, Norway and Sweden).

Manufacturing is defined according to ISIC Rev. 4 Divisions 10 to 33. Estimates for earlier years are based on vintage data for ISIC Rev. 3 Divisions 15 to 37.

13. Long-term trends in R&D-intensive manufacturing employment, 1980-2013

G7 consists of Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

Estimates for Germany prior to 1991 are based on manufacturing employment shares for western Germany.

OECD here refers to the unweighted mean of R&D intensive shares of employment for the 19 countries (i.e. the G7 and Australia, Austria, Belgium, Denmark, Finland, Ireland, Korea, the Netherlands, Norway, Portugal, Spain and Sweden).

R&D-intensive industries are defined according to ISIC Rev. 4: Chemical and pharmaceutical products (ISIC Rev. 4 Divisions 20 and 21), Machinery and equipment (26, 27 and 28) and Transport equipment (29 and 30). Estimates for earlier years are based on vintage data for equivalent ISIC Rev. 3 Divisions 24 and 29 to 35.

15. Origin of demand for business sector jobs in OECD, 1995-2011

The business services sector corresponds to ISIC Rev. 3 Divisions 10 to 74: Mining (10 to 14), Manufacturing (15 to 37), Utilities (40 to 41), Construction (45) and Business services (50 to 74).

East and Southeast Asia (excluding China) comprises Brunei Darussalam, Cambodia, Indonesia, Hong Kong (China), Japan, Korea, Malaysia, Philippines, Singapore, Chinese Taipei, Thailand and Viet Nam.

16. Origin of demand for manufacturing jobs in OECD, 1995-2011

The manufacturing sector corresponds to ISIC Rev. 3 Divisions 15 to 37.

East and Southeast Asia (excluding China) comprises Brunei Darussalam, Cambodia, Indonesia, Hong Kong (China), Japan, Korea, Malaysia, Philippines, Singapore, Chinese Taipei, Thailand and Viet Nam.

17. Origin of demand for business services jobs in OECD, 1995-2011

The business services sector corresponds to ISIC Rev. 3 Divisions 50 to 74.

East and Southeast Asia (excluding China) comprises Brunei Darussalam, Cambodia, Indonesia, Hong Kong (China), Japan, Korea, Malaysia, Philippines, Singapore, Chinese Taipei, Thailand and Viet Nam.

18. Origin of demand for jobs in Europe, 1995-2011

Europe refers to the 21 OECD members of the European Union (i.e. the EU28 excluding Bulgaria, Croatia, Cyprus, Latvia, Lithuania, Malta and Romania).

East and Southeast Asia (excluding China) comprises Brunei Darussalam, Cambodia, Indonesia, Hong Kong (China), Japan, Korea, Malaysia, Philippines, Singapore, Chinese Taipei, Thailand and Viet Nam.

19. Jobs sustained by foreign final demand, by skill intensity, 2011 and 2013 estimates

General notes:

The business sector is defined according to ISIC Rev. 3 Divisions 10 to 74: total economy excluding Agriculture, forestry and fishing (Divisions 01 to 05); Public administration (75); Education (80); Health (85) and Other community, social and personal services (90 to 95).

Skill intensity is defined according to major groups of the International Standard Classification of Occupations 2008 (ISCO-08): High-skilled occupations (ISCO-08 major Groups 1 to 3), medium skilled (4 to 7) and low skilled (8 to 9).

EU21 refers to the 21 OECD members of the European Union (i.e. the EU28 excluding Bulgaria, Croatia, Cyprus, Latvia, Lithuania, Malta and Romania).

Additional notes:

While jobs sustained by foreign final demand in 2011 are derived directly from the OECD ICIO table for 2011, the estimates for 2013 are preliminary projections or nowcasts.

Occupational employment data for the United States are sourced from the Current Population Survey. The conversion table for the occupational classification from SOC and Census to ISCO 2008 classifications is described in Eckardt and Squicciarini (2015).

20. Skill content of employment sustained by domestic and foreign final demand, 2011

See general notes under 19.

Additional notes:

Occupational employment data for the United States are sourced from the Current Population Survey. The conversion table for the occupational classification from SOC and Census to ISCO 2008 classifications is described in Eckardt and Squicciarini (2015).

21. Decomposition of growth in GDP per capita, 2002-07 and 2009-14

Calculations are based on GDP at constant prices, converted to USD using 2005 Purchasing Power Parities.

For Australia, estimates refer to fiscal years beginning 1st July.

For New Zealand, underlying GDP series refer to fiscal years beginning 1st April.

22. Gap in GDP per capita, in GDP per person employed and in labour utilisation, non-OECD economies, 2014

Calculations are based on GDP at current prices, converted in USD using 2014 Purchasing Power Parities (PPPs).

Differences are computed *vis-à-vis* the 17 OECD countries with highest GDP per capita in 2014.

Labour productivity is estimated as GDP per person engaged.

Labour utilisation is calculated as the ratio of total employment and population.

Percentage differences in labour productivity and labour utilisation may not add up to the gaps in GDP per capita since the decomposition is multiplicative.

23. Decomposition of labour productivity growth by industry, 2001-07 and 2009-13

Labour productivity growth is defined as the annual change in gross value added (in volume terms) per hour worked.

The aggregate industrial activities are defined according to ISIC Rev. 4: Mining and utilities (Divisions 05-09 and 35-39); Manufacturing (10-33); Construction (41-43); Wholesale, retail, hotels, food services, transportation (45-56); Information and communication (58-63); Finance and insurance (64-68); and Professional, scientific, technical and other business services (69-82).

24. Labour productivity in information industries, 2001 and 2013

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

The business sector is defined according to ISIC Rev. 4 Divisions 05 to 66 and 69 to 82, i.e. total economy excluding Agriculture, forestry and fishing (Divisions 01 to 03); Real estate activities (68); Public administration (84); Education (85); Health (86 to 88) and Other service activities (90 to 98).

Information industries are defined according to ISIC Rev. 4 Divisions 26 (Manufacture of computer, electronic and optical products) and Divisions 58 to 63 (Information and communication service activities).

For Mexico, data refer to 2003.

For Canada, Luxembourg, Portugal, Switzerland, data refer to 2011. For Germany, Mexico, Poland, Spain, Sweden and the United Kingdom, data refer to 2012.

25. Knowledge intensity of business investment, selected EU economies and the United States, 1995-2013

KBC investment data in current prices and local currency up to 2013 are kindly provided by the INTAN-Invest network. Data for non-residential GFCF up to 2010 are also sourced from INTAN-Invest. The time series is extended up to 2013 using the yearly growth rate in non-residential GFCF in the country, as reported in the *Structural Analysis (STAN) Database*. KBC assets consistent with the definition in the *System of National Accounts* (SNA) include: software, R&D, entertainment, literary and artistic originals, and mineral exploration. Other KBC assets include: design, new product developments in the financial industry, brands, firm-specific training and organisational capital.

In this analysis, the European Union covers 14 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

For the European Union, total EU-wide KBC investment and fixed capital investment are divided by EU-wide gross value added before referencing to 1995.

The business sector is defined according to ISIC Rev. 4 Divisions 01 to 82 excluding 68 (real estate) and 90 to 96, i.e. Sections A to N (excluding L) and R to S.

26. Business investment in fixed and knowledge-based capital, selected economies, 2013

See notes under 25.

27. Knowledge capital intensity by sector, selected economies, 1995 and 2013

See notes under 25.

28. Investment in organisational and managerial capabilities by size, 2011-12

General notes:

Shares of value added by firm size are computed on the basis of OECD Entrepreneurship at a Glance data. Investment in training is estimated using PIAAC, the *Structural Analysis (STAN) Database* and other national data sources. Micro firms employ 1-10 workers, small and medium-sized firms employ 11-250 workers, and large firms employ more than 250 workers. Available data for Japan do not allow distinguishing between SMEs and large establishments in terms of value added. For Japan, the small-medium value category includes large companies. The size distribution of value added for Australia, Canada and the United States is estimated on the basis of the cluster analysis detailed in Squicciarini et al. (2015). Figures refer to the market sector and exclude agriculture, constructions and finance, because of data availability issues.

Additional notes:

Investment in managerial capabilities relate to managers (ISCO 2008 occupation Class 1), whereas broader organisational capabilities relate also to non-managerial occupational profiles. See the methodology detailed in Le Mouel and Squicciarini (2015).

29. Investment in firm-specific on-the-job training, by firm size, 2011-12

See general notes under 28.

30. Trends in world foreign direct investment flows, 1995-2013

From 2005 onwards, data refer to the FDI definition of the 6th revision of the Balance of Payments Manual.

The OECD share in World total is based on the average of inward and outward FDI flows.

31. Foreign direct investment inflows, yearly averages, 1995-2001, 2002-07 and 2008-13

Data from 2005 to 2013 refer to the IMF (2009), Balance of Payments and International Investment Position Manual, 6th edition definition of FDI. Data prior to 2005 refer to the IMF (1993), Balance of Payments and International Investment Position Manual, 5th edition definition of FDI.

Other OECD includes: Australia, Canada, Chile, Iceland, Israel, Korea, Mexico, New Zealand, Norway, Switzerland and Turkey.

Other BRIICS includes: Brazil, India, Indonesia, the Russian Federation and South Africa.

South-East Asia includes: Cambodia, Hong Kong (China), Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam.

32. Foreign direct investment, outward flows from BRIICS, 2002-07 and 2008-13

For Indonesia, the 2004-07 average is shown.

The IMF (2009), *Balance of Payments and International Investment Position Manual*, 6th edition definition of FDI is used for 2005-13 data, IMF (1993), *Balance of Payments and International Investment Position Manual*, 5th edition definition for 2002-04 data.

33. Exports of intermediate and final goods from R&D-intensive manufacturing industries, 2000-13

R&D intensive manufactures are defined according to ISIC Rev. 4: Pharmaceuticals (Division 21), Computer, electronic and optical products (Division 26) and Air and spacecraft and related machinery (Group 303).

OECD here does not include Luxembourg and the Slovak Republic.

34. Global manufacturing trade networks: Flows of intermediate and final manufactured goods by area, 2013

Trade flows are based on reported import data and exclude intra-regional trade.

ASEAN refers to Brunei Darussalam, Indonesia, Cambodia, Malaysia, Philippines, Singapore, Thailand and Viet Nam (i.e. excluding Laos and Myanmar). East Asia consists of Japan, Korea, China, Hong Kong (China) and Chinese Taipei.

35. Global manufacturing trade networks, major bilateral flows of manufactured intermediate goods, 2000

Intermediate goods are used as inputs into the production of other goods. This analysis only considers intermediates from manufacturing activities (ISIC Rev. 4 Divisions 10 to 32); for example, processed food, textiles, basic chemicals, basic metals, and parts and components of machinery and equipment. Raw materials from agriculture, mining and quarrying activities are not included nor are outputs from electricity, gas and water suppliers.

Calculation of flows is based on import data only. The flows shown represent partner country imports that are higher than USD 15 billion or for which the partner share in a country's total imports is higher than 12%. Significant import flows from China, Germany, Japan and the United States are highlighted. For each country shown, the length of the arc on the circle is proportional to the sum of the export and import flows chosen according to the criteria.

To improve the readability of the diagram, some of the smaller flows were removed, notably those concerning Chile, Costa Rica, Greece, Israel, Luxembourg, Portugal, Romania and Turkey.

36. Global manufacturing trade networks, major bilateral flows of manufactured intermediate goods, 2014

See notes under 35.

38. Business sector services value added in OECD manufacturing exports, by industry, 1995 and 2011

Business sector services are defined according to ISIC Rev. 3 and include: Wholesale and retail trade, hotels and restaurants (Divisions 50 to 55); Transport, storage and communication (60 to 64); Finance and insurance (65 to 67); and Other business services (70 to 74).

39. Global demand for Computer, electronic and optical equipment, percentage shares of total, 1995 and 2011

Other East and Southeast Asia comprises of Brunei Darussalam, Cambodia, Chinese Taipei, Hong Kong (China), Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam.

Computer, electronic and optical equipment is defined according to ISIC Rev. 3 Divisions 30, 32 and 33.

40. Global demand for Motor vehicles, percentage shares of total, 1995 and 2011

Other East and Southeast Asia comprises of Brunei Darussalam, Cambodia, Chinese Taipei, Hong Kong (China), Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam.

Motor vehicles is defined according to ISIC Rev. 3 Division 34.

41. Global demand for Textiles and apparel, percentage shares of total, 1995 and 2011

Other East and Southeast Asia comprises of Brunei Darussalam, Cambodia, Chinese Taipei, Hong Kong (China), Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam.

Textiles and apparel is defined according to ISIC Rev. 3 Divisions 17 to 19.

42. Regional final demand for Computer, electronic and optical equipment, 1995 and 2011

General notes:

East and Southeast Asia comprises Brunei Darussalam, Cambodia, China, Chinese Taipei, Hong Kong (China), Japan, Korea, Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam.

Europe consists of the EU28 member countries as well as Iceland, Norway, Switzerland and the Russian Federation.

EU13 includes Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, the Slovak Republic and Slovenia.

Additional note:

Computer, electronic and optical equipment is defined according to ISIC Rev. 3 Divisions 30, 32 and 33.

43. Regional final demand for Motor vehicles, 1995 and 2011

See general notes under 42.

Additional note:

Motor vehicles is defined according to ISIC Rev. 3 Division 34.

44. Regional final demand for Textiles and apparel, 1995 and 2011

See general notes under 42.

Additional note:

Textiles and apparel is defined according to ISIC Rev. 3 Divisions 17 to 19.

46. Embodied low-carbon renewable energy used for electricity production, 2002-11

Renewable energy sources are defined as geothermal, solar thermal, solar photovoltaic, tide, wave and ocean technologies, and wind power. This differs from the definition of renewable energy according to IEA, which also includes hydro-electric as well as biofuels and waste.

47. Top net exporters and net importers of embodied low-carbon renewables used for electricity production, 2011

A tonne of oil equivalent (toe) is a unit of energy defined as the amount of energy released by burning one tonne of crude oil. According to the International Energy Agency (IEA), 1 toe = 41.868 gigajoules (GJ).

Renewable energy sources are defined as geothermal, solar thermal, solar photovoltaic, tide, wave and ocean technologies, and wind power. This differs from the definition of renewable energy according to IEA, which also includes hydro-electric as well as biofuels and waste.

48. R&D growth over the business cycle by source of financing, OECD area, 1985-2014

Business and government-financed R&D expenditures are subcomponents of Gross Domestic Expenditure on R&D (GERD) (i.e. intramural R&D expenditures on R&D performed in the national territory). Funding sources are typically identified by the R&D-performing units.

Government budget data tend to be more timely, but may not coincide with R&D performer-reported funding by government, owing to factors such as differences between budgetary plans and actual disbursements.

49. Trends in basic and applied research and experimental development in the OECD area, 1985-2013

Due to the presence of missing breakdowns of GERD by type of R&D (basic, applied and experimental development), as well as breaks in series, long term trends have been estimated by chain-linking year-on-year growth rates. These are calculated each year on a variable pool of countries for which balanced data are available in consecutive years without intervening breaks. The trend series is an index of the volume of expenditures on basic and applied research and experimental development, based on GERD data in USD PPP 2010 constant prices. Some OECD countries are completely missing from the calculations due to no detailed breakdowns by type of R&D being available. Further details on the calculations are available on request.

China's share of GERD by type of R&D has been estimated based on the sum of current and capital expenditures. For the OECD, a GERD-weighted estimate has been computed on the pool of 15 countries for which data by type of R&D were available in 2013. Data used for each country refer to the sum of current and capital expenditures, except for Chile, Norway, Spain and the United States for which only current costs are included in estimates reported to the OECD.

50. Recent trends in R&D performance, OECD and selected economies, 2007-13

For the United States, except for GOVERD, which includes capital expenditure used for R&D, reported figures refer to current expenditures but include a depreciation component, which may differ from the actual level of capital expenditure.

OECD estimates for the EU28 zone may differ slightly from those published by Eurostat. In this publication, national estimates are aggregated using USD Purchasing Power Parity indices (PPPs) instead of EUR exchange rates applied by Eurostat. For example, the EU28 measure of GERD to GDP intensity is an average of EU countries' GERD intensities, weighted by the share of countries' GDP to EU GDP in USD PPPs, as opposed to EUR-based GDP shares.

R&D intensity ratios are normalised using official GDP figures. These are compiled according to the *System of National Accounts* (SNA) 2008 except for China and Japan, where figures are available on the basis of SNA 1993.

51. Trends in government tax incentive and direct support for business R&D, 2000-13

Results are restricted to selected OECD economies for which time-series data on the amount of direct funding and tax support for business R&D are available for a minimum period of six years.

For Canada, France and the United Kingdom, preliminary R&D tax incentive estimates are reported for 2013. The 2012 cost estimate for the United Kingdom is also provisional.

Estimates do not cover sub-national and income-based R&D tax incentives and are limited to the business sector (excluding tax incentive support to individuals). Data refer to estimated initial revenue loss (foregone revenues) unless otherwise specified.

Estimates refer to the cost of incentives for business R&D expenditures, both intramural and extramural, unless otherwise specified. Direct support figures refer only to intramural R&D expenditures.

Country specific notes are available at *www.oecd.org/sti/rd-tax-stats.htm*.

52. Business R&D intensity and government support to business R&D, 2013

For Canada, Chile, France, Norway, Portugal, South Africa, Spain and the United Kingdom, preliminary R&D tax incentive estimates are reported for 2013 (or closest year). Figures are rounded to the second decimal unless rounding would result in a value of zero.

For Belgium, Brazil, Ireland, Israel, South Africa, Spain, Switzerland, the United Kingdom and the United States, figures refer to 2012. For Australia, Iceland, Mexico and the Russian Federation, figures refer to 2011.

Estimates of direct funding for Belgium, Brazil, France, Italy and Portugal are based on imputing the share of direct government-funded BERD in the previous year to the current ratio of BERD to GDP. For Austria, the 2011 share is used for 2013.

In Austria and South Africa, R&D tax incentive support is included in official estimates of direct government funding of business R&D. It is removed from direct funding estimates to avoid double counting. In the case of South Africa, where the overlap of estimates cannot be identified based on available budget data, this transformation was not undertaken.

Estonia, Germany, Luxembourg, Mexico, New Zealand, Sweden and Switzerland did not provide information on expenditure-based R&D tax incentives for 2013. For Israel, the R&D component of incentives cannot be identified separately at present. No data on the cost of expenditure-based R&D tax incentive support are available for Poland.

Estimates do not cover sub-national and income-based R&D tax incentives and are limited to the business sector (excluding tax incentive support to individuals). Data refer to estimated initial revenue loss (foregone revenues) unless otherwise specified.

Estimates refer to the cost of incentives for business expenditures on R&D, both intramural and extramural, unless otherwise specified. Direct support figures refer only to intramural R&D expenditures, except for Brazil.

Country specific notes are available at *www.oecd.org/sti/rd-tax-stats.htm*.

53. R&D in OECD and key partner countries, 2013

Owing to methodological differences, data for some non-OECD economies may not be fully comparable with those for other countries.

R&D expenditures data refer to 2013 except for Australia, Brazil and India (2011).

Researchers data are in full-time unites and refer to 2013 except for Australia (2008), Brazil and India (2010), Canada, Israel and the United States (2012), and Iceland and Mexico (2011).

For Brazil, India and Indonesia, data are provided by the UNESCO Institute for Statistics.

For Indonesia, data refer to 2009.

For Israel, defence R&D is partly excluded from available estimates.

For South Africa, Ireland and Switzerland, data refer to 2012.

For United States, data for researchers have been estimated based on contemporaneous data on business researchers and past data for other sectors.

54. Trends in scientific publication output and excellence, selected countries, 2003-12

Scientific production/Output/Number of documents is the total number of documents published in scholarly journals indexed in Scopus (all document types are included).

Excellence indicates the amount (in %) of an institution's scientific output included in the set of 10% of the most-cited papers in their respective scientific fields. It functions as a measure of high-quality output of research institutions.

55. Institutions with the largest number of top-cited publications, by sector, 2003-12

The indicator is based on the total number of documents by authors in the listed affiliations featuring in the top 10% most-cited documents within each document's relevant domains.

56. Top 4 countries with the largest number of 10% top-cited publications, by field, 2003-12

The indicator is based on the number of documents featuring in the top 10% most-cited documents within each scientific domain. The percentages are based on the ratio between each of the top four largest countries in each field and the sum of top-cited publications for OECD and BRIICS countries.

57. New doctoral degrees awarded to women in OECD countries, by field of education, 2005-12

The figure refers to the following OECD countries on the basis of data availability: Austria, Belgium, Canada, the Czech Republic, Germany, Denmark, Finland, Hungary, Ireland, Iceland, Israel, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Norway, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

For Italy, 2008-10 data are OECD estimates.

For Norway, data are based on NIFU's Doctoral Degree Register, which also includes "Licentiate" degrees (equivalent to a doctoral degree).

Data for the following fields of education are not shown in the figure: Agriculture, Education and Services.

58. Female scientific authors in selected fields, by country, 2011

This is an experimental indicator based on a stratified random sample of scientific authors.

Estimates are based on the corresponding authors' self-reported gender in the OECD Pilot Survey of Scientific Authors carried out in January 2015.

Samples are drawn from documents published in 2011 and indexed in the Scopus database. Fields covered include Arts and Humanities, Business, Chemical Engineering, Immunology and Microbiology, Materials Science, Neuroscience and Physics and Astronomy.

Weighted estimates take into account sampling design and non-response patterns by fields, country and journal status.

59. Global scientific collaboration trends, 1996-2013

Calculations based on fractional counts. Institutional collaboration is based on multiple affiliations applying to a given document.

Results for 2000-02 are not displayed because of incomplete indexation in the Scopus database of authors for publications in those years. Figures would accordingly understate the true extent of scientific collaboration in those years.

61. International net flows of scientific authors, selected economies, 1999-2013

This is an experimental indicator.

Estimates are based on differences between implied inflows and outflows of scientific authors for the reference economy, as indicated by a change in the main affiliation of a given author with a Scopus ID over the author's indexed publication span. This figure decomposes net flows recorded over the period on a year-by-year basis for economies exhibiting the largest volumes of gross flows. An inflow is computed for year t and economy c if an author who was previously affiliated to another economy is first identified at t as affiliated to an institution in c. Likewise, an outflow is recorded when an author who was affiliated to c in a previous period is affiliated in a different economy at year t. In the case of multiple publications per author in a given year, the last publication in any given year is used as reference, while others are ignored.

The actual mobility date is undetermined, as more than one year may span between publications. As a result, the timing implied by this figure may be subject to a lag with respect to the point in which mobility flows took place. For more prolific authors, the timing will be more accurate. Estimates for early years in the database are not reported because mobility flows can only be computed once an author has a second publication captured in the database. Likewise, incomplete indexing of all authors over 2000-03 may result in understating total flows and as a consequence, albeit to a lesser extent, estimated net flows.

62. International mobility of scientific authors by field, 1996-2013

For computational reasons, share estimates are based on the comparison between the main (modal) affiliation of a given author with a Scopus ID over the author's indexed publication span. Only authors with two or more publications and in different years are considered. A mobility episode is identified for a given year when an author who was previously affiliated to an institution in a given economy is first observed to have changed affiliation to an institution in another economy. In the case of multiple publications per author in a given year, the last publication in any given year is used as reference, while others are ignored.

The indicator is computed as the share of identified moves out of potential moves, per author. Authors with more publications (higher number of potential moves) have therefore a larger weight in the calculation.

Total numbers of moves are presented based on a fractional measurement of affiliation changes and fields.

Field attribution is based on the classification of the journal in which a document is published. When a document is published in a journal with multiple 4-digit fields, the attribution to a 2-digit field is made on a fractional basis. The field of reference is that of the document in the destination economy, as fields need not remain constant over a given author's publication span.

63. International collaboration in science and innovation, 2003-12

International co-authorship of scientific publications is defined at the institutional level. A scientific document is deemed to involve an international collaboration if there institutions from different countries or economies are present in the list of affiliations reported by single or multiple authors. Estimates are based on whole counts from information contained in the Scopus database.

International co-inventions are measured as the share of patent applications with at least one co-inventor located in a different economy in total patents invented domestically. Data refer to IP5 patent families with members filed at the EPO or the USPTO, by first filing date and according to the inventor's residence using whole counts.

64. Trends in the IP bundle, 1996-2014

The IP bundle in the European market refers to EPO patent applications and OHIM trademark and design applications. The Japanese market refers to patent, trademark and design applications filed at the JPO, and the US market refers to patents and trademarks filed at the USPTO. Designs cannot be registered at USPTO. Before 2001, only USPTO patent grants are considered. Patent families are compiled using information on patent families within the Five IP offices (IP5). Data are presented by filing date. Patent statistics from 2012 are estimates.

65. R&D expenditures and the IP bundle of top R&D companies, 2012

Data relate to companies in the top 2 000 corporate R&D sample, ranked by R&D expenditures.

Data refer to patent applications filed in 2010-12 at the EPO or the USPTO that belong to IP5 families owned by the top R&D companies, using fractional counts.

Data refer to new trademark applications filed at the USPTO and the OHIM in 2010-12, using fractional counts.

66. Top 100 and 250 corporate R&D players by location of headquarters and affiliates, 2012

Data relate to companies in the top 2 000 corporate R&D sample, ranked by R&D expenditures.

67. Top 100 and 250 corporate R&D players by industry, 2012

Data relate to companies in the top 2 000 corporate R&D sample, ranked by R&D expenditures. Industries are defined according to ISIC Rev. 4.

68. Technological specialisation of top R&D investors by headquarters' location, 2010-12

The revealed technological advantage index is calculated as the share of patents owned by a company in a particular technology field relative to the share of total patents belonging to the company. Company data refer to the top 2 000 corporate R&D sample having filed for patents in 2010-12. Patent data refer to IP5 patent families by the first filing date owned by the top R&D companies. Patents are allocated to technology fields on the basis of their International Patent Classification (IPC) codes, following the concordance provided by WIPO (2013).

69. IP filings by foreign affiliates of top R&D corporations, by location of the headquarters, 2010-12

Data refer to patents applications filed at the EPO or the USPTO that belong to IP5 families and to trademark applications at OHIM or USPTO, by filing date, using fractional counts.

Data relate to headquarters' locations featuring at least 100 patent families and 100 trademark applications in 2010-12.

Foreign affiliates correspond to affiliates whose location is different from the location of the registered office of the global ultimate owner (here referred to as headquarters), according to the group structure in 2012.

Economies are ordered according to the share of patent families applied for by foreign affiliates of top R&D corporations.

70. Top players in emerging technologies, 2010-12

Data refer to patent applications filed at the EPO or the USPTO that belong to IP5 families, by filing date and according to the applicant's residence using fractional counts. Patent "bursts" correspond to periods characterised by a sudden and persistent increase in the number of patents filed by Cooperative Patent Classification (CPC) groups. Top patent bursts are identified by comparing the filing patterns of all CPC groups. The intensity of a patent burst refers to the relative strength of the observed increase in filing patterns. Only CPC classes featuring a positive and non-ending burst intensity from 2005 are included.

Descriptions of CPC groups are available at *http://worldwide.espacenet.com/classification?locale=en_EP*.

71. Intensity and development speed in ICT and environment-related technologies, 2000-12

Data refer to patent applications filed at the EPO or the USPTO that belong to IP5 families, by filing date, using fractional counts. ICT-related patents are defined on the basis of their International Patent Classification (IPC) codes. Environment-related patents are defined on the basis of their IPC codes or Cooperative Patent Classification (CPC) codes. Patent "bursts" correspond to periods characterised by a sudden and persistent increase in the number of patents filed in environment-related technologies. Top patent bursts are identified by comparing the filing patterns of all other technologies. The intensity of a patent burst refers to the relative strength of the observed increase in filing patterns. Only patent classes featuring a positive and non-ending burst intensity from 2000 are included.

Descriptions of IPC groups are available at *http://web2.wipo.int/ipcpub*.

Descriptions of CPC groups are available at *http://worldwide.espacenet.com/classification?locale=en_EP*.

72. Top players in selected disruptive technologies, 2005-07 and 2010-12

Data refer to IP5 patent families with members filed at the EPO or the USPTO, by first filing date and according to the applicant's residence using fractional counts. The Intellectual Property Office (IPO) of the United Kingdom has allocated patent documents to technology fields. For further details on IPO's patent landscape reports on *Eight Great Technologies* (October 2014), see *www.gov.uk/government/publications/eight-great-technologies-the-patent-landscapes*.

73. Patents in new generation of ICT-related technologies, 2005-12

Patent data refer to IP5 patent families by first filing date. The Intellectual Property Office (IPO) of the United Kingdom has allocated patent documents to technology fields. For further details on IPO's patent landscape reports on *Eight Great Technologies* (October 2014), see *www.gov.uk/government/publications/eight-great-technologies-the-patent-landscapes*.

74. Top players in IoT, big data and *quantum* computing technologies, 2005-07 and 2010-12

Data refer to IP5 patent families with members filed at the EPO or the USPTO, by first filing date and according to the applicant's residence using fractional counts. The Intellectual Property Office (IPO) of the United Kingdom has allocated patent documents to technology fields. For further details on IPO's patent landscape reports on *Eight Great Technologies* (October 2014), see *www.gov.uk/government/publications/eight-great-technologies-the-patent-landscapes*.

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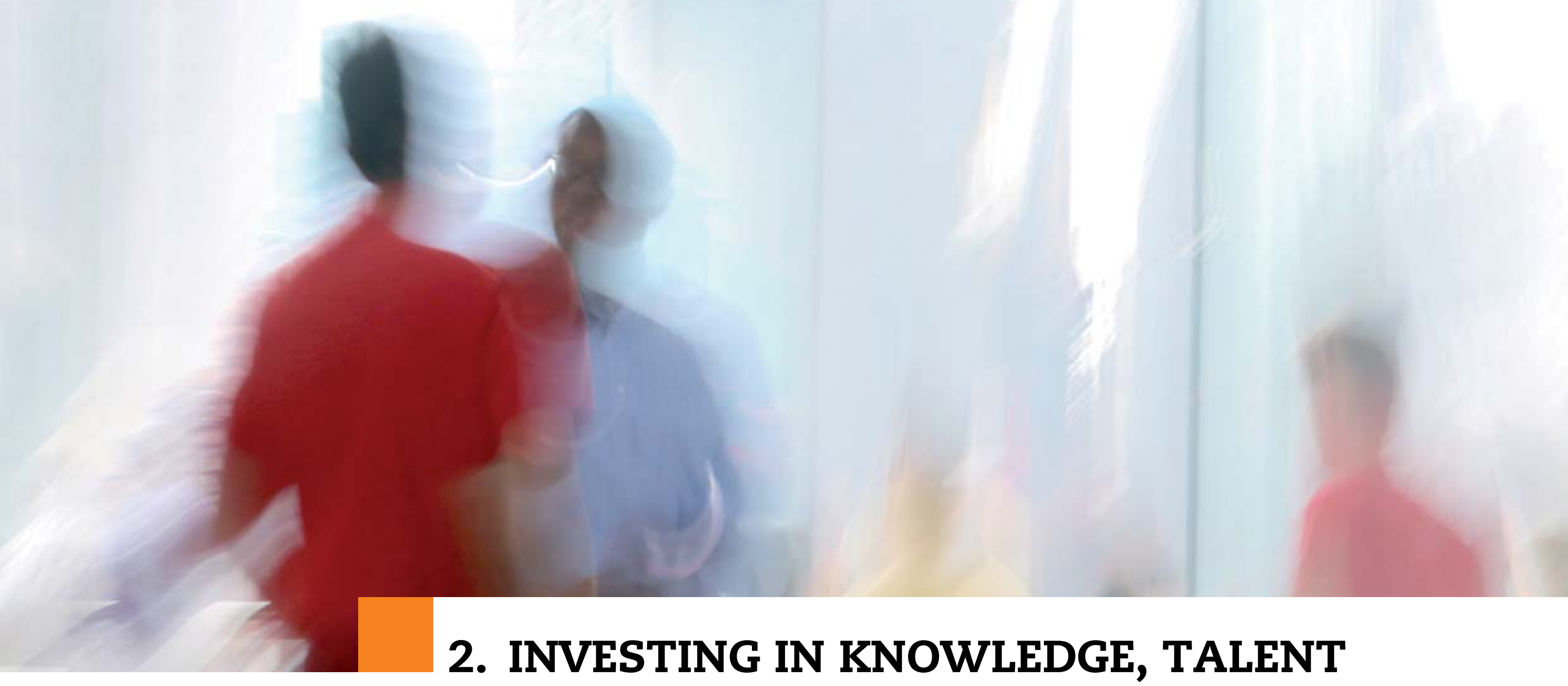


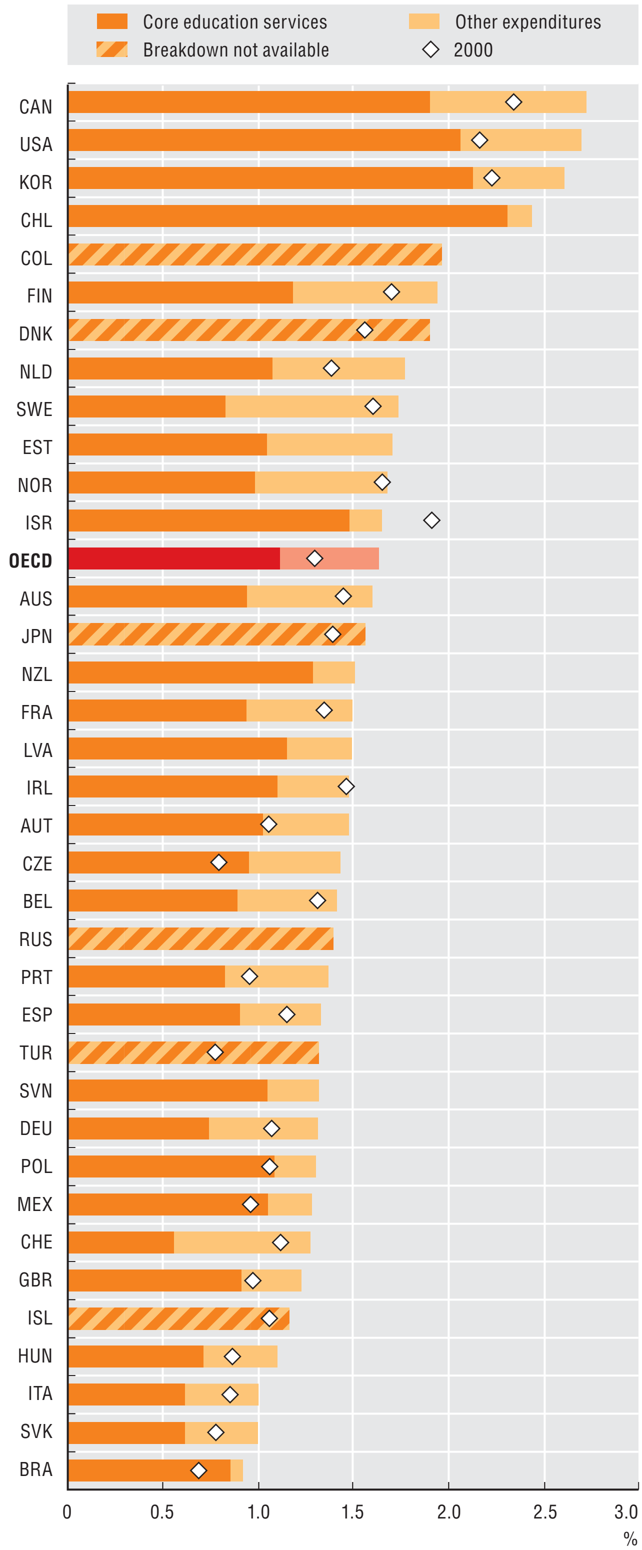
2. INVESTING IN KNOWLEDGE, TALENT AND SKILLS

Investment in education, research and innovation generates knowledge-based capital, which makes a key contribution to the productivity and competitiveness of the private and public sector alike. A first set of indicators focuses on the role of higher education systems and basic research in building competencies for innovation. There is a particular focus on scientific skills, science and engineering degrees and doctorate holders, who are individuals trained specifically for research. Other indicators look beyond the educational system to labour market outcomes, with a particular focus on human resources in science and technology and researchers. New indicators of research "excellence" highlight the research performance of countries that follow different paths of scientific specialisation. Experimental indicators identify employment of – and investment in – people performing tasks that affect the medium and long-term functioning of firms and public institutions, providing insights on the role of organisational capital. New metrics of formal and on-the-job training show how firms in manufacturing or services, both large and small, invest in the skills and competencies needed by workers. New indicators underline the role of the public sector as a funder and performer of research, and its contribution to the wider stock of economies' knowledge-based capital. A final set of indicators looks at the effective use of technology in the workplace and the skills required to perform effectively in new working environments shaped by ICTs.

1. Investment in knowledge

Spending on higher education, 2011

As a percentage of GDP



Source: OECD, based on OECD (2014), *Education at a Glance 2014: OECD Indicators*, OECD Publishing, Paris. See chapter notes.

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Investment in education, research and development (R&D), and new information and communication technologies (ICTs) is key for innovation and technology development and long-term growth. These knowledge-based assets complement one another and function as key elements of the infrastructure allowing today's knowledge-based economies to address contemporary challenges, including health and inequality.

Expenditure in higher education in OECD countries reached 1.63% of GDP in 2011 as compared to 1.30% in 2000. In Canada, the United States and Korea, this share rose above 2.5%, while it remained below 1.5% in most countries.

From 2003 to 2013, the R&D intensity of the OECD area increased slightly from 2.1% to 2.4 of GDP. This aggregate represents the combined outcome of highly heterogeneous country paths in terms of intensity of R&D investment and investment in basic and applied research versus experimental development. Economies such as Korea, Estonia, Slovenia and Portugal experienced an increase in R&D intensity comparable to that of China's. Some of the fastest-growing economies in R&D intensity also displayed a high orientation towards experimental development.

In Australia and Korea, as well as in all G7 economies except for France, the share of GDP invested in ICT in 2013 decreased compared to 2003; however, it grew in a number of European countries including the Netherlands (0.3%), Ireland (0.6%) and Estonia (0.8%). These investment patterns may reflect combinations of several factors, including the falling cost of ICTs, investment in hardware compensating (or not) for the sharp declines in prices, and increasing investment in software.

Definitions

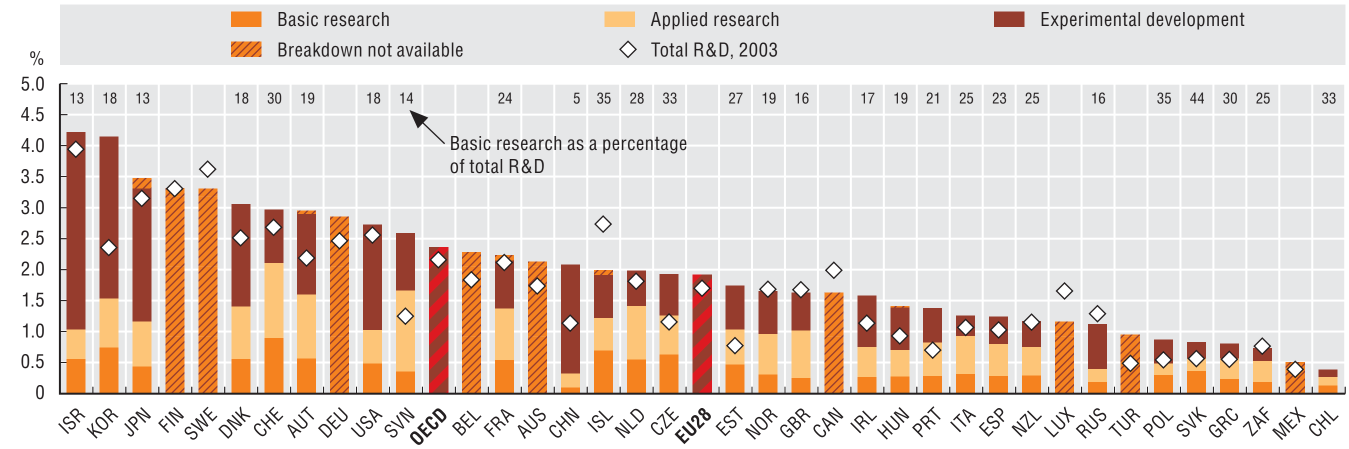
Expenditure on higher education measures spending on educational institutions by governments, enterprises and private individuals, and refers to the ISCED-97 Levels 5A, 5B and 6. *Core education services* refer to all services directly related to instruction (e.g. teachers, buildings and teaching material). *Other expenditures* comprise R&D expenditures, regardless of the source of funding, and ancillary services.

Gross domestic expenditure on R&D (GERD) is the main aggregate used for international comparisons of R&D expenditures. R&D is defined according to the *Frascati Manual* and comprises basic research, applied research and experimental development. The manual was recently revised (OECD, 2015) and is now in the process of being implemented.

ICT investment is defined following the 1993 *System of National Accounts* (SNA). It 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.

Gross domestic expenditure on R&D, by type, 2013

As a percentage of GDP



Source: OECD, *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, and *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

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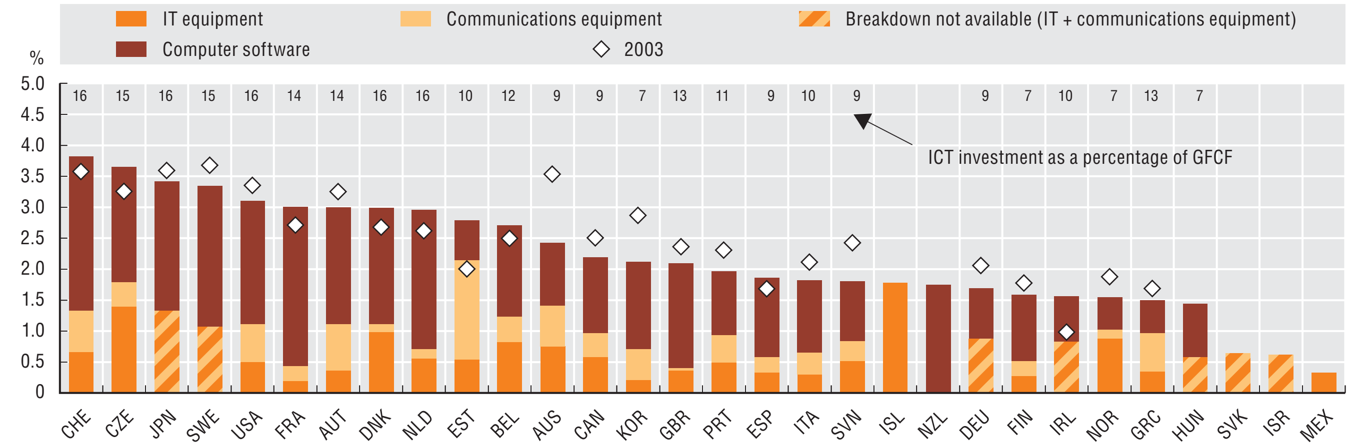
ICT investment, by asset, 2013

As a percentage of GDP



Source: OECD, based on OECD *Annual National Accounts (SNA) Database*; Eurostat, *EU-KLEMS Database* and national sources, July 2015. StatLink contains more data. See chapter notes.

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Measurability

Spending on higher education is shaped by factors such as the age structure of the population, enrolment rates and teachers' salaries. Expenditures are classified on the basis of data collected from institutions rather than from funding sources.

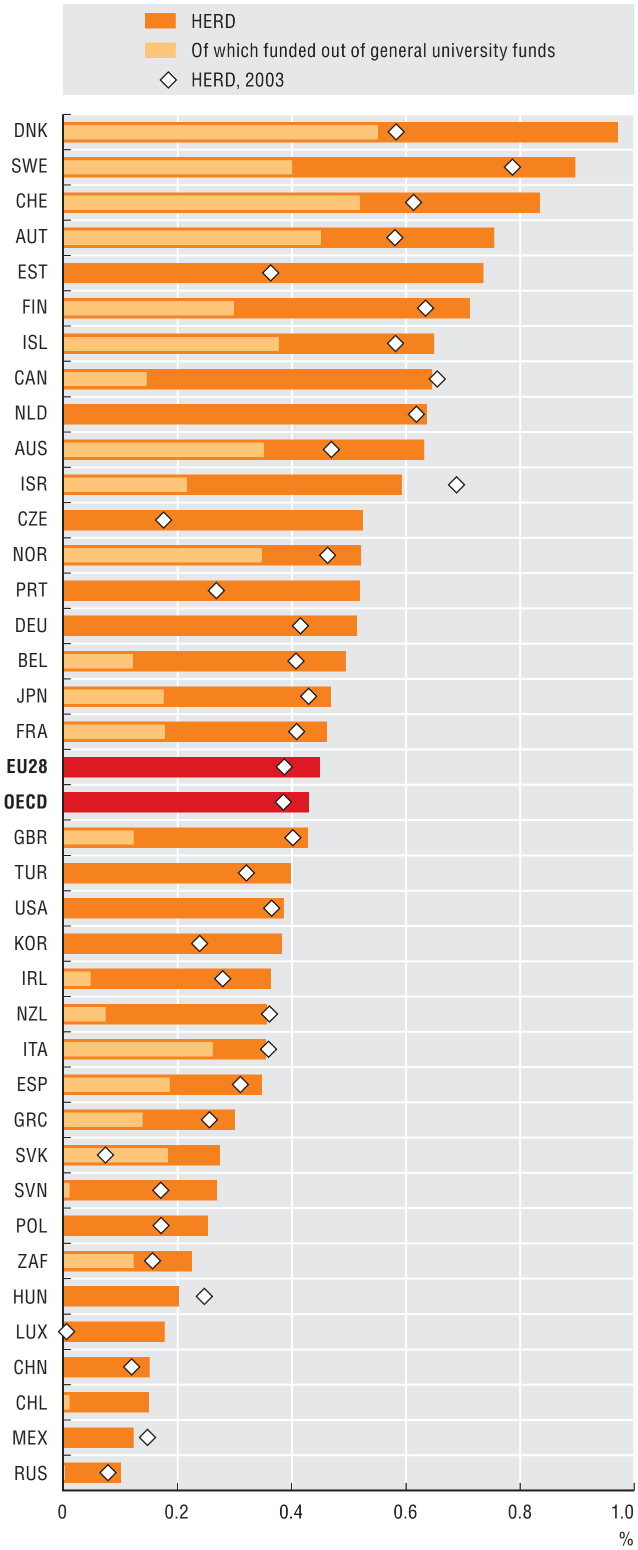
Data on R&D expenditures are collected through surveys of R&D performing institutions and firms, often complemented by administrative sources. R&D intensities reflect differences in economic structures, as industries vary in their propensity to carry out R&D. Despite common reference reporting guidelines, national R&D surveys may follow different sampling and estimation methods.

The SNA considers expenditure on ICT products as investment only if it can be physically isolated. This may understate the importance of ICT investment. Measuring investment in software is difficult. As its capitalisation in SNA is recent, methodologies may vary, also in relation to its acquisition (e.g. rental and license, embedded in hardware or developed on own account). Differences in the computation of data on telecommunications equipment can also affect comparability.

2. Higher education and basic research

Higher education expenditure on R&D, 2013

As a percentage of GDP



Source: OECD, *Main Science and Technology Indicators Database, www.oecd.org/sti/msti.htm*, June 2015. See chapter notes.

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Most basic research is performed in universities and government research organisations. Total higher education expenditure on R&D (HERD) accounts for 0.4% of GDP in the OECD area. Denmark and Sweden have the highest research intensities in the higher education sector. HERD intensity in Denmark, Estonia, the Czech Republic, the Slovak Republic and Portugal has nearly doubled over the last decade, and also increased in most other countries.

There are marked differences across OECD countries in the way HERD is funded. Several countries rely significantly on general government funding which HE institutions can choose to allocate to R&D. The relative importance of direct government funding is highest in Luxembourg, Estonia, Poland and the United States. Funds from abroad, especially from international organisations but also business, represent significant sources in many EU member countries and Israel. The involvement of domestic businesses and private non-profit organisations is largest in China, with nearly 35% of HERD funded by business, followed by the Russian Federation and Turkey. These figures may understate the full extent of business' overall contribution to HERD, which can also involve payments for the use of facilities or the outcomes of R&D carried out within universities, in the form of licences or investment in spinoffs.

On average, the higher education sector accounts for more than three quarters of all OECD basic research. The higher education sector's contribution to basic research ranges from nearly 80% in Estonia, Ireland and Denmark, to approximately 20% in Korea and the Russian Federation. The government sector's contribution to basic research is the largest in China and East European countries. In Korea, business enterprises account for the largest share of basic research.

Definitions

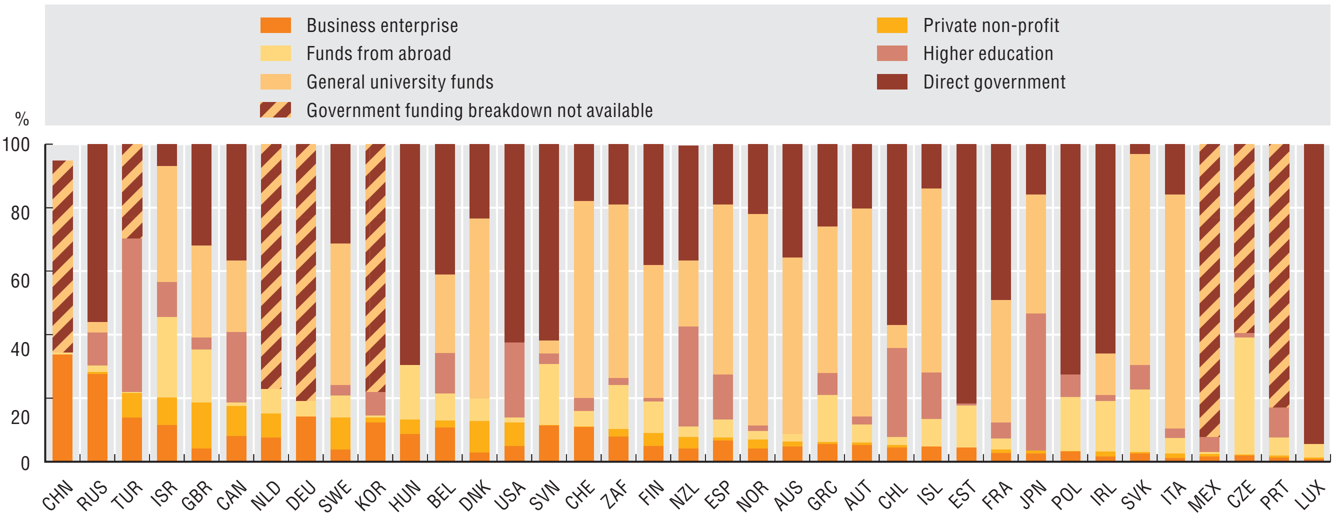
The *higher education sector* comprises universities and other tertiary education institutions, independently of their sources of finance or legal status. It also includes other organisations such as research institutes and hospitals under their direct control.

Government general university funds for R&D identify the proportion of a country's HERD that is funded by general government funds and that universities can use for purposes other than R&D. Governments sometimes use indicators related to past R&D performance to determine the volume of such funds. Direct funding by government may also be provided on an institutional basis, or for specific R&D projects.

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

Funding of R&D in higher education, 2013

As a percentage of HERD



Source: OECD, *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

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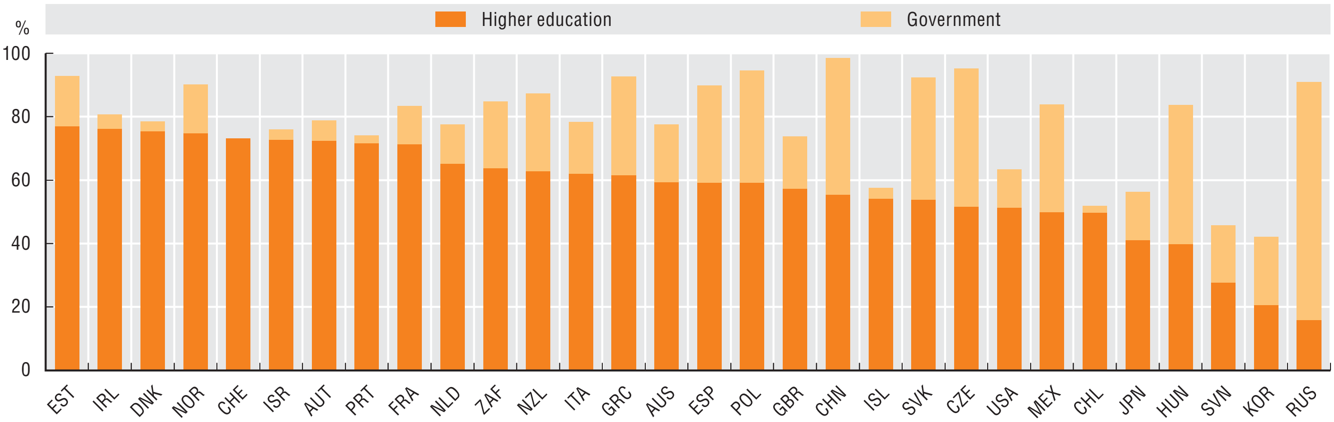
Basic research performed in the higher education and government sectors, 2013

As a percentage of domestic expenditures on basic research



Source: OECD, *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

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Measurability

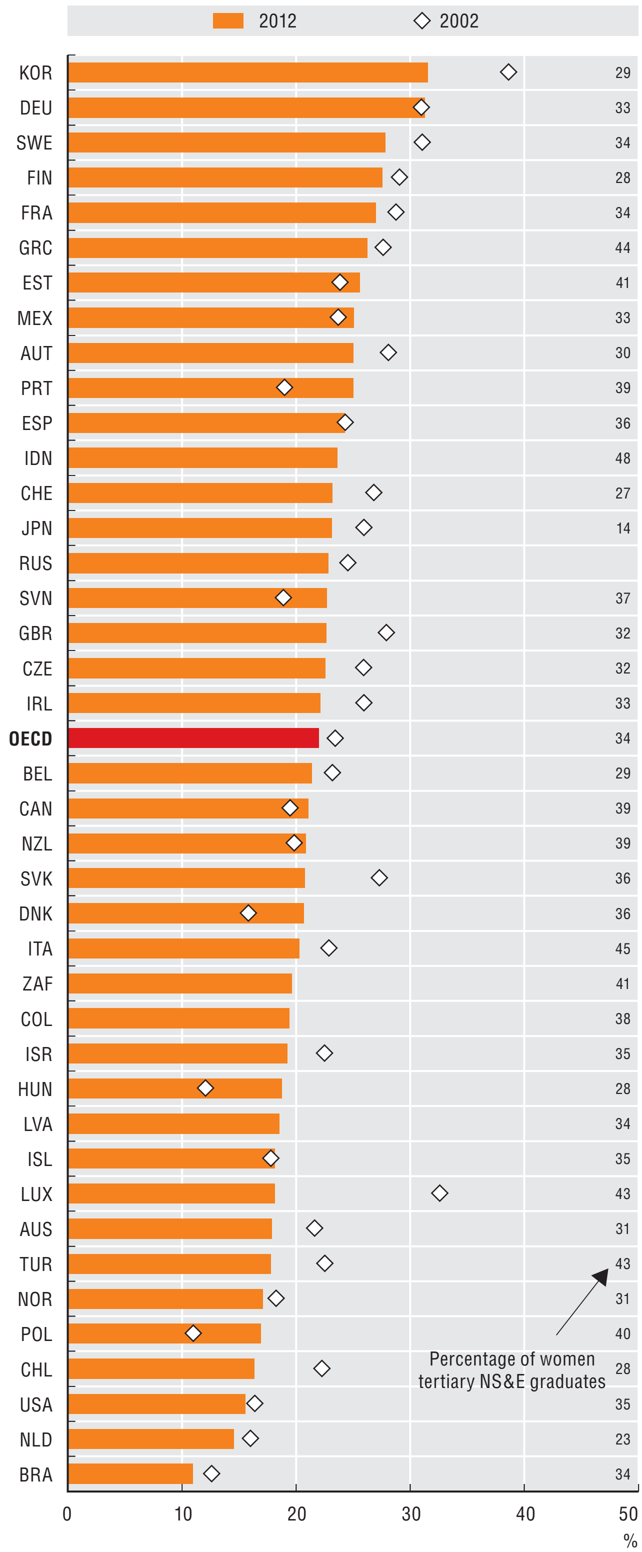
The *higher education sector* is not a formal sector within the *System of National Accounts*. It is separately identified by the OECD and other organisations because of the important and specific role played by universities and related institutions in the performance of R&D and the formal training of researchers through doctoral and other research degrees. Measurement of HERD relies on dedicated institutional surveys in most OECD countries, often complemented by administrative of other data sources.

There are difficulties in deriving comparable measures of sources of funding for higher education because of the wide diversity of R&D funding arrangements that exist across countries. As a reporting convention, government general university funds are reported as a particular form of government support for R&D, since universities retain a degree of discretion as to whether to use such funds for R&D purposes and, in principle, might be treated as internal university resources. Flows of funds across different universities appear to be increasingly common, especially around engagement in research consortia, sometimes linked to international projects.

3. Science and engineering

Tertiary education graduates in natural sciences and engineering, 2012

Based on ISCED-97 fields, as a percentage of all tertiary graduates



Source: OECD, *Education Database*, July 2015. StatLink contains more data. See chapter notes.

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Societies require a wide array of skills and assets to achieve progress. Tertiary education has expanded worldwide to support the supply of highly educated individuals and meet rising demand. Policy makers are particularly interested in the supply of scientists and engineers because of their direct association with technological progress, industrial performance and economic growth.

The supply of graduates in the natural sciences and engineering (NS&E) may relate to opportunities in labour markets and their ability to absorb highly specific skills, both at home and abroad. In 2012, 22% of students graduating at tertiary level within the OECD and BRIICS areas did so with an NS&E degree. However, over the past decade, this share has decreased among all tertiary graduates in most OECD countries, especially in Korea, Luxembourg and the Slovak Republic. Over this period of growth in higher education participation, the gender gap has narrowed slightly with women accounting for 35% on average of all NS&E graduates in 2012, with shares ranging from 14% in Japan to 45% in Italy.

The proportion of NS&E graduates among the subpopulation of doctorates is higher than for other tertiary levels, reaching an average of approximately 40% for the OECD. The natural sciences account for more than 45% of new doctoral degrees awarded in France and Luxembourg. Engineering represents more than one-quarter of new doctoral degrees in the Netherlands, Korea and the Slovak Republic. Women are still under-represented among new NS&E doctorates, especially in Japan and Korea, but outnumber men in health degrees.

Over 2008-12, on average 70 000, 49 000 and 26 000 individuals received doctoral degrees in the United States, China and Germany, respectively. This is close to half of all new doctorates in the OECD and BRIICS combined areas. NS&E degrees accounted for about 60% of new doctorates in Chile, Colombia and France and less than one third in Hungary and Mexico.

Definitions

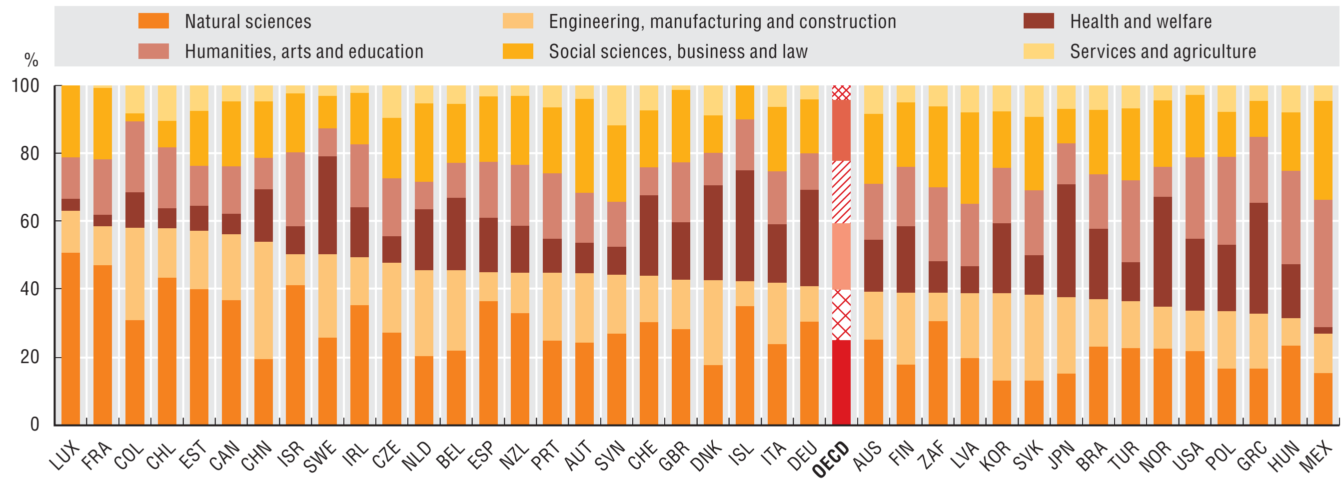
The *natural sciences and engineering* fields of education correspond to ISCED-97 fields 4 (Science, comprising the life sciences, physical sciences, mathematics and statistics and computing) and 5 (Engineering, manufacturing and construction). The science category in ISCED-97 corresponds broadly to the concept of natural sciences used in the OECD Fields of Science and Technology classification (2007).

Graduates at the tertiary level comprise individuals that have obtained a degree at ISCED-97 Levels 5A or 6.

Graduates at the doctorate level correspond to the subpopulation of tertiary graduates who have attained the second stage of university education and obtained a degree at ISCED-97 Level 6. These graduates have successfully completed an advanced research programme and been awarded an advanced research qualification (e.g. a PhD or equivalent).

Graduates at doctorate level, by field of education, 2012

As a percentage of all graduates, ISCED-97 fields



Source: OECD calculations based on OECD *Education Database* and national sources, July 2015. StatLink contains more data. See chapter notes.

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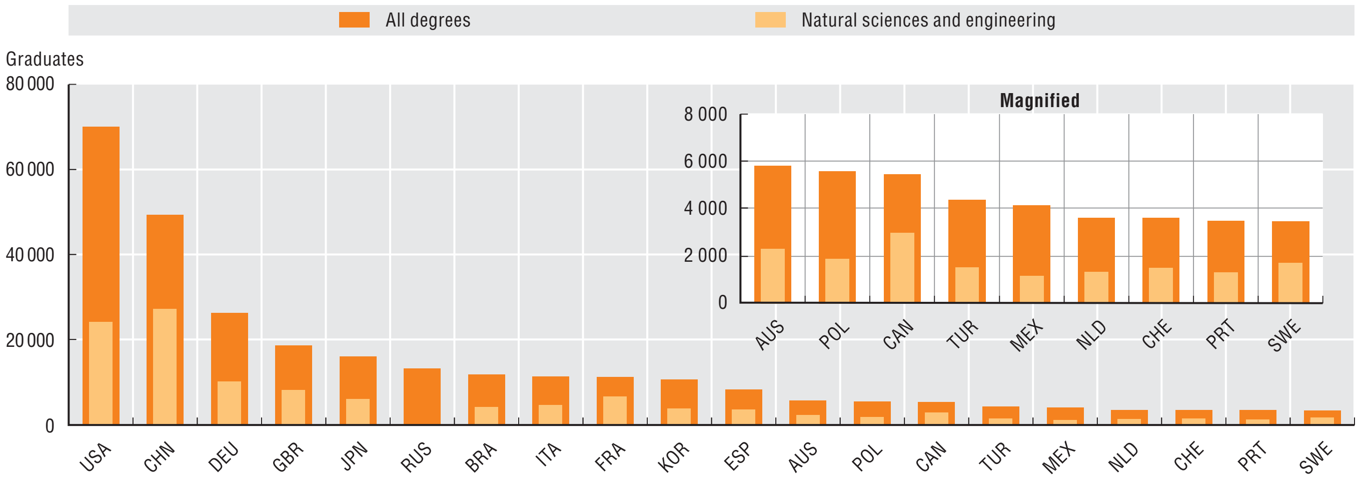
New doctorates in natural sciences and engineering, 2008-12

Countries with largest average annual counts



Source: OECD calculations based on OECD *Education Database* and national sources, July 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273584

Measurability

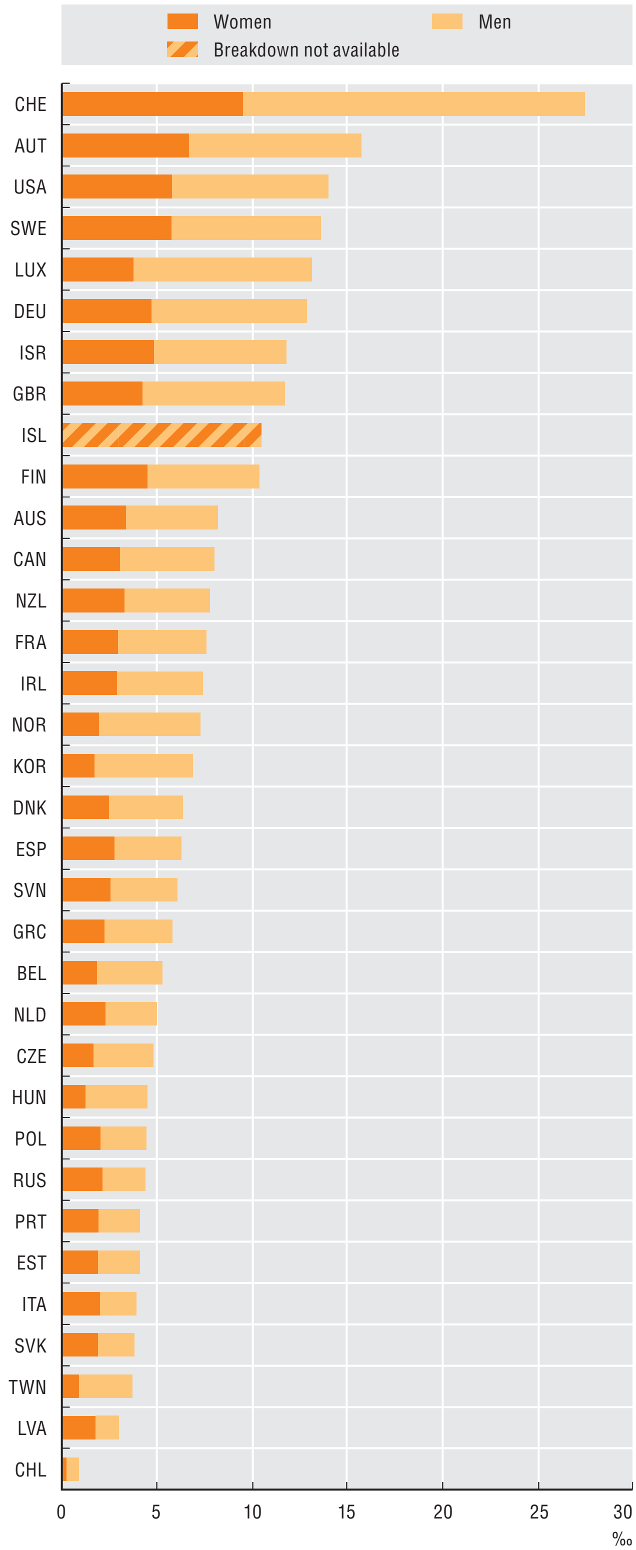
Data on graduates by field of education are computed on the basis of annual data jointly collected by UNESCO-UIS/OECD/Eurostat. This data collection aims to provide internationally comparable information on key aspects of education systems in more than 60 countries worldwide (*www.oecd.org/education/database.htm*).

A graduate is defined as a student who has successfully completed all requirements of a particular programme of study. Because of national differences regarding the definition of graduation, international comparability of "successful graduation" remains a major issue. Other measurement challenges include the avoidance of doublecounting of individuals graduating from several programmes in the same year or remaining at the same educational level over time. Some of these problems are expected to be overcome with the forthcoming implementation of the 2011 revision of the International Standard Classification of Education (ISCED-11) in the UNESCO-UIS/OECD/Eurostat data collection. A particular feature of the revised classification is the provision of more detailed information on the broader community of graduates at tertiary level.

4. Doctorate holders

Doctorate holders in the working age population, 2012

Per thousand population aged 25-64



Source: OECD calculations based on OECD data collection on Careers of Doctorate Holders 2014, *www.oecd.org.sti/cdh*; and other international sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273598

Increasing specialisation in science and research has made professionals with advanced research degrees a cornerstone of modern science and innovation systems worldwide. There are marked differences among countries with respect to the share of individuals with doctorate degrees. Switzerland accounts for the largest share among the working age population, due in part to a relatively large share of foreign doctoral graduates. In 2012, for one-third of countries where data are available, doctoral holders represented more than 1% or the working age population. These countries also tend to exhibit high rates of R&D intensity and innovation. Not all doctorate holders work as researchers, and not all researchers hold doctorate degrees. On average, women account for 40% of the doctoral population, but there are significant differences in representation by science domains.

Employment rates of doctorate holders are systematically higher than among other tertiary level graduates in the working age population. In 2012, employment rates of doctorates reached 93% on average across countries for men and 88% for women. Differences between men and women are less marked for doctorate holders than for other tertiary level graduates. This is explained mainly by the high relative employment rates of women with doctorates relative to their female counterparts with other tertiary degrees.

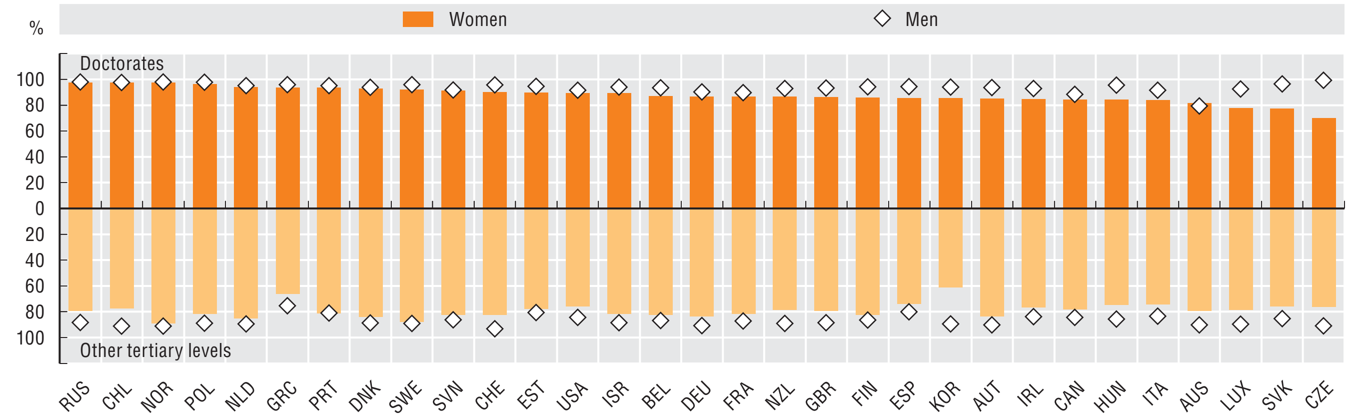
With few exceptions, at least one quarter of the doctoral population and 35% on average are employed in education. The health sector accounts for a significant proportion of doctorate employment in Germany, Iceland, Hungary, Switzerland and the Netherlands. This category is shown aggregated with public administration due to confidentiality disclosure rules. Manufacturing and related industrial activities represent a relative minor destination for doctorate holders, but professional activities, including R&D services, and related market services such as finance and information and communication are another major destination for doctorate holders in countries such as Belgium, France, Finland, Portugal, Norway, the Czech Republic, Sweden and Switzerland. These sectors tend to provide services to manufacturing industries.

Definitions

Doctorate holders are residents of a country that have completed the second stage of tertiary education (ISCED-97 Level 6) leading to an advanced research qualification. The *employment rate of doctorate holders* is the ratio of the number of doctorate holders employed (employees and self-employed) relative to the total number of doctorate holders resident in the country. The main *economic activities* of doctorate holders are defined according to the International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 4.

Employment rate of doctorate holders and other tertiary graduates, 2012

As a percentage of working-age individuals in the relevant attainment group, by gender



Source: OECD calculations based on OECD data collection on Careers of Doctorate Holders 2014, *www.oecd.org.sti/cdh*; and other international sources, June 2015. See chapter notes.

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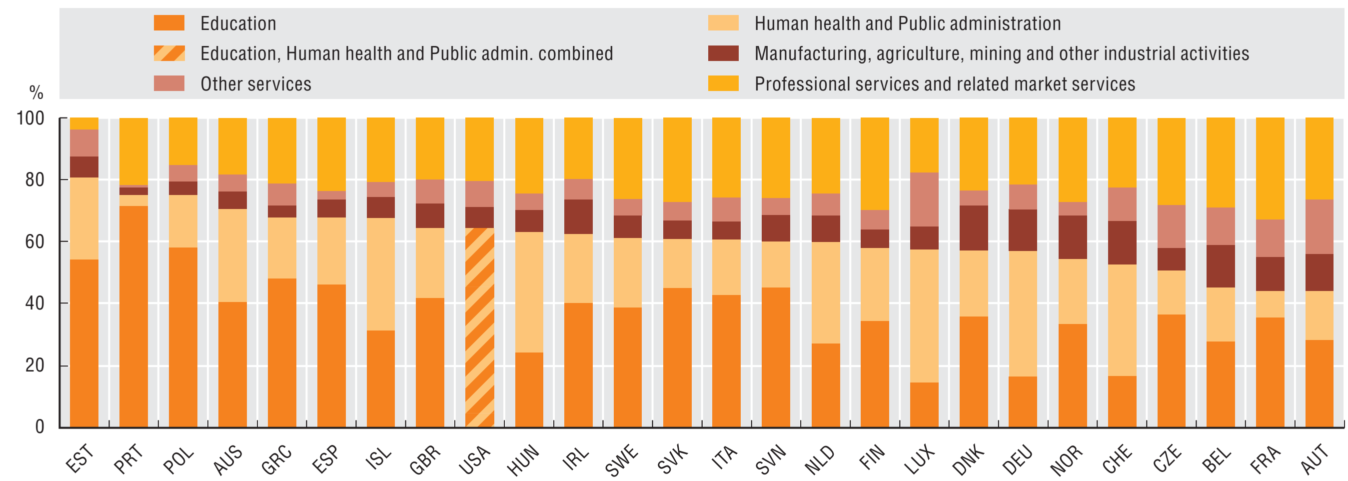
Doctorate holders by economic activity, 2012

As a percentage of all employed doctorate holders



Source: OECD calculations based on OECD data collection on Careers of Doctorate Holders 2014; Eurostat, EU Labour Force Survey (Micro-data), July 2015; and United States Current Population Survey (CPS), July 2015. See chapter notes.

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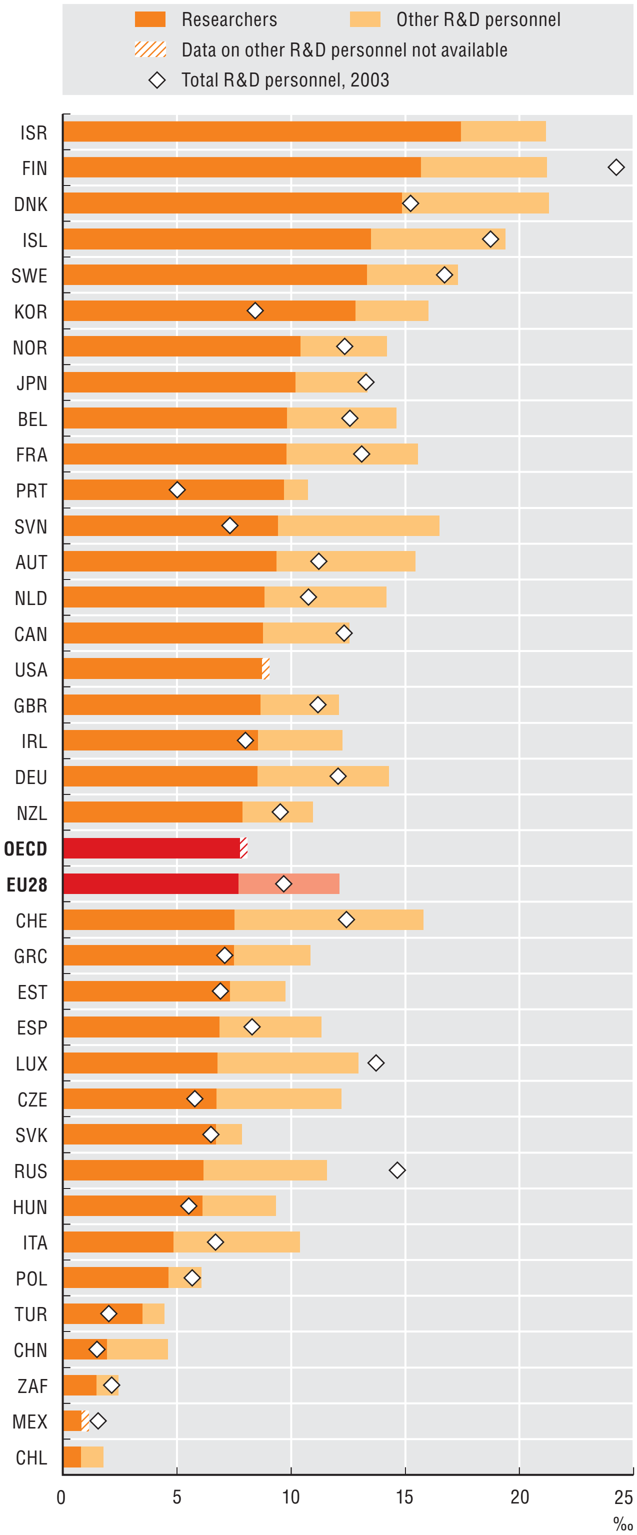
Measurability

The OECD initiated the Careers of Doctorate Holders (CDH) project to provide robust empirical evidence on the career path and performance of doctorate holders. As the number of doctorate holders has increased, household surveys and population censuses have begun to identify and report on them separately from other tertiary educated individuals. With the help of an international expert group, the CDH project has developed a set of methodological guidelines, a model survey questionnaire and templates for output tables. Their implementation requires building comprehensive registers for the population of doctorate holders. Some countries draw on alternative data sources such as censuses, registers or workforce surveys. Estimates from the latter may be imprecise because of the relatively small size of this population. In addition, some results have been suppressed or aggregated into broader categories (e.g. by main activity) because of confidentiality rules. The use of different methodologies may affect the coverage of the target population or the availability of certain variables of interest (see chapter notes and *www.oecd.org/sti/cdh*).

5. Researchers

R&D personnel, 2013

Per thousand employment



Source: OECD, *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, June 2015. See chapter notes.

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R&D activities in OECD and key partner economies rely on the contribution of personnel engaged in R&D. The share of R&D personnel in total employment –measured on a full-time equivalent (FTE) basis – exceeds 2% in Denmark, Finland and Israel, more than twice the OECD average. Employment of R&D personnel has risen over the last decade, mainly owing to an increase in the number of researchers relative to technicians and other R&D personnel. The reported share of researchers in total R&D personnel varies widely, from 45% in Chile to 90% in Portugal.

The business enterprise and the higher education sectors are the main employers of researchers. The business sector accounts for the bulk of researchers in more than half of countries reporting estimates, with a share above 65% in Israel, Japan, Korea and Sweden. The share of researchers in the business sector has increased in a majority of countries over the decade, especially in Hungary and Turkey. However, methodological changes aimed at addressing reporting difficulties by R&D performers hinder attempts to accurately measure changes in the numbers and distribution of researchers across sectors.

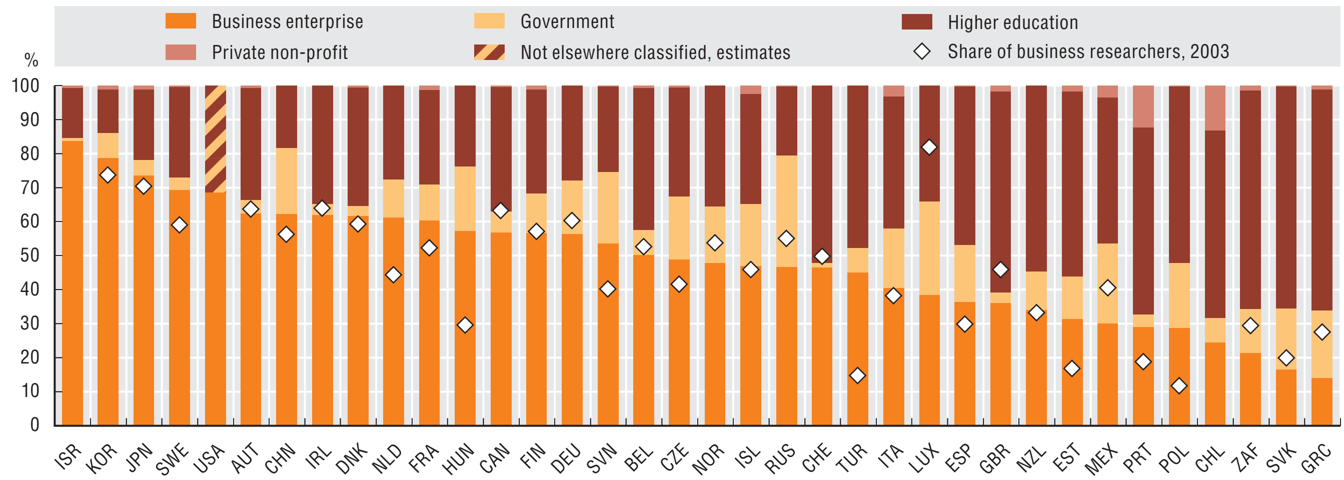
The share of women in the population of researchers ranges from 20% in Israel and Germany to nearly 45% in Estonia, Portugal and South Africa, among countries for which data are available. Higher education institutions are the main employers of female researchers, except in Denmark, France, Hungary, Israel, Slovenia and Sweden, where most women work in the business sector.

Definitions

Research and development personnel include all persons employed directly in R&D activities and therefore cover technicians and support staff as well as researchers. *Researchers* are defined as professionals engaged in the conception and creation of new knowledge, products, processes, methods and systems and are directly involved in the management of projects. R&D personnel and researchers are represented in full-time equivalent units. A person working half-time on R&D during the course of a given year is counted as a 0.5 person year in research FTE. FTE data are a more accurate measure of the volume of human resources devoted to research in a country than headcounts or jobs. For international comparison purposes, R&D personnel figures are normalised by total employment as reported in OECD National Accounts statistics.

Researchers, by sector of employment, 2013

As a percentage of total researchers, full-time equivalents



Source: OECD, *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

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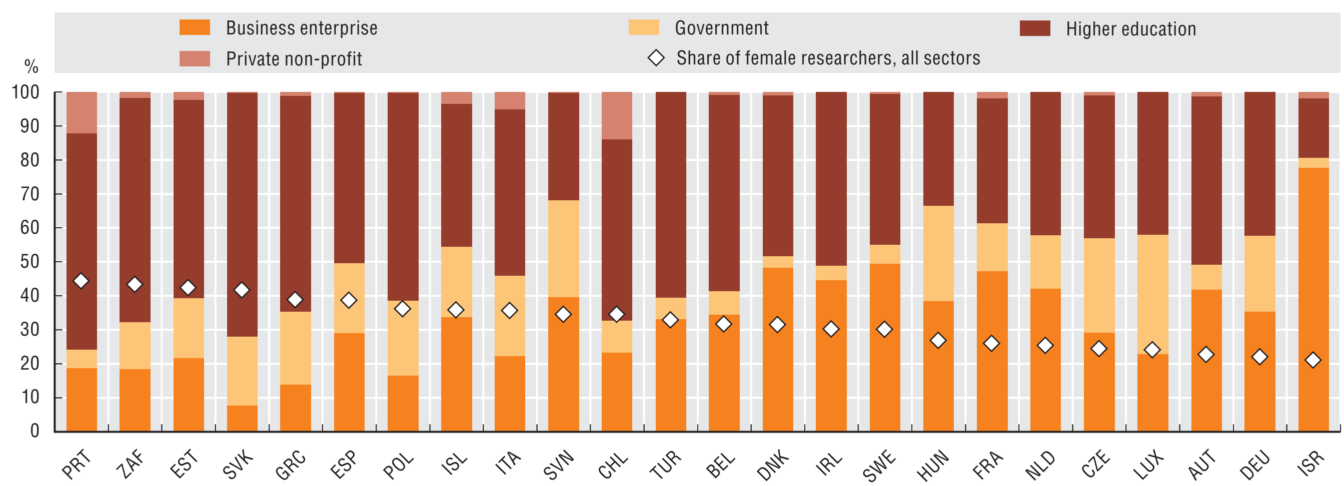
Female researchers, by sector of employment, 2013

Percentages, based on full-time equivalents



Source: OECD, *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273646

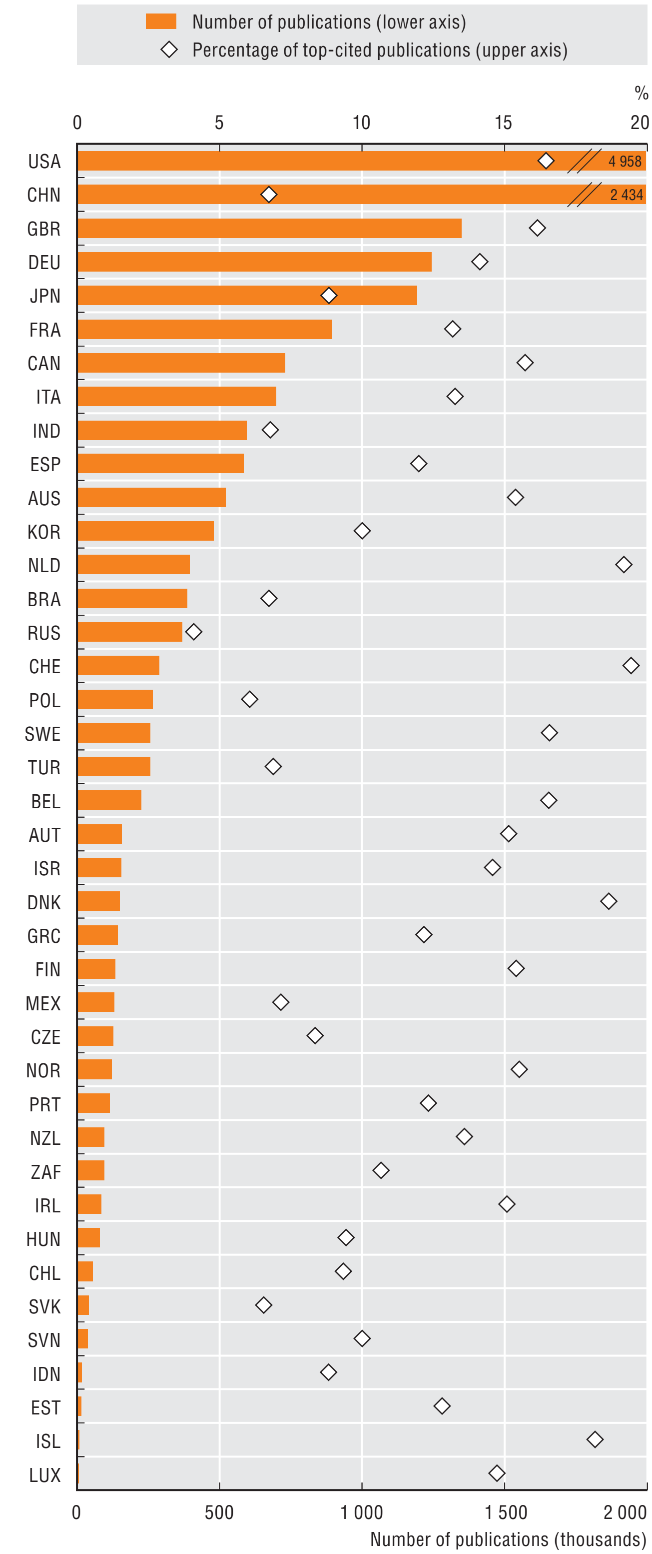
Measurability

The production of internationally comparable estimates of R&D personnel is fraught with practical difficulties, as evidenced by the lack of data for some OECD countries. For example, methods used to calculate FTE units may vary not only from country-to-country but also across sectors within countries, owing to differences in the data sources used to estimate R&D in each sector. Estimating FTEs is particularly challenging in higher education, as many researchers typically engage in other activities, such as teaching or administrative tasks, some of which at the border of R&D. Visiting researchers and other external personnel also present identification and attribution problems. In the business sector, R&D financial records are not always fully aligned with personnel records. Responsibility for filling R&D questionnaires has to be shared with human resource departments which may have limited information on R&D projects. Improved guidelines to address these limitations have been provided in a new edition of the *Frascati Manual* (OECD, 2015). Once national agencies have adopted these recommendations, outcomes should be reflected in future OECD R&D databases and related publications.

6. Research excellence

The quantity and quality of scientific production, 2003-12

Number of documents and percentage among world's 10% most cited



Source: OECD and SCImago Research Group (CSIC) (2015), *Compendium of Bibliometric Science Indicators 2014*, *http://oe.cd/scientometrics*. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273656

The indicator of top-cited publications provides a "quality-adjusted" measure of research output. The United States led the production of scientific publications over 2003-12. Although China accounts for the second largest number of documents, it lags behind the United Kingdom and Germany in terms of numbers of highly cited documents. Switzerland has the largest share of documents with a high citation impact, closely followed by the Netherlands and Denmark.

Countries exhibit specialisation in a number of scientific domains. A relative activity index provides evidence of the fields in which a given country accounts for a relatively high share of scientific production, compared to the global norm. For example, Brazil is highly specialised in Dentistry. Very high levels of specialisation are also found in Iceland and Chile in the field of Earth and Planetary Sciences. Luxemburg is highly specialised in Economics and Finance, while the Russian Federation exhibits a strong specialisation in Physics. Conversely, most economies exhibit less marked specialisation levels.

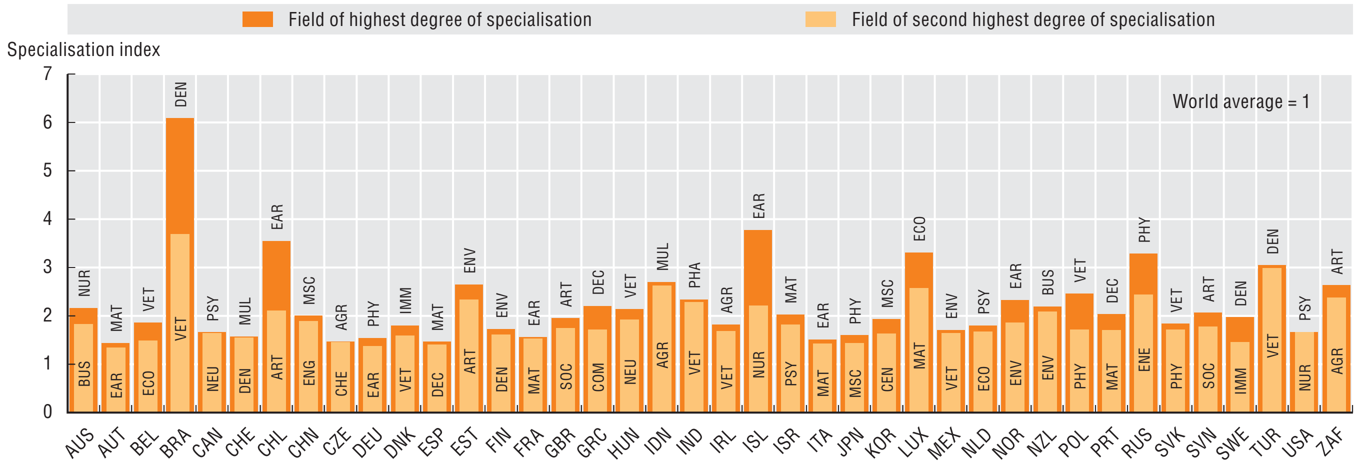
The research performance of countries varies across fields. A new indicator shows the two fields in which scientists in each country attain the largest fraction of documents featuring among each field's 10% globally most-cited documents. Across countries, areas of relative specialisation do not always coincide with those of highest average domestic excellence rates. Top fields in Brazil, India and Mexico have lower values than in other countries at around 10%, indicating that these domestic leading fields barely attain levels of excellence comparable to the entire world.

Definitions

Estimates of *scientific publication output* are based on whole counts of documents, indexed within Elsevier's Scopus database, by authors affiliated to institutions in each country. The counting method assigns an equal weight of 1 to each of the document's authoring units, in this case distinct countries of author affiliation regardless of number. The *Relative Activity Index* measures relative specialisation. The indicator is calculated by dividing a field's share of paper within a given country by the global share of that particular field. Economies that have field distributions very similar to that of the entire world, should exhibit specialisation values very close to 1. A value of 2 for a given field and country indicates that the weight of the field in the country is twice that of the entire world. The indicator of scientific excellence indicates the percentage of a unit's scientific output that is included in the group of the 10% most-cited publications in the respective scientific fields.

Field specialisation in scientific publication output, 2003-12

Relative activity indices, top two most specialised fields per country



Source: OECD and SCImago Research Group (CSIC) (2015), *Compendium of Bibliometric Science Indicators 2014*, *http://oe.cd/scientometrics*. See chapter notes.

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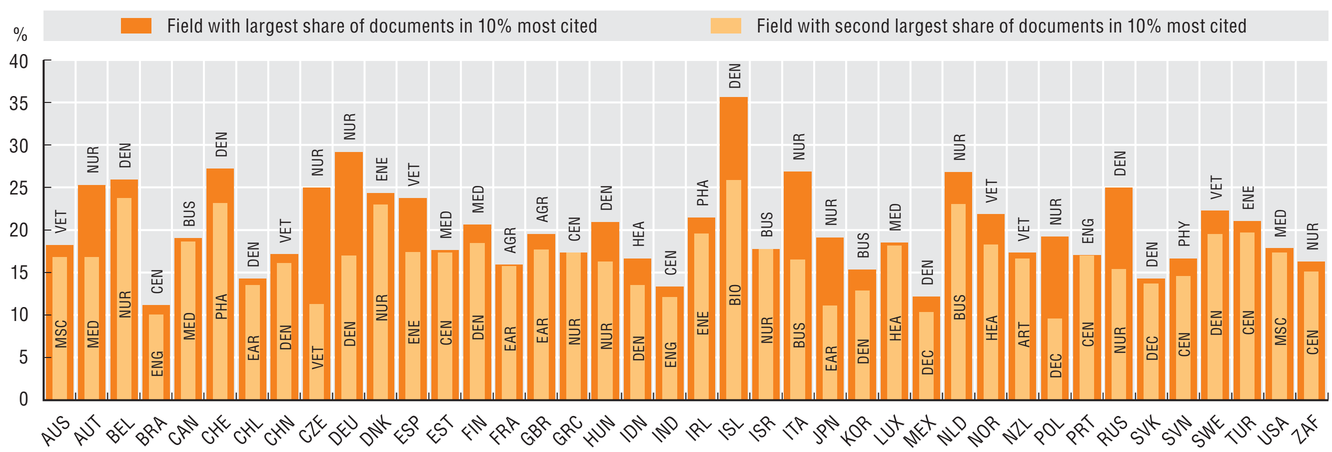
Excellence rate for top two scientific fields within countries, 2003-12

Percentage of documents among 10% most cited, by field and country



Source: OECD and SCImago Research Group (CSIC) (2015), *Compendium of Bibliometric Science Indicators 2014*, *http://oe.cd/scientometrics*. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273670

Measurability

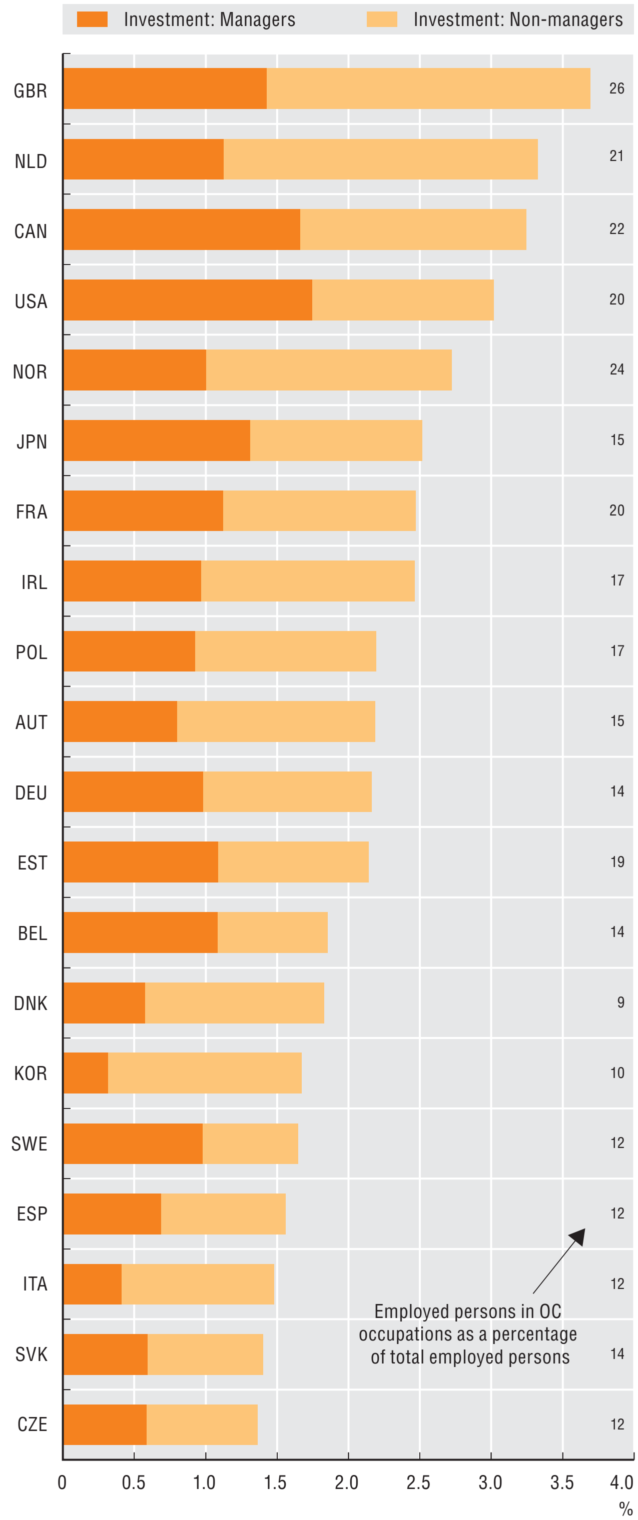
Scientific publications provide a partial measure of scientific production based on the numbers of documents published in peer reviewed journals and indexed by data providers. Publication norms vary by field and sector (OECD and CSIC, 2015), depending for example on the use of books as dissemination mechanisms or on the implications of disclosure and the value of secrecy. Indexing may also exhibit language-related biases. For this reason, the share of 10% most cited publications is normalised by field.

In the case of Scopus, Elsevier uses its All Science and Journal Classification (ASJC) to classify each journal under one or more subject. The ASJC has 27 main fields comprising 334 subjects. Each field and its related abbreviations are detailed in the *Reader's guide*. Documents are assigned to fields on the basis of the journal in which they are published. This assignment approach is therefore an approximation as a given journal's classification may not provide an accurate representation of each document's thematic content. In 2014, the 22 283 active journals covered in Scopus were attributed to an average of 2.06 subjects each. Only 39% of all titles were allocated to a single subject.

7. Organisational capital

Employment and investment in organisational capital, 2011-12

As a percentage of total value added



Source: OECD calculations based on the *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and other national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273688

Organisational capital (OC) is the combination of knowledge, processes and systems that firms rely upon to organise their activities. OC represents a firm-specific strategic asset that correlates positively with a wide array of firm performance and productivity-related indicators, as well as with long-term operating and stock performance and executive compensation. OC enables more efficient and effective production and increases competitiveness.

Investment in OC and the corresponding share of employment vary widely within and across economies, shaped by structural and firms-specific features. Structural factors include the industrial composition of economies and the relative importance of manufacturing and services, the heterogeneity of firms within industries, and the extent of participation by firms in global value chains. Firm-specific factors include the skill endowment of the workforce and whether OC tasks are centralised or performed more widely across occupational profiles.

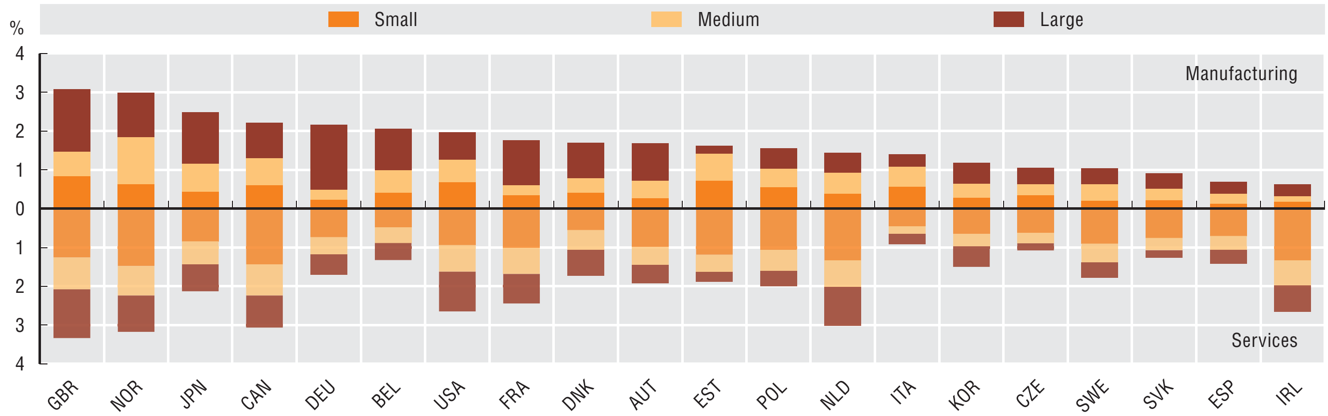
Economy-wide estimates of investment in OC amount on average to 2.2% of total value added. With few exceptions (e.g. Japan and the United States) non-managerial occupations such as supervisors and system administrators account for about 60% of total investment in OC. Employment in OC-related occupations ranges between 9% in Denmark and 26% in the United Kingdom. In most economies, investment in OC as a share of value added is higher in services than in manufacturing. This also holds true for SME investment with small manufacturing firms generally displaying particularly low OC investment intensity compared with services. Conversely, with few exceptions (e.g. the United States), large manufacturers have a higher propensity to invest in OC than large firms in services. This is the case for Germany and Japan, where differences amount to about 1 percentage point of value added. Notable differences also emerge when looking at industry-specific investment in OC within and across industries. While median values range between 0.5% and about 4% in the business sector, the top 10% of investors exhibit values 3 to more than 30 times higher than those of the bottom 10% of investors in the same industry.

Definitions

Organisational capital is defined as the firm-specific human capital (i.e. workers) performing sets of tasks that affect the medium and long-term functioning of firms. These tasks involve: developing objectives and strategies; organising, planning and prioritising work; building teams, matching employees to tasks, and providing training; supervising and co-ordinating activities; and communicating across and within groups to provide guidance. *Managers* are workers in ISCO-08 1-digit occupations 1; *non-managers* belong to all other occupational categories (e.g. supervisors).

Investment in organisational capital, by industry and firm size, 2011-12

As a percentage of value added in the industry

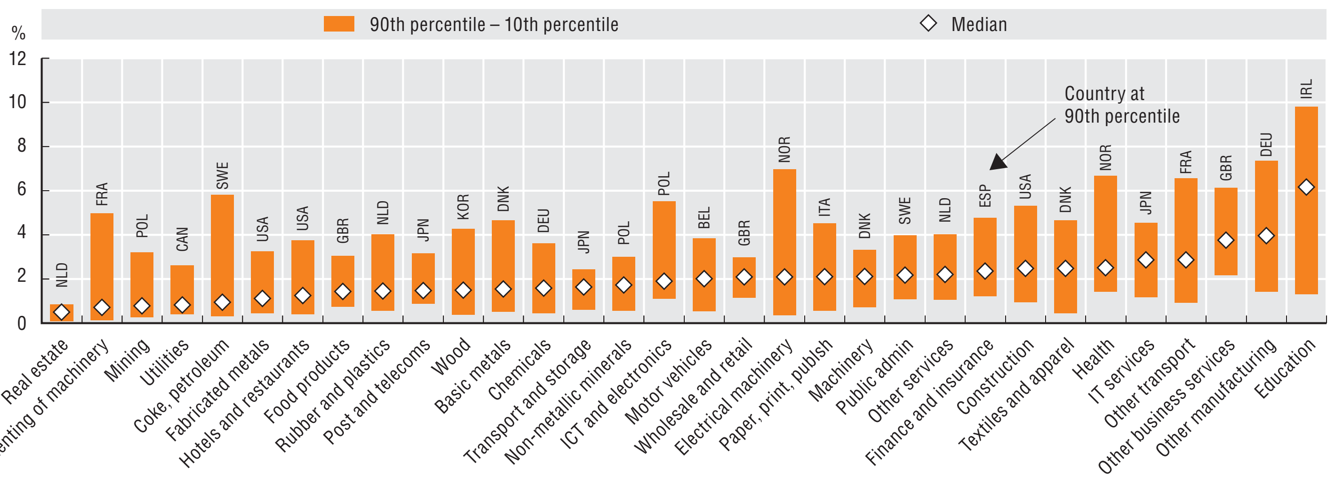


Source: OECD calculations based on the *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and other national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273696

Investment in organisational capital, by industry, 2011-12

As a percentage of value added and range of dispersion across countries



Source: OECD calculations based on the *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and other national data sources, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273707

Measurability

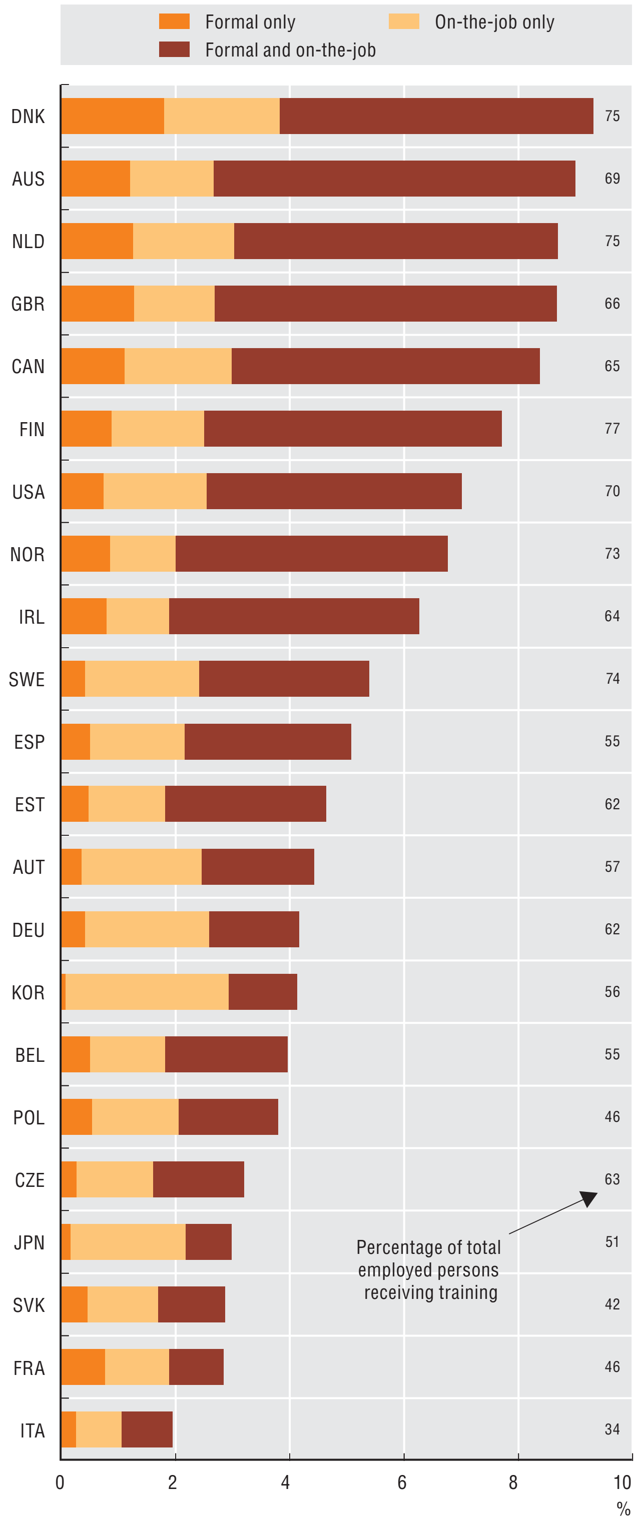
This experimental indicator assumes that managers are not the only contributors to OC generation. The methodology involved identifies OC-related workers by examining the content of tasks on the job and uses a three-step approach to estimate investment in OC.

Data from the OECD Programme for the International Assessment of Adult Competencies (PIAAC) are used to identify tasks corresponding to OC-related activities and then rank occupations in terms of frequency of performance of OC-relevant tasks. The number of employees contributing to generation of OC and investment in OC are estimated using occupation-specific employment and income figures from official statistics, such as Labour Force Surveys and National Accounts. Investment in OC is assumed to correspond to 20% of the time (and hence labour compensation) of workers belonging to occupational categories identified as OC-intensive. The accuracy of estimates may vary depending on the availability of detailed occupation and industry-specific data related to employment and labour compensation (for more details see Le Mouel and Squicciarini, 2015).

8. Firm-specific training

Firm-specific training: Employment and investment by type, 2011-12

As a percentage of total employed persons and gross value added



Source: OECD calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and national sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273718

Firms' investment in training helps workers to acquire the skills and competences that firms need. Training improves the performance of workers and their ability to adapt to technological and organisational change, it helps to retain workers thanks to the rewarding effect it has on employees and, more generally, relates positively to productivity growth. Workers engage in training because it may lead to greater earnings and better working conditions, jobs and career paths. Training also lowers the probability of redundancy and increases the chances of finding a job after an unemployment spell or changing occupation.

Firms' investment in different types of training depends on factors such as business cycles, industry structure, firm characteristics, distribution of wages, the existence of labour market friction and the nature of the training provided (i.e. vocational or general training).

In the countries considered, 61% of workers on average underwent formal and/or on-the-job training at least once in 2011-12. Substantial differences emerge in the share of workers trained (34% in Italy versus 77% in Finland) and the size of the investment. While investment in formal and on the-job training on average account for 0.7% and 1.6% of total value added respectively, investment intensity doubles when both forms of training are offered together. Denmark, Korea and Australia present the highest percentages of investment in formal (1.8%), on-the-job (2.8%) and both types of training (6.3%), respectively.

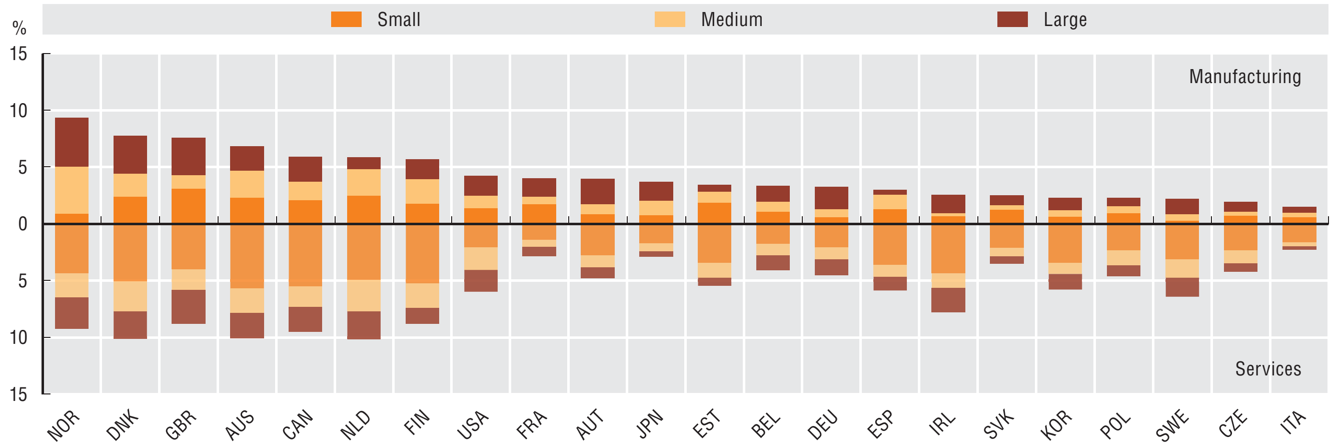
In most countries, firms in the service sectors invest a higher share of value added in training than manufacturing (6.3% versus 4.2% on average, respectively). Small and medium enterprises (SMEs) follow a similar pattern, with SMEs in services that generally invest more than SMEs in manufacturing, whereas in half of the countries considered large manufacturers invest a higher share of value added in training than in services. Differences become starker at the industry level: median values across countries vary between less than 1% (in Real Estate) to more than 12% (in Education) of the industry gross value added, and the top 10% of investors spend up to 30 times as much as the bottom 10% of investors in the same industry.

Definitions

Formal training refers to training in an organised, outside-work environment resulting in the attainment of a degree at an education institution (e.g. MSc or BA university degrees). *On-the-job training* is a structured form of training that may take place both inside and outside a firm (e.g. computer programming at a vocational education institution). On-the-job training does not typically lead to the attainment of an education degree and may take place during or outside working hours.

Investment in firm-specific training by type, industry and firm size, 2011-12

As a percentage of value added in the industry

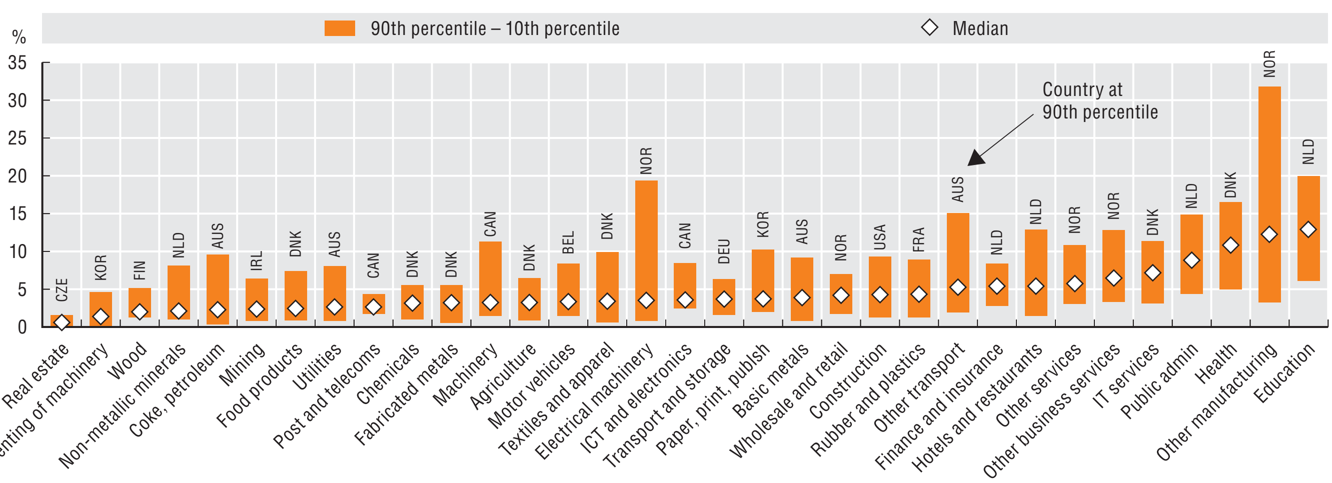


Source: OECD calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and national sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273724

Investment in firm-specific training by industry, 2011-12

As a percentage of value added and range of dispersion across countries



Source: OECD calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and national sources, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273734

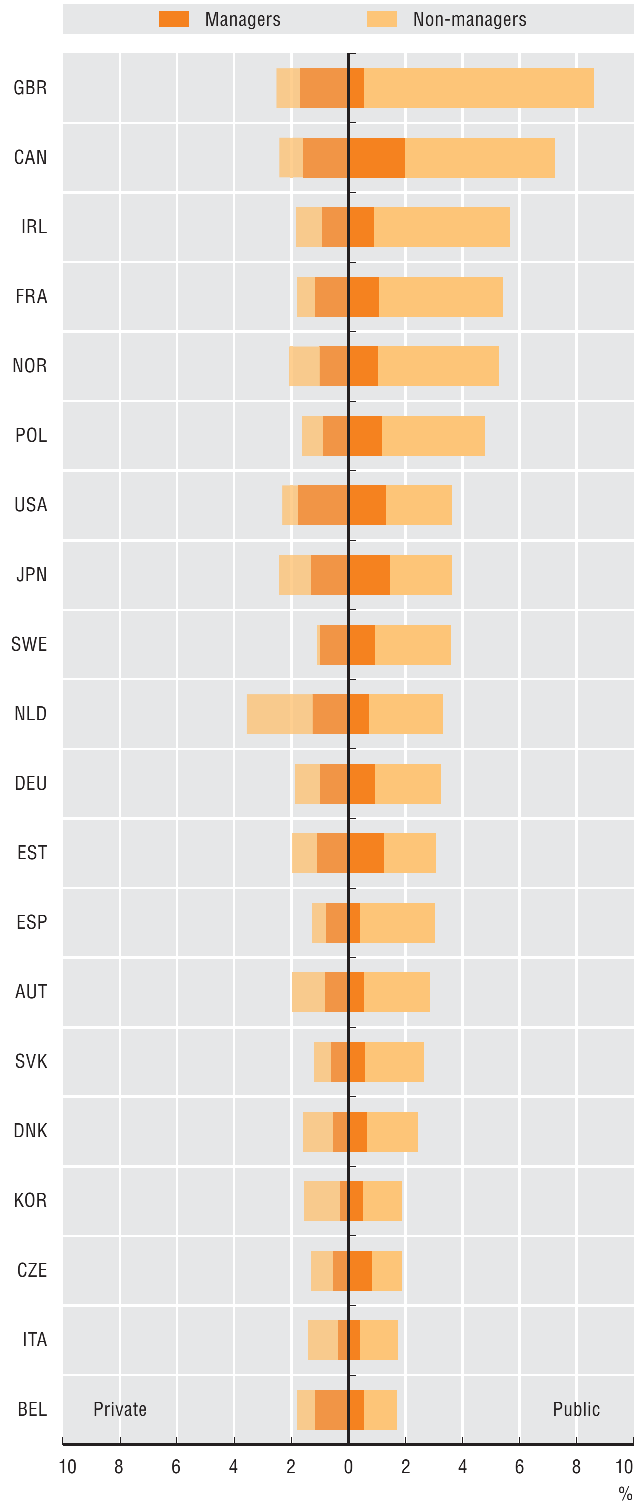
Measurability

These experimental indicators distinguish between different types of training (i.e. formal and on-the-job training – shown here –, and informal learning). The latter is defined as training resulting from the daily activities of employees at the workplace, including learning by doing and learning from peers and/or supervisors. Estimates take into account factors including: who sponsors the training (i.e. the firm, the worker or both), its usefulness for the current occupation, whether training takes place during or outside working hours, and the characteristics of the company and the industry where training takes place. Figures are calculated following an expenditure-based approach and encompass both direct and opportunity costs (i.e. the forgone hours of work due to training). Investment figures are obtained from several sources including: the OECD Programme for the International Assessment of Adult Competencies (PIAAC) survey, Labour Force Surveys, Continuing Vocational Training Surveys and National Accounts. Indicators on informal learning and further details about the methodology can be found in Squicciarini et al. (2015).

9. Public sector intangibles

Investment in organisational capital in the public and private sectors, 2011-12

As a percentage of value added in each sector



Source: OECD calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and national sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273741

The relationship between public sector investment in physical infrastructure and productivity in the private sector has been extensively researched, as has the role of public investment in R&D. However, little is known about public sector investment in other forms of knowledge-based capital (KBC). A new experimental OECD indicator quantifies public sector investment in organisational capital (OC) and training, and compares it with investment in the private sector. Investment in OC affects the medium and long-term functioning of public institutions and firms, while training endows workers with skills and competencies needed on the job.

In today's knowledge-based economies both public and private sectors need to invest in organisational capabilities, to cope with economic and societal challenges. Moreover, as knowledge, including organisational know-how, depreciates fast, investment in training helps adapt the OC to maintain or improve performance.

Overall, with the exception of Belgium and the Netherlands, the share of value added invested in OC is higher in the public sector than in the private sector. Such differences are driven mainly by the contribution of non-managerial occupations, like supervisors and system administrators, which is considerably higher in the public sector.

The public sector also invests more in training than the private sector (on average 10.4% and 4% of sector value added, respectively). While on average private sector investment in training is equally distributed between formal and on-the-job training, formal training is more important in the public sector and accounts for up to 77% (Norway) of total investment in the sector. This to some extent reflects the presence of the education sector itself within the public sector, where the likelihood of investment in formal training is higher.

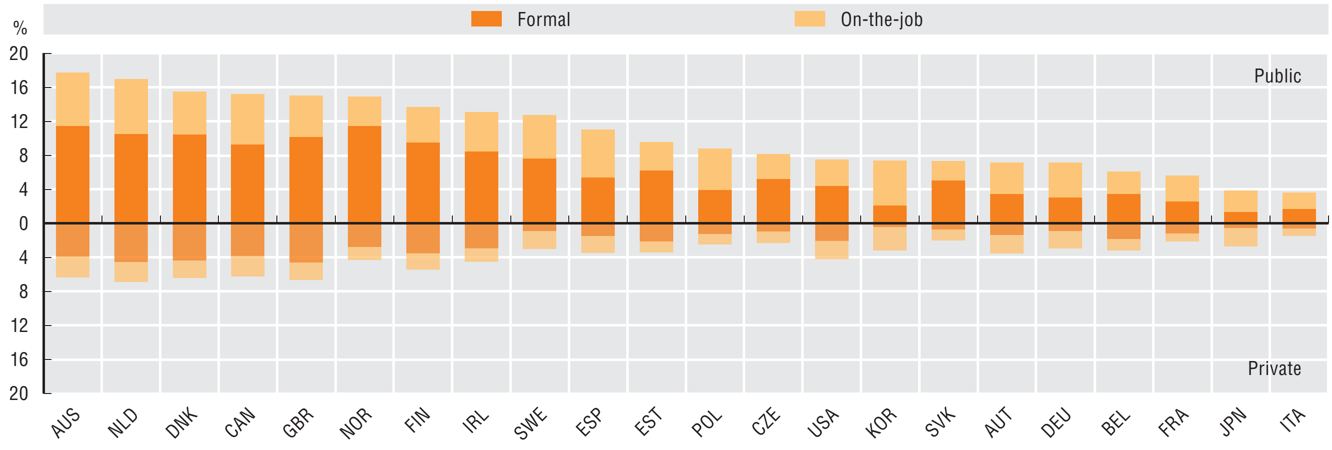
The importance of maintaining and enhancing organisational capabilities is confirmed by the share of managers and non-managers receiving training: on average, 66% of private sector managers and 84% of public sector managers receive some form of training compared to 61% of the overall population (see Chapter 2, Section 8). The percentage of workers in non-managerial occupations contributing to OC that receive training is even higher: 71% and 85% in the private and public sector, respectively.

Definitions

Private refers to investment by private entities operating in the business sector (ISIC Rev. 3 Codes 01 to 72 and 74). *Public* refers to investment by public entities operating in ISIC Rev. 3 Sectors 73 and 75 to 93. *Training* encompasses both *formal* and *on-the-job training*, in other words, training taking place in an organised fashion, either inside or outside the firm that may result in attainment of a degree at an education institution (see Squicciarini et al., 2015).

Investment in firm-specific training in the public and private sectors, 2011-12

As a percentage of value added in each sector



Source: OECD calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and national sources, June 2015. See chapter notes.

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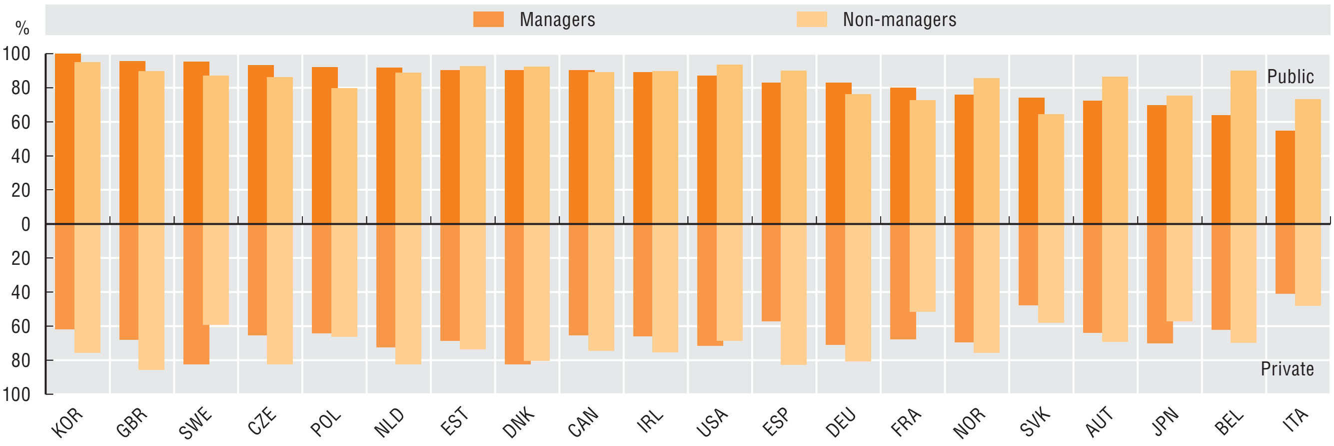
Employees contributing to organisational capital who receive training, public and private sectors, 2011-12

As a percentage of total managers and non-managers in each sector



Source: OECD calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*; OECD, *Structural Analysis (STAN) Database*, *http://oe.cd/stan* and national sources, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273768

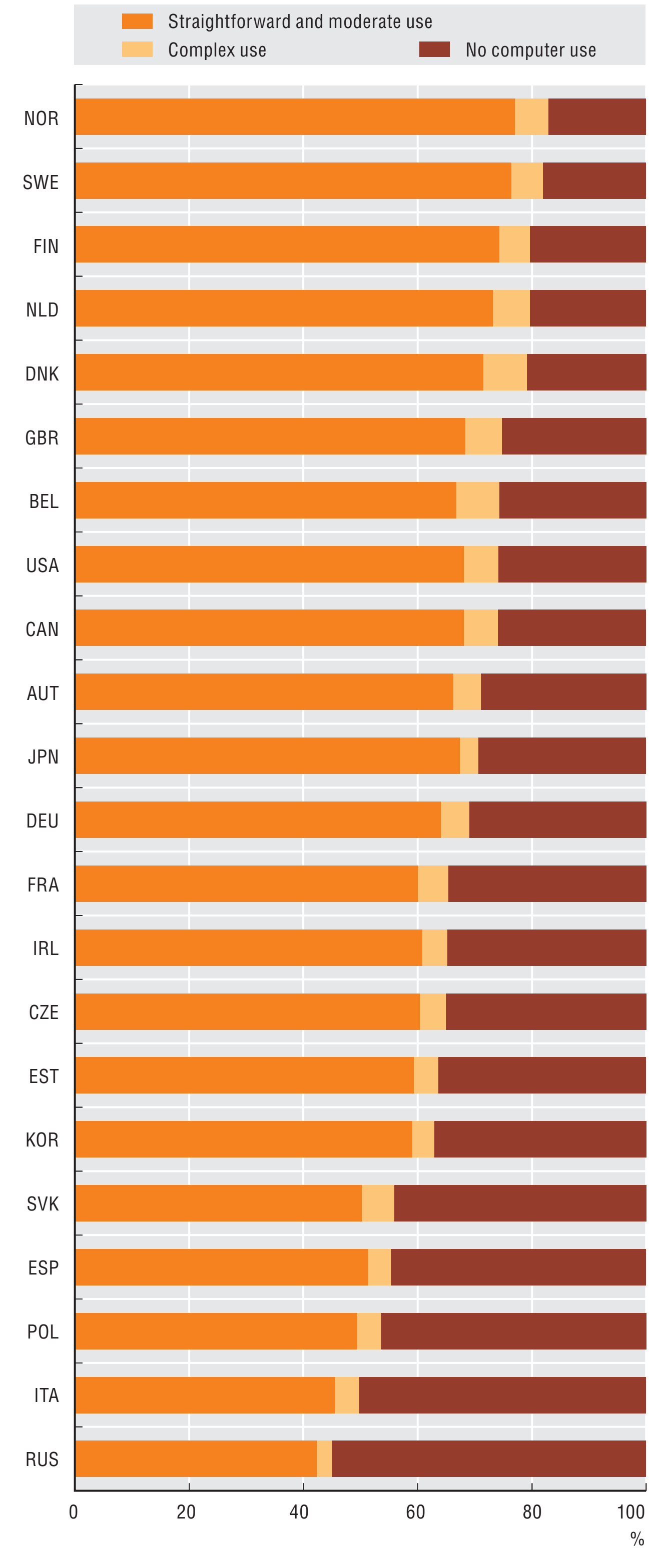
Measurability

The variation in salaries between managerial and non-managerial occupations makes investment estimates look very different from frequency figures. Gross value added (GVA) in the private sector is adjusted by the share of employees working in private entities over total employment in the sector. Similarly, total GVA in the public sector is adjusted by the share of employees working in public entities over total employment in the sector. This approach aims to reflect the industrial structure of economies and to mirror the presence of private entities in public sectors (e.g. health) and public companies in the private sector (e.g. utilities). Such adjustments rely on information from the OECD Programme for International Assessment of Adult Competencies (PIAAC) database detailing the public or private nature of firms. In PIAAC, interviewers attribute occupational categories to ensure consistency. Occupations contributing to OC are identified using information regarding the frequency of organisational-related tasks carried out by workers and may vary from country to country (see Le Mouel and Squicciarini, 2015). Future work will address issues of capitalisation and depreciation of KBC assets.

10. Skills in the digital economy

Computer use at work, 2012

Percentage shares of workers



Source: OECD, based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273776

The diffusion of ICTs in the workplace is changing the way in which work is carried out and increasing the demand for new skills. These skills relate both to the effective use of new technologies and the ability to work in new working environments.

The results from the first OECD Programme for the International Assessment of Adult Competencies (PIAAC) show large differences in computer use at work across countries. In 2012, about 80% of individuals reported using a computer for work in the Nordic countries against 50% in Italy. However, most individuals reported straightforward or moderate computer use.

The data on frequency of ICT use at work permit the measurement of ICT intensity of different occupations. For each country, the difference between the average ICT index value across all occupations and the OECD average can be broken down into an ICT intensity effect and an occupational composition effect. In the Nordic countries, the higher than average ICT index value is driven by the higher than average ICT intensity of different occupations (the ICT intensity effect dominates), while in the case of the United Kingdom and the United States, the composition of the workforce dominates. ICT index values below average in Germany, France or Italy are mainly explained by the lower use of ICT skills at work within occupations.

The increasing use of ICTs at work requires workers to perform different tasks and to develop complementary skills. On average, intensive use of ICTs at work is associated with greater interaction between co-workers and clients, more problem solving, less physical work and higher numeracy. For most tasks, correlations with ICTs tend to decrease with the skill level of the occupation. This suggests that shifts in skill profiles towards a higher use of ICTs may be more significant for workers in low-skilled occupations.

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 or maintaining a computer network.

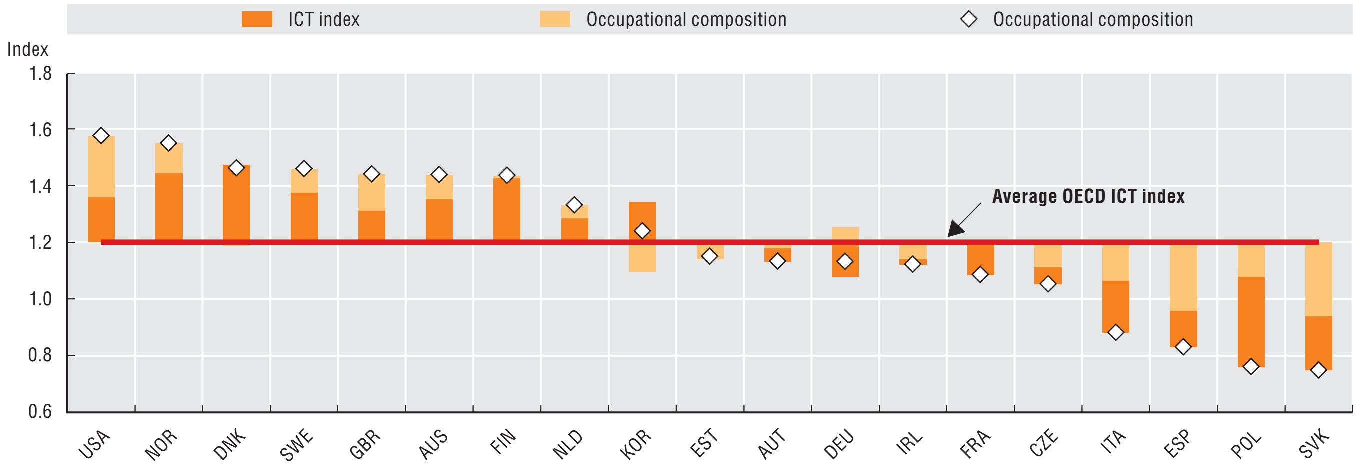
The *ICT index* is a derived variable computed within the *PIAAC Database* on the basis of questions that assess straightforward and moderate ICT use at work.

ICT intensity relates to how, on average in different occupations, workers use ICTs more (or less) compared to the OECD average. *Occupational composition* relates to how employment in a given country is more (or less) concentrated in occupations that use ICTs more (or less) compared to the OECD average.

Skills levels are defined according to the International Standard Classification of Occupations (ISCO-08): high (ISCO 1 to 3), medium (ISCO 4 to 8) and low (ISCO 9).

Index of ICT use at work, 2014

Cross-country differences in ICT intensity of occupations and occupational composition

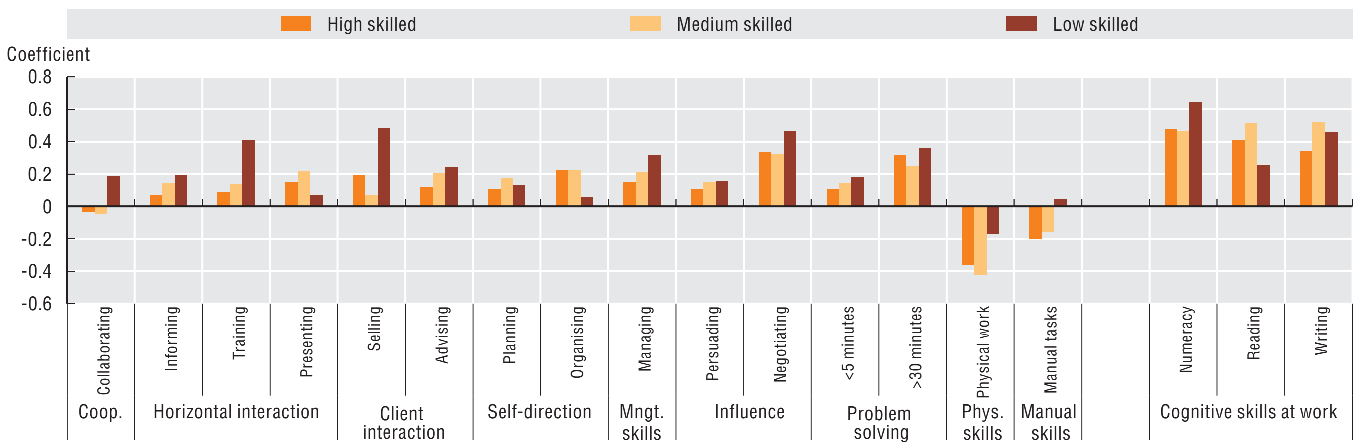


Source: OECD, based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273786

ICT complementary skills, by skill level, 2012

Pairwise correlation coefficients between ICT and other skills used at work



Source: OECD calculations based on *Programme for International Assessment of Adult Competencies (PIAAC) Database*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273796

Measurability

The PIAAC survey collects information on the performance frequency of certain tasks at work. The indicator provides only an indirect measure of the skills required in a given occupation, based on the self-evaluation of workers in that occupation.

Questions about ICT use at work are directed only at PIAAC respondents who report "having experience with computers in the current/last job". To correct for the upward bias resulting from this selection, the ICT index has been adjusted by attributing the lowest possible value to respondents who reported having no computer experience at work.

Correlations between ICT usage and other tasks and cognitive skills in PIAAC are based on a large set of countries, but at one point in time only. The results are therefore representative of many countries, but do not capture *changes* in skills associated with ICTs. National surveys, such as the German IAB/BIBB, the British Skills Survey or the Dutch Skills Survey, enable changes in ICTs and tasks to be tracked over time, but may reflect country-specific features. The analysis of the O*NET survey in the United States tends to confirm the results based on PIAAC and presented above.

Notes and references

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 recognises 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 of the European Union Member States of the OECD and the European Union:

"The Republic of Cyprus is recognised 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."

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

2.1. Investment in knowledge

Spending on higher education, 2011

Core educational services include all expenditures directly related to instruction: all expenditures on teachers, school buildings, teaching materials, books, and administration of schools. Other expenditures include ancillary education expenditures, such as housing, meals and transport provided by institutions, and R&D expenditures at higher education institutions.

For Brazil, Canada, Hungary, Ireland, Poland, Portugal and Switzerland, data refer to public institutions only.

For Canada, data refer to 2010.

For Chile, data refer to 2012.

Gross domestic expenditure on R&D, by type, 2013

Data for total GERD (all types of R&D) refer to 2003 and 2013. Data by type of R&D correspond to the same reference year as GERD or, in their absence, are based on component shares for the most recent available year: 2012 for Denmark, France, Italy, the Netherlands, the United Kingdom and Portugal, and 2011 for Austria, Ireland and Greece.

Shares by type of R&D are based on total GERD, including capital expenditures, except for Chile, Norway, the Russian Federation, Spain and the United States. For these countries, estimates are based on current R&D estimates.

For Australia, data for total GERD refer to 2004 and 2011.

For Ireland, data for total GERD refer to 2012.

For Israel, defence R&D is partly excluded from available estimates.

For Switzerland, data for total GERD refer to 2004 and 2012.

For South Africa, data for total GERD refer to 2012.

For the United States, and with the exception of GOVERD, which includes capital expenditure used for R&D, figures reported refer to current expenditures, but include a depreciation component which may differ from the actual level of capital expenditure.

R&D intensity ratios are normalised using official GDP figures. These are compiled according to the *System of National Accounts* (SNA) 2008, except for Chile, China, Japan, the Russian Federation and Turkey, where figures are available on the basis of SNA 1993.

ICT investment, by asset, 2013

For Norway, Spain and Sweden, data refer to 2012.

For Portugal, data refer to 2011.

Data for Iceland, Israel, Mexico, New Zealand and the Slovak Republic were incomplete and only represent the asset for which data were available.

National sources (used only for investment data) include the National Statistical Institutes of Canada, Denmark, Germany, Japan, the Netherlands, New Zealand, Switzerland, the Central Bank of Korea and the United States Bureau of Economic Analysis (BEA).

2.2. Higher education and basic research

Higher education expenditure on R&D, 2013

General University Funds (GUF) estimates identify the component of general institutional grants received by the higher education sector that are ultimately used for R&D. Estonia, Poland and the United States report no relevant grants fitting the GUF description. No estimates are available for China, the Czech Republic, Germany, Hungary, Korea, Luxembourg, Mexico, the Netherlands, Portugal and Turkey. The GUF figures correspond to the same reference year as HERD or, in their absence, are based on shares for the most recent available year: Belgium (2011), France, Israel and Italy (2012).

For Australia and Switzerland, data refer to 2004 and 2012.

For Austria, data refer to 2004 and 2013.

For Israel and Korea, R&D in the social sciences and humanities are not included in 2003 estimates.

For Mexico, data refer to 2011.

For South Africa, data refer to 2012.

For the United States, figures reported refer to current expenditures, but include a depreciation component which may differ from the actual level of capital expenditure.

R&D ratios are normalised using official GDP figures. These are compiled according to the *System of National Accounts* (SNA) 2008 except for Chile, China, Japan, the Russian Federation and Turkey, where figures are available on the basis of SNA 1993.

Funding of R&D in higher education, 2013

When estimates for “direct government” and “GUF” are not available separately, the class “subtotal government” is used to encompass both categories.

For Australia, Israel, Italy, Portugal, South Africa and Switzerland, data refer to 2012.

For Austria, Belgium and Mexico, data refer to 2011.

For the previous period’s share of higher education R&D financed by business enterprise and private non-profit, data refer to 2003 except for Australia, Austria, France, Israel, Portugal and Switzerland (2002), Belgium, Mexico and South Africa (2001), Chile (2007), and Italy and Luxembourg (2005).

For Australia, Australian competitive grants (ACG) – federal and other schemes – are identified separately and included respectively in direct government and private non-profit.

For China, expenditure by source of funds is divided into government, business enterprise, funds from abroad and “other”. These categories slightly differ from those in the *Frascati Manual*. Money that has no specific source of financing has been allocated to “other sector (domestic)”. This includes self-raised funding, in particular for independent research institutions (IRIs, formerly GRIs) and the higher education sector, and leftover government money from previous years/grants.

For Denmark, higher education funds are included in government funds.

For Israel, defence R&D is partly excluded from available estimates.

For Germany, higher education and private non-profit funds are included in government funds.

In Luxembourg’s survey, R&D data by source of funds are broken down as percentages between: Enterprise group, Ministry of Economy, Partner enterprise of R&D projects, European Commission, International organisations, Other foreign sources (other national governments, higher education, others).

For Poland, there are no General University Funds (GUF) as described in the *Frascati Manual*. The Ministry of Science and Higher Education finances the majority of teaching activities.

Basic research performed in the higher education and government sectors, 2013

Data refer to the sum of current and capital expenditures, except for Chile, Norway, the Russian Federation, Spain and the United States, for which only current costs are included in estimates reported to the OECD.

For Australia, data refer to 2008.

For Austria, Greece and Ireland, data refer to 2011.

For Denmark, France, Italy, the Netherlands, Portugal, the Russian Federation, South Africa, Switzerland and the United Kingdom, data refer to 2012.

For Mexico, data refer to 2009.

For Israel, defence R&D is partly excluded from available estimates.

For the Netherlands, part of expenditures dedicated to experimental development and within the higher education sector are reported within basic research. Additionally, PNP expenditures are included in the government sector.

For Switzerland, the government sector refers to the federal or central government only.

For the United States, and with the exception of GOVERD, which includes capital expenditure used for R&D, figures reported refer to current expenditures, but include a depreciation component which may differ from the actual level of capital expenditure.

2.3. Science and engineering

Tertiary education graduates in natural sciences and engineering, 2012

Data refer to graduates at the ISCED-97 5A and 6 levels, and ISCED-97 fields 3 (Science) and 4 (Engineering, manufacturing and construction).

For Australia, data refer to 2011.

For Brazil, Canada, Chile and Greece, data refer to 2004 and 2012.

For Estonia, data refer to 2005 and 2012.

For France, data refer to 2009.

For Luxembourg, data refer to 2008 and 2012.

For Norway, Portugal, Switzerland, the United Kingdom and the United States, data refer to 2003 and 2012.

For the Russian Federation, data refer to 2006 and 2012.

For Slovenia, data refer to 2005 and 2012.

Graduates at doctorate level, by field of education, 2012

For Brazil, China and Norway, figures are based on national sources: for Brazil, *Capes Database*, Ministry of Education of Brazil, July 2015; for China, Educational Statistics website of the Ministry of Education of the Peoples' Republic of China, July 2015; for Norway, the Nordic Institute for Studies in Innovation, Research and Education (NIFU), June 2015.

For Brazil and China, an approximate conversion of nationally available information was carried out and mapped onto the ISCED-1997 classification of fields of study.

For Australia, data refer to 2011.

For Brazil and China, data refer to 2013.

For France and Poland, data refer to 2009.

For Norway, data are based on NIFU's Doctoral Degree Register, which also includes "Licentiate" degrees (equivalent to a doctorate degree).

New doctorates in natural sciences and engineering, 2008-12

For Brazil and China, an approximate conversion of nationally available information was carried out and mapped onto the ISCED-1997 classification of fields. Figures are based on national sources: for Brazil, *Capes Database*, Ministry of Education of Brazil, July 2015; for China, Educational Statistics website of the Ministry of Education of the Peoples' Republic of China, July 2015.

Owing to data availability by field of education, data refer to the 2007-11 average for Australia; 2009-12 average for China; 2007-09 average for France and Poland; and 2011-12 average for Italy.

2.4. Doctorate holders

General notes for all figures:

For Australia, data refer to 2011.

For Germany, Greece and the Netherlands, data refer to 2013.

For Greece, there is limited coverage of non-permanent residents.

For Greece and the Netherlands, data refer to doctoral graduates from 1990 onwards.

Additional notes:

Doctorate holders in the working age population, 2012

For Canada, Chile and New Zealand, data refer to 2011.

For Iceland, there is no breakdown between men and women.

For Denmark and the Netherlands, data exclude doctorates awarded abroad.

For Korea, data refer only to national citizens.

For Switzerland, data refer to 2013.

Due to the small sample size, the following data should be treated with caution: for Luxembourg and Norway, data on female doctorate holders; for Estonia, data on both female and male doctorate holders.

For Chinese Taipei, data include only PhDs in the National Profiles of Human Resources in Science and Technology (NPHRST) compiled by STPI, NARL: *http://hrst.stpi.narl.org.tw/index.htm#noticeChinese.pdf*.

This indicator combines data from different statistical sources as described below.

Sources (Doctorate holders): Australia, Chinese Taipei, Chile, Denmark, Germany, Greece, Korea, the Netherlands, Portugal, the Russian Federation, Slovenia and Switzerland: OECD Careers of Doctorate Holders 2014. Belgium, Estonia, Finland, France, Hungary, Ireland, Israel, Italy, Latvia, Luxembourg, the Slovak Republic, Spain, Sweden, the United Kingdom and the United States: *OECD Educational Attainment Database 2014*. Austria, the Czech Republic, Iceland, Norway and Poland: EU Labour Force Survey (Microdata), June 2015. Canada and New Zealand: *Database on Immigrants in OECD Countries (DIOC) 2010/11*.

Employment rate of doctorate holders and other tertiary graduates, 2012

For Canada, Chile, Estonia and New Zealand, data refer to 2011.

For the United States, data refer to 2013. Doctorate holders' data exclude those with a doctorate in humanities, education, business, law and communications.

Due to the small size sample, the following data should be treated with caution: the doctorate employment rate of women in Belgium, the Czech Republic, Estonia, Norway and Luxembourg.

For Denmark, Belgium, the Netherlands, and the United States, data exclude doctorates awarded abroad.

For Korea, data refer only to national citizens.

This indicator combines data from different statistical sources as described below.

Sources (Doctorate holders): Australia, Chile, Denmark, Germany, Greece, Korea, the Netherlands, Portugal, the Russian Federation, Slovenia and the United States: OECD Careers of Doctorate Holders 2014. Belgium, Finland, France, Hungary, Ireland, Israel, Italy, Luxembourg, the Slovak Republic, Sweden, Switzerland and the United Kingdom: *OECD Educational Attainment Database 2014*. Austria, the Czech Republic, Spain, Norway, Poland and Slovenia: EU Labour Force Survey (Micro-data), June 2015. Canada, Estonia and New Zealand: OECD *Database on Immigrants in OECD Countries (DIOC) 2010/11*.

Sources (other tertiary levels): OECD Educational Attainment Database 2014. For Canada, Estonia and New Zealand: OECD *Database on Immigrants in OECD Countries (DIOC) 2010/11*.

Doctorate holders by economic activity, 2012

For presentational reasons and to preserve cell confidentiality rules, grouped economic activities combine different section headings of ISIC Rev. 4, as listed below. Manufacturing, agriculture, mining and other industrial activities includes Sections A, B, C, D, E and F. Professional services and related market services includes J, K, L and M. Human health and Public administration includes O and Q. Other services includes G, H, I, N, R, S, T and U.

For Denmark and the Netherlands, data excludes doctorates awarded abroad.

For Switzerland, data refer to 2013.

For the United States, data refer to population aged 25 years and over.

Sources: Australia, Denmark, Germany, Greece, the Netherlands, Portugal, Switzerland: OECD Careers of Doctorate Holders 2014. Austria, Belgium, the Czech Republic, Estonia, Finland, France, Spain, Hungary, Iceland, Ireland, Italy, Luxembourg, Norway, Poland, the Slovak Republic, Slovenia, Sweden and the United Kingdom: EU Labour Force Survey (Micro-data), June 2015. The United States: Current Population Survey (detailed tables on educational attainment), July 2015.

Section headings for economic activities in ISIC Rev. 4:

A	Agriculture forestry and fishing
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam, air conditioning
E	Water supply; sewerage, waste management and remediation activities
F	Construction
G	Wholesale and retail trade, repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific and technical activities
N	Administrative and support activities
O	Public administration and defence; compulsory social security
P	Education
Q	Human health and social work activities
R	Arts, entertainment and recreation
S	Other service activities
T	Activities of households as employers
U	Activities of extraterritorial organisations and bodies

2.5. Researchers

R&D personnel, 2013

For Austria, data refer to 2004 and 2013.

For Canada, Ireland, Israel, the OECD zone, South Africa and the United States, data refer to 2012.

For Iceland and Mexico, data refer to 2011.

For Switzerland, data refer to 2004 and 2012.

For the United States, 2012 data for researchers have been estimated based on contemporaneous data on business researchers and past data for other sectors.

Researchers, by sector of employment, 2013

For a number of countries, methodological improvements were adopted over the period 2003-13, which may hinder data comparisons over time.

For Iceland, data refer to 2001 and 2011.

For Israel, South Africa and the United States, data refer to 2012.

For Mexico, data refer to 2004 and 2011.

For Switzerland, data refer to 2004 and 2012.

Previous year data points for the share of business researchers refer to 2003 except for Austria and Finland (2004).

For China and Israel, the military part of defence R&D is excluded.

For the Netherlands, the private non-profit sector is included in the government sector.

For Norway, data refer to university graduates instead of researchers in the business sector.

For Sweden, data refer to university graduates instead of researchers in the business sector before 2005.

For the United States, 2012 data for researchers have been estimated based on contemporaneous data on business researchers and past data for other sectors.

Female researchers, by sector of employment, 2013

For Austria, Belgium, Denmark, Germany, Greece, Iceland, Ireland, Israel, Luxembourg and Sweden, data refer to 2011.

For France, Italy, Portugal and South Africa, data refer to 2012.

For the Netherlands, the private non-profit sector is included in the government sector.

2.6. Research excellence

The quantity and quality of scientific production, 2003-12

"Top-cited publications" are the 10% most-cited papers in each scientific field. This measure is an indicator of research excellence. Estimates are based on whole counts of documents by authors affiliated to institutions in each economy.

Field specialisation in scientific publication output, 2003-12

The "Relative activity index" is calculated by computing the ratio between a field's output share within the reference country and the corresponding share at world level. The index shows the extent of a country's specialisation in one field relative to the global "norm".

Excellence rate for top two scientific fields within countries, 2003-12

The 10% most-cited documents is an indicator of scientific excellence. This rate indicates the amount (in percentage) of a unit's scientific output included in the set of the 10% most-cited papers in their respective scientific fields. This measure is an indicator of the high quality of research output of a unit.

Results displayed exclude multidisciplinary fields. Data on top three fields, including multidisciplinary, are available as more data.

2.7. Organisational capital

General notes for all figures:

Identification of occupations that relate to organisational capital (OC) is based on survey results from the Programme for the International Assessment of Adult Competencies (PIAAC), classified according to the International Standard Classification of Occupations (ISCO, 2008).

Additional notes:

Employment and investment in organisational capital, 2011-12

Employment and investment are calculated for the total economy and expressed as ratios of total employed persons and total value added, respectively.

Investment in organisational capital, by industry and firm size, 2011-12

The industry classification used is ISIC Rev. 3. Small firms have between 1 and 50 employees, medium firms between 51 and 250 employees, and large firms more than 250 employees.

Investment in organisational capital, by industry, 2011-12

The industry classification used is ISIC Rev. 3. The Agriculture sector has been removed due to poor coverage of OC occupations.

2.8. Firm-specific training

General note for all figures:

Identification of investment in firm-specific training is based on survey results from the Programme for the International Assessment of Adult Competencies (PIAAC) and external data (LFS, SNA and OECD sources).

Additional notes:

Firm-specific training: Employment and investment by type, 2011-12

Employment figures are calculated as the ratio of total employed persons receiving training at least once per year, by type of training (formal vs. on-the-job), over total employment in the economy.

Investment figures are calculated as investment by type of training over total gross value added.

Investment in firm-specific training by type, industry and firm size, 2011-12

Investment figures are calculated as investment by type of training and size of the employing company, over gross value added in the industry.

Small firms have between 1 and 50 employees, medium firms between 51 and 250 employees, and large firms more than 250 employees.

Investment in firm-specific training by industry, 2011-12

Investment figures are calculated as investment by type of training over gross value added in the industry.

The confidence interval is calculated as the 90th percentile over the 10th percentile of the cross-country distribution. The country code on the top of the bar indicates the country with the training intensity closest to the 90th percentile of the cross-country distribution of industry values.

2.9. Public sector intangibles

Investment in organisational capital in the public and private sectors, 2011-12

"Private" refers to OC investment in private entities operating in the business sector (ISIC Rev. 3 Codes 01 to 72 and 74). Investment is divided by total gross value added in the same sectors, adjusted by the share of employees working in private entities over total employment in those sectors.

"Public" refers to OC investment in public entities operating in ISIC Rev. 3 Sectors 73 and 75 to 93. Investment is divided by total gross value added in the same sectors adjusted by the share of employees working in public entities over total employment in those sectors.

Identification of occupations that relate to organisational capital (OC) is based on survey results from the Programme for the International Assessment of Adult Competencies (PIAAC), classified according to the International Standard Classification of Occupations (ISCO, 2008), the *Structural Analysis (STAN) Database* and other data sources.

Investment in firm-specific training in the public and private sectors, 2011-12

"Private" refers to investment in firm-specific training in private entities operating in the business sector (ISIC Rev. 3 Codes 01 to 72 and 74). Investment is divided by total gross value added in the same sectors, adjusted by the share of employees working in private entities over total employment in those sectors.

"Public" refers to investment in firm-specific training public entities operating in ISIC Rev. 3 Sectors 73 and 75 to 93. Investment is divided by total gross value added in the same sectors adjusted by the share of employees working in public entities over total employment in those sectors.

Investment in firm-specific training is estimated using survey results from the Programme for the International Assessment of Adult Competencies (PIAAC), the *Structural Analysis (STAN) Database* and other data sources.

Employees contributing to organisational capital who receive training, public and private sectors, 2011-12

Identification of firm-specific training and organisational capital is based on survey results from the Programme for the International Assessment of Adult Competencies (PIAAC) and external data (LFS, SNA, OECD sources).

The figure refers to managers and non-managers who are receiving training at least once in the year, as a percentage of total employed managers and non-managers in the sector. Figures for "Public" refer to employed persons in a public establishment in industries ISIC Rev. 3 73 and 75 to 93. Figures for "Private" refer to employed persons in a private establishment in industries ISIC Rev. 3 1 to 72, and 74. "Total trained OC" reports the percentage of employed persons contributing to organisational capital (OC) who received training at least once in the year.

2.10. Skills in the digital economy

Computer use at work, 2012

For the Russian Federation, the PIAAC sample does not include the population of the Moscow municipal area. The data published, therefore, do not represent the entire resident population aged 16-65, but rather the population of the Russian Federation excluding the population residing in the Moscow municipal area.

For the United Kingdom, data refer to England only.

Index of ICT use at work, 2014

Data for the average OECD ICT index refer to the simple average value of the index across 19 countries presented here.

ICT complementary skills, by skill level, 2012

Data show average coefficient values across the following countries covered by the PIAAC sample: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, the Russian Federation, the Slovak Republic, Spain, Sweden, the United Kingdom and the United States.

For the Russian Federation, the PIAAC sample does not include the population of the Moscow municipal area. The data published, therefore, do not represent the entire resident population aged 16-65, but rather the population of the Russian Federation excluding the population residing in the Moscow municipal area.

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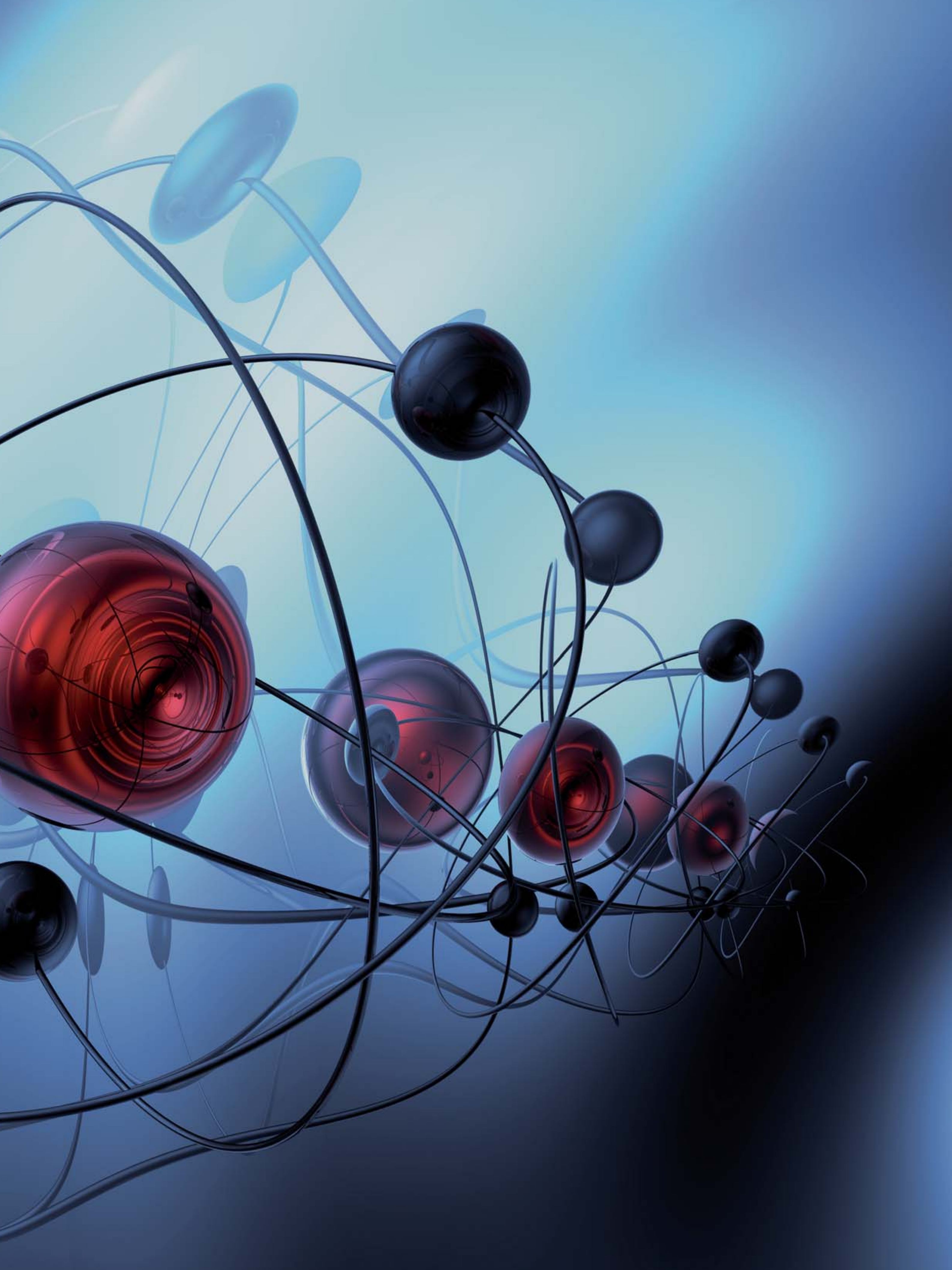
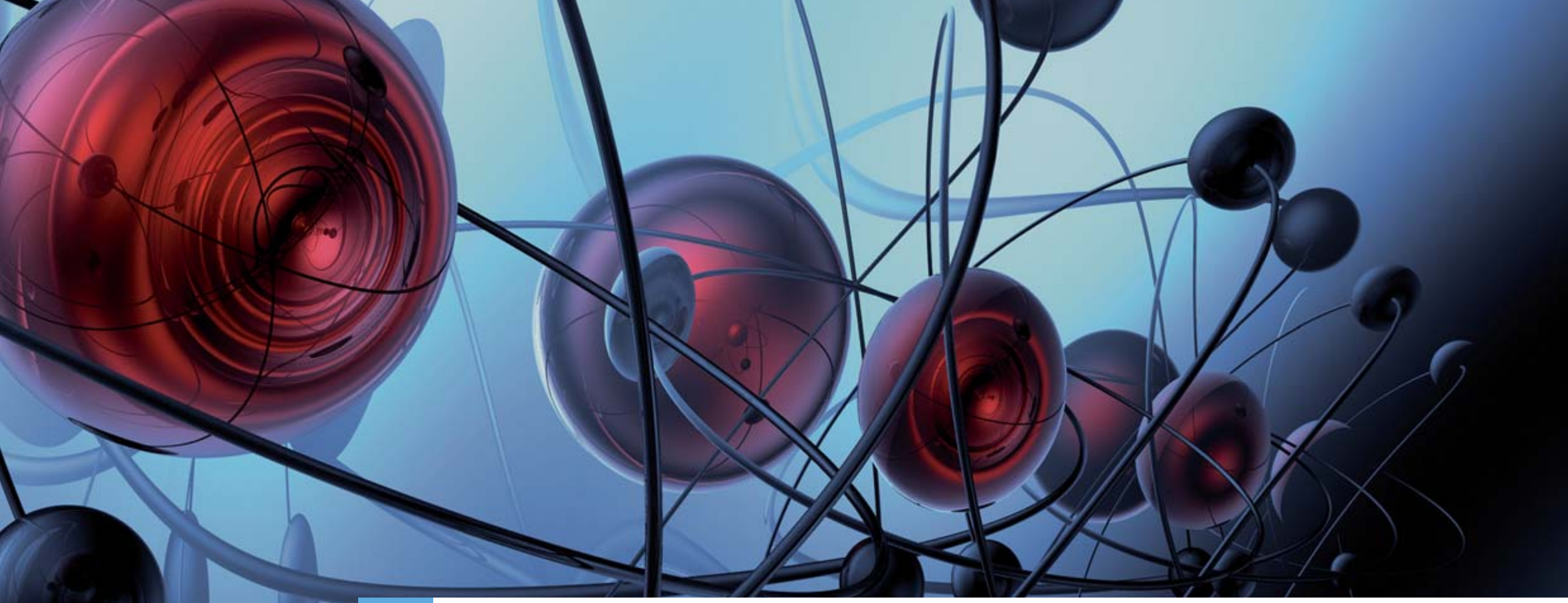




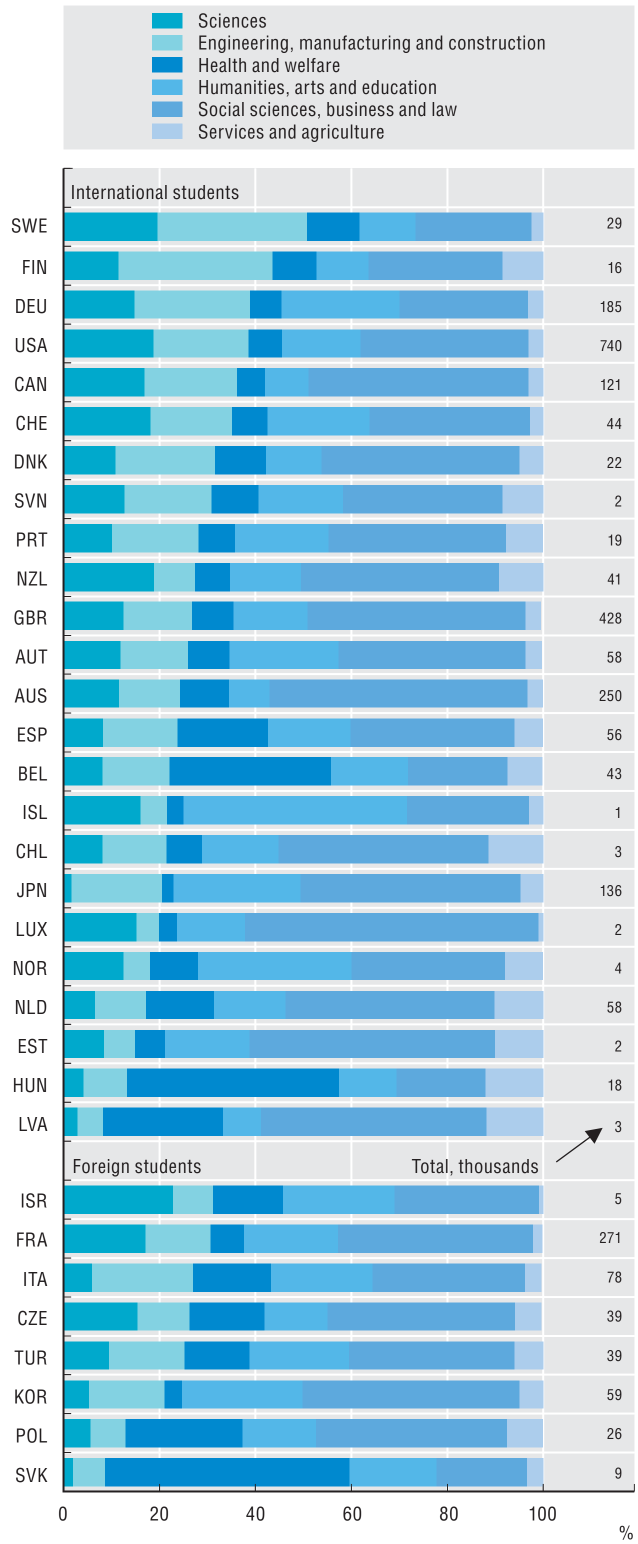
3. CONNECTING TO KNOWLEDGE

Increasing the efficiency and effectiveness of innovation efforts requires improvement in channels for diffusion of knowledge. The international mobility of highly skilled individuals, from students to scientists, is one of the major drivers of knowledge circulation worldwide. An experimental indicator building on the careers of scientists who publish in scholarly journals finds that mobility patterns and quality of scientific output of those who stay, move or return to their home country differ sharply. New citation-based indicators suggest that scientific collaboration is an increasingly pervasive feature of research excellence. They also help to single out the role of scientific leadership in international collaboration. Open access to research plays an important role in the diffusion of scientific knowledge, and the results of a novel and experimental survey of scientists provides new evidence in this area. Linking patents and scientific publications reveals the importance of research crossing several disciplines in new technology development and new indicators help to identify the geographical roots of relevant science. Leading innovators look for competencies beyond their national borders and international collaborations among firms take a variety of forms, such as co-funding and co-inventions. However, open innovation goes beyond R&D interactions and collaborative invention, as shown by the importance of institutional and market-based collaboration in the introduction of new innovations.

1. International mobility of highly skilled individuals

International and foreign students enrolled in tertiary education, 2012

Total and breakdown by field of education



Source: OECD calculations based on OECD (2014), *Education at a Glance 2014: OECD Indicators*, OECD Publishing, Paris. See chapter notes.

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International mobility among highly educated individuals at different stages of their personal development and professional careers constitutes a key driver of knowledge circulation worldwide. For example, students in higher education that study or spend some time in a foreign tertiary-level institution, where they build links with other individuals and acquire competences which will be carried over to other places during their working lives. The United States attracts the largest number of international students, followed by the United Kingdom, France, Australia and Germany. The majority of these students specialise in the social sciences, business, law and the humanities, except in Belgium, Finland, Hungary, Iceland, the Slovak Republic and Sweden, where the fields of science and engineering and health and welfare account for a higher share of international students.

The extent of international mobility after the completion of education is also significant in a number of cases, notwithstanding the larger degree of restrictions on work-related mobility. In several OECD countries, such as Canada and Israel, the share of working-age population educated at tertiary level is higher among the foreign-born population than among the native-born. These countries often shape their immigration policies towards attracting highly skilled individuals. However, in a number of countries, including France, Germany, Japan, Italy and the United States, the native population exhibits higher educational attainment rates.

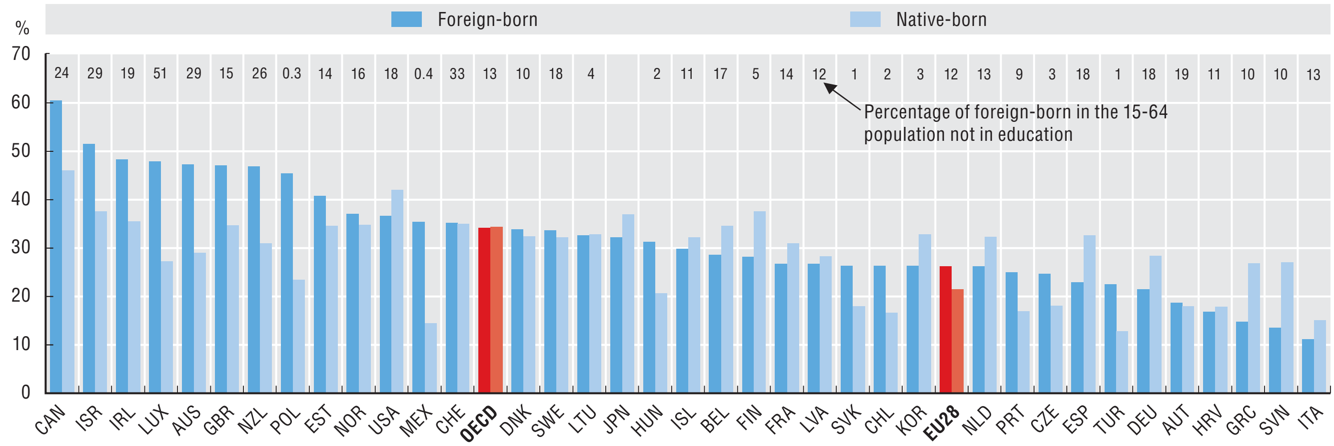
Foreign-born individuals may account for a significant percentage of the overall population with doctoral degrees in some countries. For example, foreign-born doctorate holders account for more than 50% of all doctorate holders in Canada, Luxembourg and New Zealand. The share of foreign-born doctorate holders increased between 2000-01 and 2010-11 among two thirds of the countries for which data are available, including Italy, Spain and the United States.

Definitions

International students are students that have crossed borders expressly with the intention to study. The UNESCO Institute for Statistics, the OECD and Eurostat define international students as those who are not residents of their country of study or those who received their prior education in another country. Foreign students are defined according to their citizenship. The fields of education correspond to those defined in the International Standard Classification of Education (ISCED-97). Tertiary education comprises Levels 5 and 6 of the ISCED-97 classification. Highly educated individuals in immigrant and native-born populations have completed education at the tertiary level as defined above. Doctorate holders are individuals that have received an advanced research qualification at Level 6 of ISCED-97.

Highly educated individuals in immigrant and native-born populations, 2013

As a percentage of relevant group, 15-64 year-old population not in education



Source: OECD/European Union (2015), *Indicators of Immigrant Integration 2015: Settling In*, OECD Publishing, Paris. StatLink contains more data. See chapter notes.

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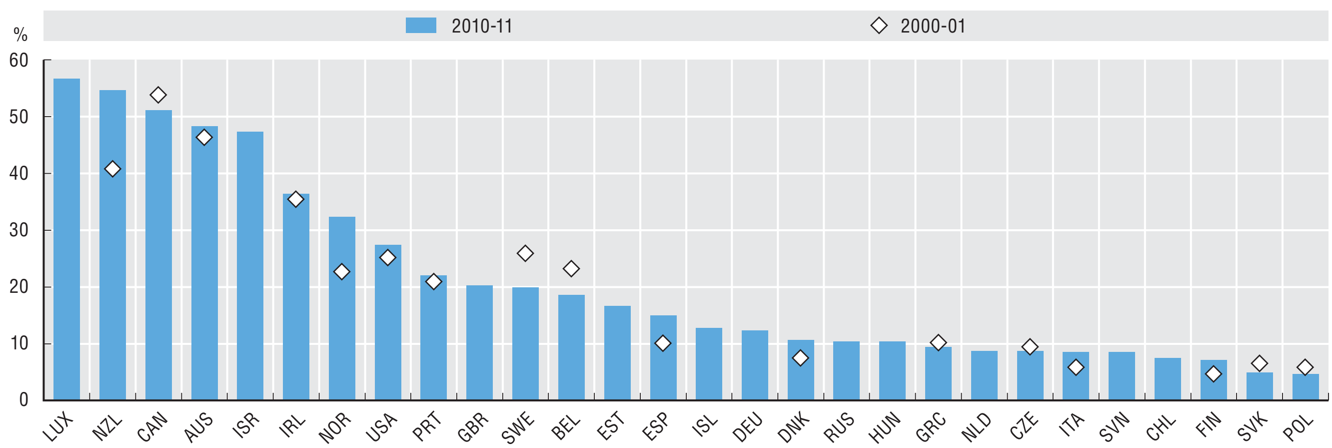
Foreign-born doctorate holders, 2000-01 and 2010-11

As a percentage of all doctorate holders



Source: OECD, *Database on Immigrants in OECD Countries (DIOC)*, *www.oecd.org/els/mig/dioc.htm*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273825

Measurability

The 2014 UNESCO-OECD-Eurostat (UOE) collection of education statistics is the primary source of data on tertiary enrolment data by source and destination country. The concept of international students is more directly relevant for the analysis of mobility. When data on international students are not available, data on foreign students are used to obtain a more complete picture.

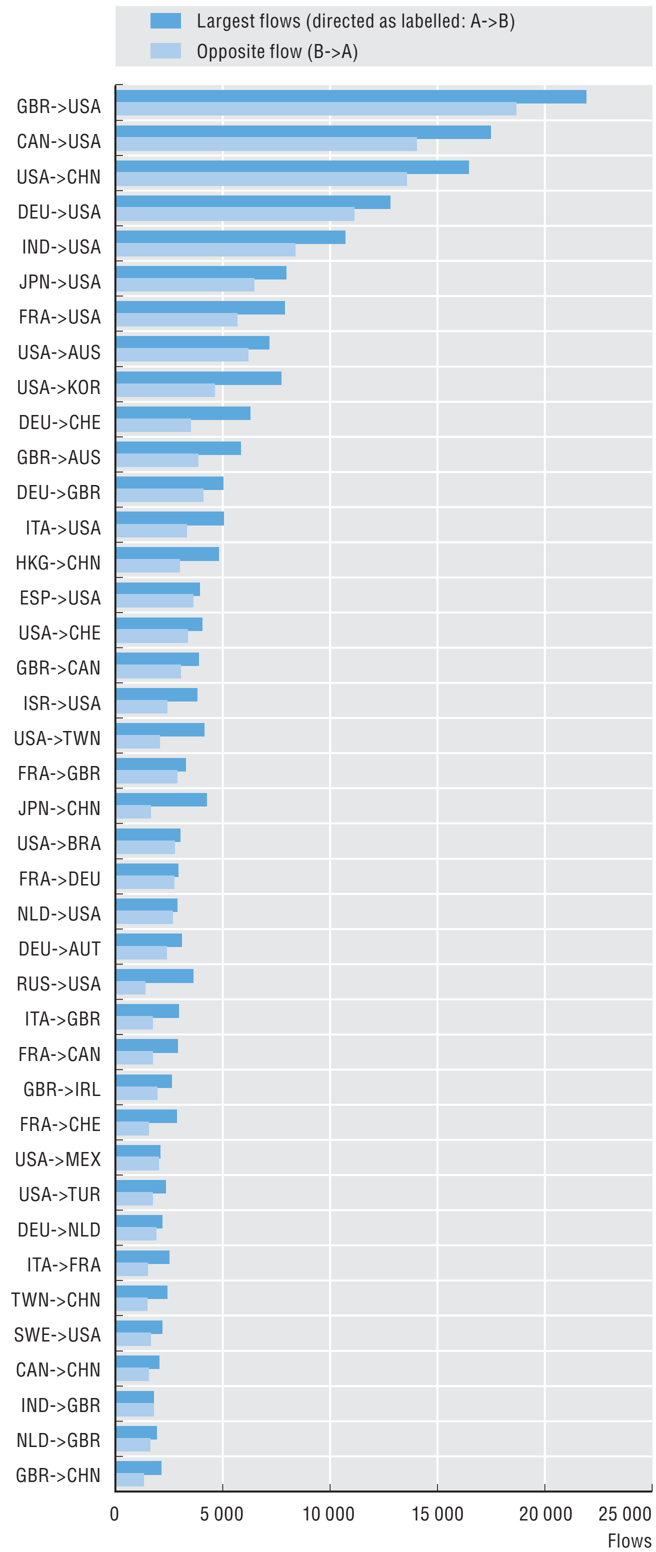
The *Database on Immigrants in OECD Countries (DIOC)* provides comprehensive and comparative information on demographic and labour market characteristics of immigrants living in OECD countries. The main sources of data are population censuses, population registers and in some cases labour force surveys. The main observation variable used by DIOC is the place of birth (i.e. foreign or native), as a best available proxy for identifying the immigrant population.

The use of ISCED-97 levels as a standard measure of educational attainment may not fully capture the true extent of individual skills nor the scope for applying those skills in the host economy, for example, if there is limited recognition of academic degrees obtained abroad or if access to networks and command of the local language is limited.

2. Scientists on the move

International bilateral flows of scientific authors, 1996-2013

Largest bilateral flows, by first and last recorded main affiliation



Source: OECD calculations based on *Scopus Custom Data*, Elsevier, Version 4.2015, *http://oe.cd/scientometrics*, June 2015. StatLink contains more data. See chapter notes.

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The diffusion and circulation of scientific knowledge is aided by the mobility of scientists. One means to track mobility of scientists who publish is to trace changes in institutional affiliation over their full list of publications in scholarly journals. This approach shows that the nine largest international bilateral flows of scientists over the period 1996-2013 involved exchanges with the United States. While the total inflow exceeds the outflow, more scientists who start by publishing in the United States change affiliation to institutions in China and Korea than vice versa. The United Kingdom is the second most connected economy. German-based researchers moving to Swiss affiliations account for the largest flow for non-English-speaking countries.

In 2013, Swiss-based authors experienced the highest mobility rates within the OECD, both on an outgoing and incoming basis. Mobility patterns vary across economies; for example, in Italy and Israel, a majority of inflows are returnees – originally affiliated to an institution in the country. In Switzerland the majority of researchers with an international mobility record represented new inflows.

With few exceptions, individuals not changing affiliations (stayers) are more likely to publish in journals of lower "prestige". For countries exhibiting lower median citation impact values, outflows tend to be associated with higher rated publications than their staying or returning counterparts. In the case of the United States, outflows fare significantly worse in terms of journal impact scores. The median scores of inflows are still higher than those for stayers in this country.

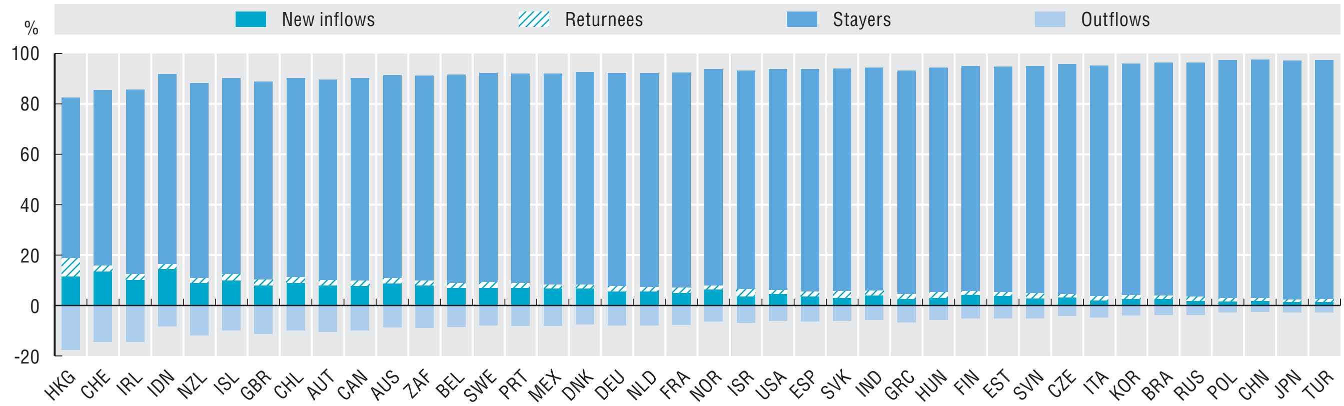
Definitions

Scientific authors are listed in the Scopus database of peer-reviewed scientific publications and identified by a unique author ID assigned by Elsevier. International mobility is inferred from authors with at least two publications over the reference period and is based on changes in institutional affiliation and sequence of publications. Stayers maintain the same country of affiliation over the reference period. Returnees are authors observed to move to a country in which they were first affiliated, as distinct from new inflows. Outflows are measured in terms of the affiliation at the beginning of the reference period.

A proxy of scientific impact is estimated by calculating the median SJR impact score for each author and mobility profile. SJR is a measure of scientific influence of scholarly journals that accounts for both the number of citations received by a journal and the importance or prestige of the journals where the citations are made. It is a variant of the eigenvector centrality measure used in network theory (González-Pereira et al., 2010).

International mobility of scientific authors, 2013

As a percentage of authors, by last main recorded affiliation in 2013

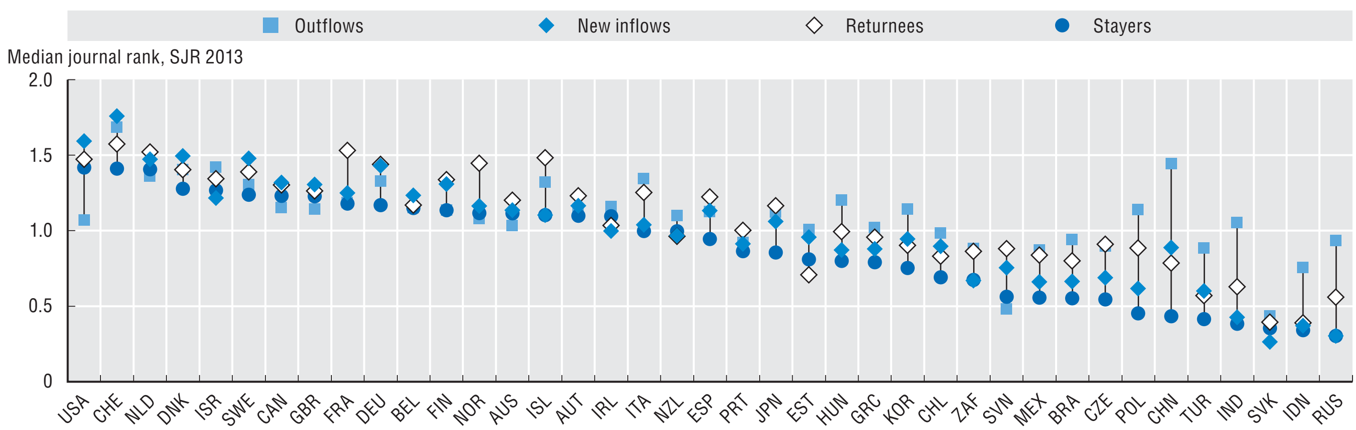


Source: OECD calculations based on *Scopus Custom Data*, Elsevier, Version 4.2015, *http://oe.cd/scientometrics*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273846

Expected citation impact of scientific authors, by mobility profile in 2013

Median Scimago Journal Rank (SJR) scores for 2013



Source: OECD calculations based on *Scopus Custom Data*, Elsevier, Version 4.2015; and on *Scopus* journal title list, accessed May 2015, *http://oe.cd/scientometrics*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273851

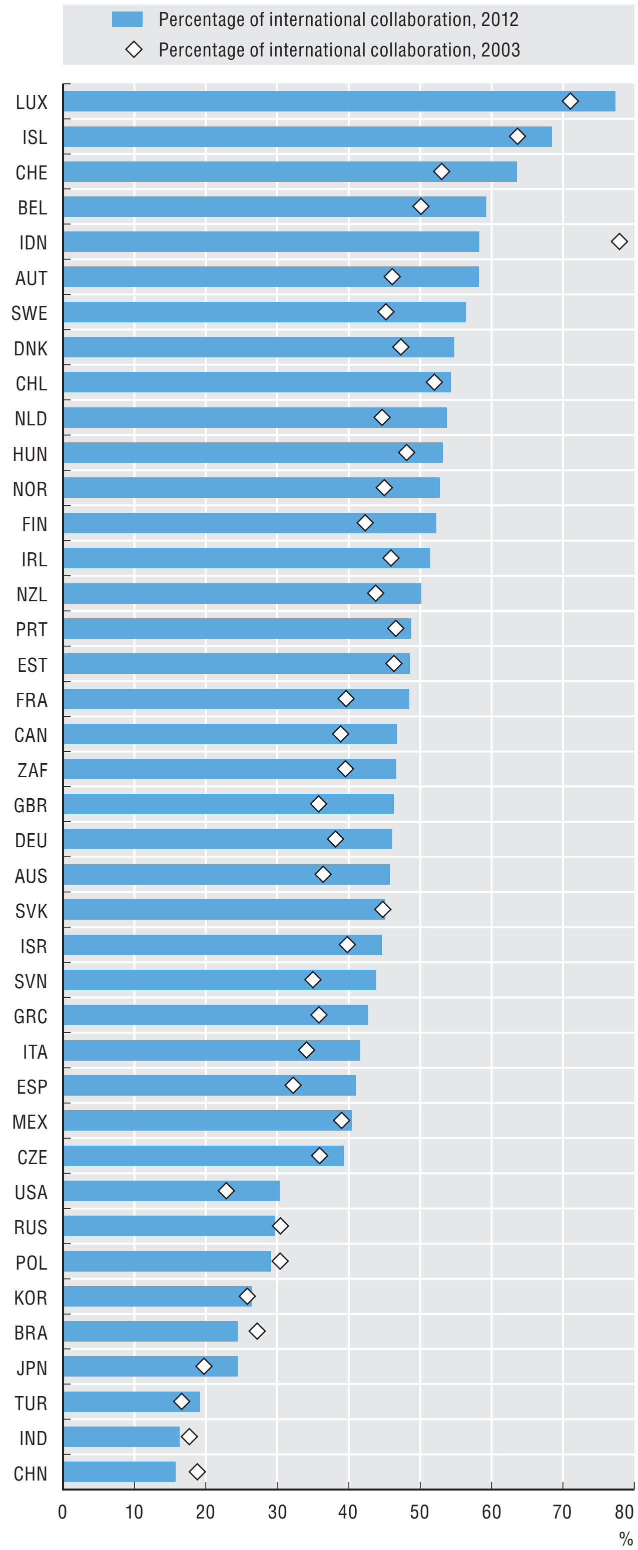
Measurability

Bibliometric indicators provide a complementary picture of global researcher mobility. First developed by Elsevier (2011), these indicators are experimental and require careful interpretation (Moed et al., 2013). Mobility records are not as accurate for less prolific authors and for those who move from and into non-academic roles. Affiliations may be recorded with a lag and may not reflect where the research took place. Affiliations may also be multiple and require disambiguation. In this version, such authors, rather than omitted from calculations, are assigned a “main country” per document, with one country picked at random in the case of equal weights. This approach may overstate total mobility rates but further checks confirm this does not bias the representation of the international mobility network nor the main patterns derived from it. Failure to assign author IDs consistently can also distort mobility estimates by understating mobility when an individual has multiple IDs or overstating it for individuals with common names. The open researcher and contributor ID (ORCID) seeks to assign unique identifiers linkable to an individual’s research output. The international scientist mobility network and its main drivers have been analysed in Appelt et al. (2015). Results on mobility are robust to the choice of the SNIP or SJR as the measure of journal prestige (*www.journalmetrics.com*).

3. Excellence in scientific collaboration

International scientific collaboration, 2003 and 2012

As a percentage of all documents, whole counts



Source: OECD and SCImago Research Group (CSIC) (2015), *Compendium of Bibliometric Science Indicators 2014*, *http://oe.cd/scientometrics*. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273861

Over the 2003-12 period, collaboration on scientific research among institutions in different countries intensified and became widespread across most economies. In 2012, Luxembourg, Iceland, Switzerland and Belgium exhibited the largest international collaboration rates. Authors from smaller countries are more likely to engage in international collaboration, although this is not always the case.

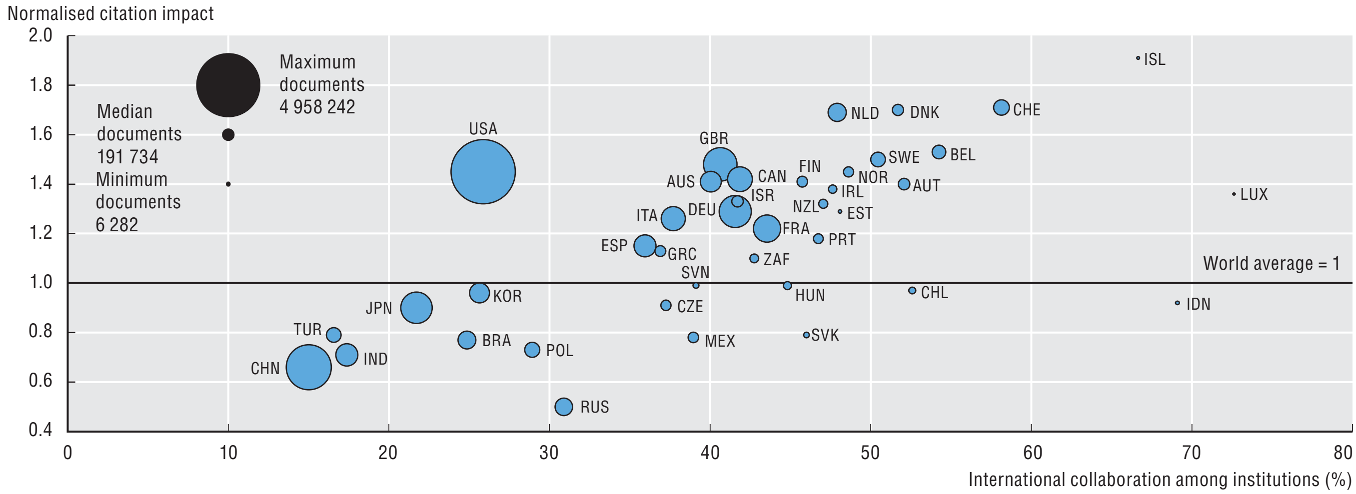
Estimates at the country level suggest a positive relationship between measures of scientific research collaboration and citation impact. This relationship appears to be stronger in economies with lower levels of scientific production (i.e. the smaller sized bubbles in figure), highlighting the importance of scale, which smaller economies attempt to overcome by participating more intensively in global networks.

Joint analysis of excellence and leading authorship (i.e. the affiliation of the leading author) can provide further insights into the source of a country's highly cited publications. In the United States, for example, 17% of publications are among the top 10% most-cited, of which 14% had a US-based author listed as the leading author, while only 3% are led by authors with affiliations abroad. Accordingly, the United States has the largest share of top-cited publications led by domestic authors, followed by the Netherlands and the United Kingdom. Other countries with higher overall excellence rates display lower levels of leading excellence because of the higher importance of collaborative articles led by authors from other countries.

Definitions

Collaboration is defined as co-authorship involving different institutions. *International collaboration* refers to publications co-authored among institutions in different countries. Estimates are computed for each country by counting documents for which the set of listed affiliations includes at least one address within the country and one outside. The *normalised impact* measure is derived as the ratio between the average number of citations received by the documents published by authors affiliated to an institution in a given economy and the world's citation average, over the same time period, by document type and subject area. The indicator of scientific excellence indicates the amount (in percentage) of a unit's scientific output that is included into the global set of the 10% of the most cited papers in their respective scientific fields. This indicator can be used in combination with information on the affiliation of the corresponding author, domestic or abroad – see *Measurability* box – to better describe the role of international collaboration as a driver of scientific excellence.

The citation impact of scientific production and the extent of international collaboration, 2003-12

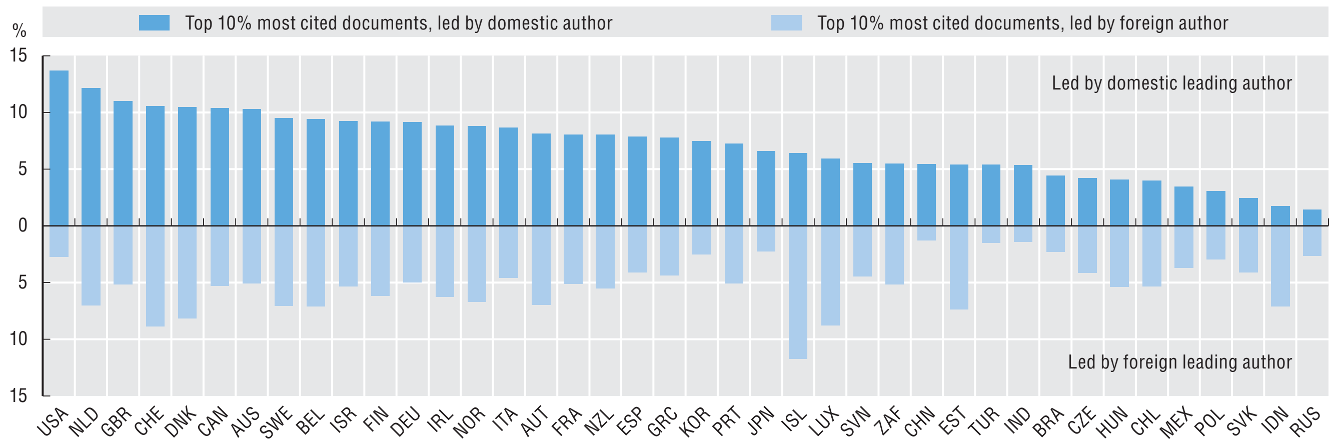


Source: OECD and SCImago Research Group (CSIC) (2015), *Compendium of Bibliometric Science Indicators 2014*, *http://oe.cd/scientometrics*. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273878

Top 10% most cited documents and scientific leading authorship, 2003-12

As a percentage of all documents, whole counts



Source: OECD and SCImago Research Group (CSIC) (2015), *Compendium of Bibliometric Science Indicators 2014*, *http://oe.cd/scientometrics*. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273886

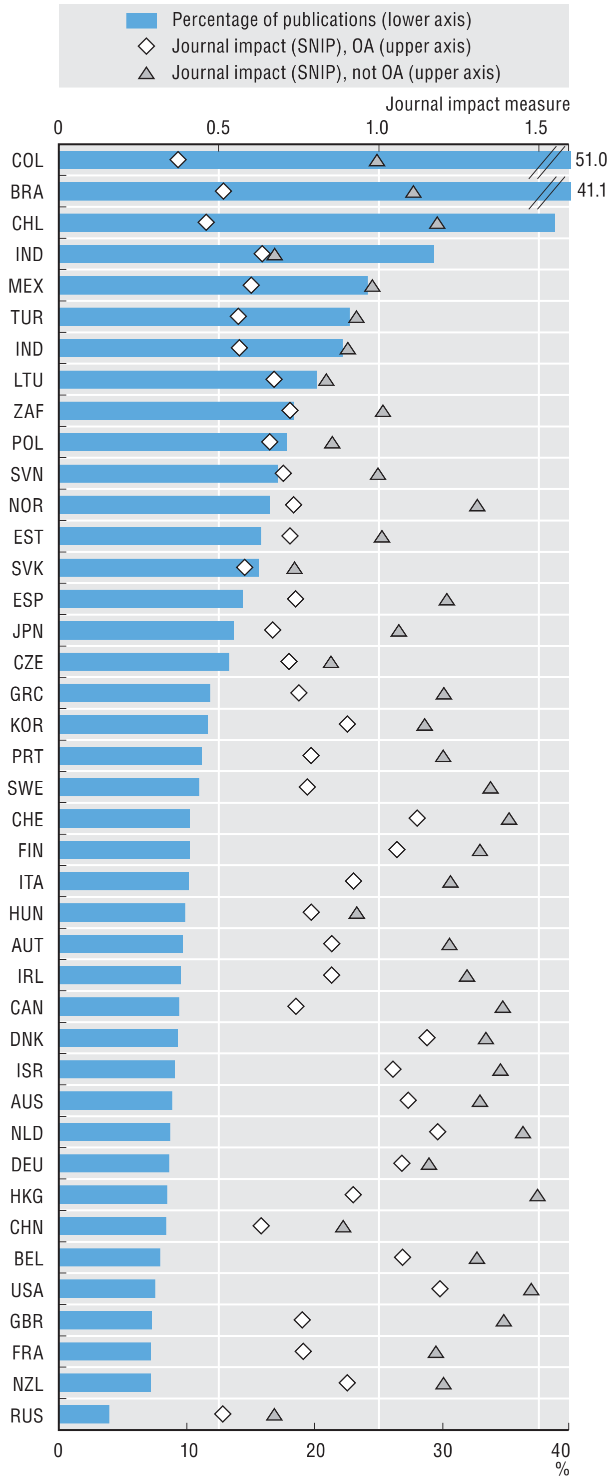
Measurability

Publications are attributed to countries on the basis of the authors' institutional affiliations. This requires a means of counting publications where multiple authors and affiliations are listed. In addition to the fractional counting and whole counting methods, an alternative approach is to attribute the entire document to the leading author's affiliation using information on the identity of the corresponding author (Moya-Anegón et al., 2013). The concept of leading authorship can obey different norms within scientific groups and disciplines. The leadership criterion for attribution gives no weight to other contributors not listed as leading, so it should be interpreted carefully in conjunction with other indicators. The scientific leadership indicator helps to understand the role of a given institution or country in collaboration activities, as reflected in publication output. The scientific leadership indicator shows the share of scientific output (in this case, highly cited documents) where an author from this country is listed as leading author. At the country level, the indicator is defined only for documents involving international collaborations.

4. Open access to research

Open access journal (OA) publishing, by affiliation of corresponding author, 2011-13

As a percentage of all publications, and average journal impact (SNIP2013)



Source: OECD calculations based on *Scopus Custom Data*, Elsevier, version 4.2015; and on *Scopus* journal title list, accessed May 2015, *http://oe.cd/scientometrics*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273898

Access to the content of scientific research articles plays an important role in the diffusion of scientific knowledge as it encourages the application of knowledge and supports advances in science. Interest in open access (OA) to publications is relevant to the promotion of open science, i.e. the efforts to make the outputs of publicly funded research more widely accessible in digital format to the scientific community and to society more broadly.

There is considerable heterogeneity in the extent to which scholarly research literature is openly and freely available. Authors based in different countries differ in their propensity to publish in journals that make their content freely accessible online. Among articles published in 2011-13 and catalogued in the Scopus database, those with corresponding authors based in Colombia, Brazil, Chile and India were most likely to be published in journals identified as being OA. In most OECD countries, the share of documents published in OA journals is less than 10%. Within countries, the implied citation "prestige" of journals as measured by citation indicators is higher for documents published in non-OA journals.

In Scopus, 2 800 titles, i.e. about 12% of the 22 283 active journals covered, are identified as being OA journals. Among those published in OECD countries, the average share of journals listed as OA is 8%, but it is much higher for those published in the BRIICS at 25%. Data reveal significant differences in the use of OA journals as a means of research diffusion across countries. OA publication patterns not only differ by country, but also by scientific domain. Only a few fields have more than 10% of their journals rated as OA. The lowest OA rates are found in Business and accounting, Arts and humanities, Engineering, Energy and Economics.

Analysis of the results from a new OECD survey of scientific authors publishing in 2011 shows that repository-based (green) OA) plays an important role, especially among authors in countries with an apparently low level of journal-based (gold) OA. The survey results provide a more comprehensive analysis of the citation impact of OA.

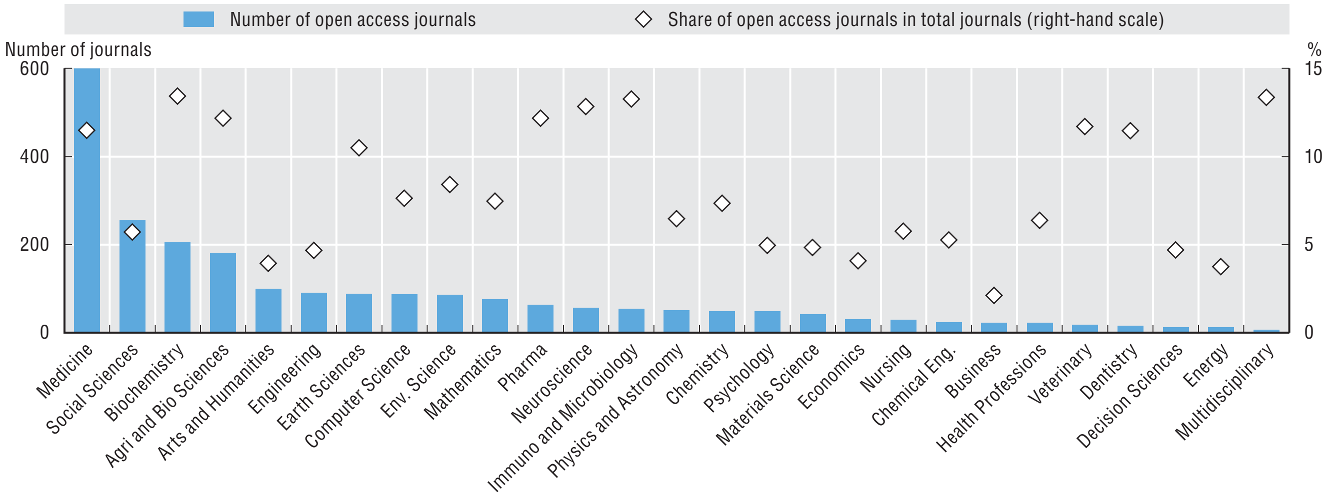
Definitions

Open access (OA) is typically defined as the possibility of unrestricted online access to scientific articles. Access can occur via a number of channels, such as institutional repositories, journal publishers' websites and researchers' webpages. The term "gold OA" refers to OA provided by a publisher, while "green OA" refers to the practice of self-archiving the pre-print or the post-print of an article, generally by its author (OECD, 2015c).

The *Source Normalized Impact per Paper (SNIP)* indicator measures contextual citation impact by weighting citations based on the total number of citations in a subject field (see *www.journalindicators.com/methodology*).

Open access (OA) publishing, by field, 2014

Number of active OA journals published in OECD countries

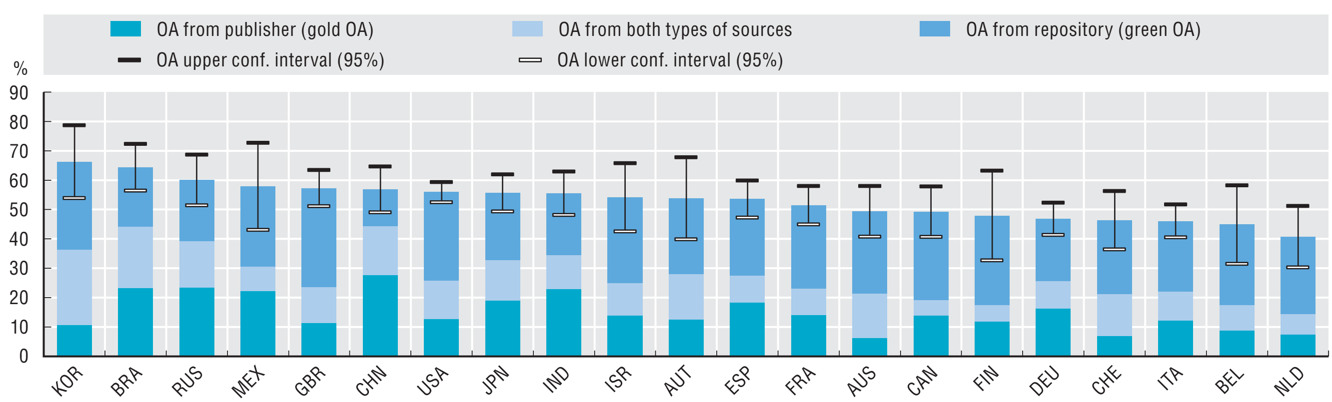


Source: OECD and SCImago Research Group (CSIC), calculations based on *Scopus* journal title list, *www.elsevier.com/__data/assets/excel_doc/0005/226742/title_list.xlsx*, accessed December 2014. StatLink contains more data.

StatLink http://dx.doi.org/10.1787/888933273907

Open access to scientific documents by corresponding author's affiliation, selected fields, 2011

Percentages, by mode of open access (OA), and 95% confidence intervals



Note: This is an experimental indicator, based on a stratified random sample of scientific authors.
Source: OECD, based on preliminary analysis of OECD Pilot Survey of Scientific Authors 2015, *www.oecd.org/science/survey-of-scientific-authors.htm*. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273916

Measurability

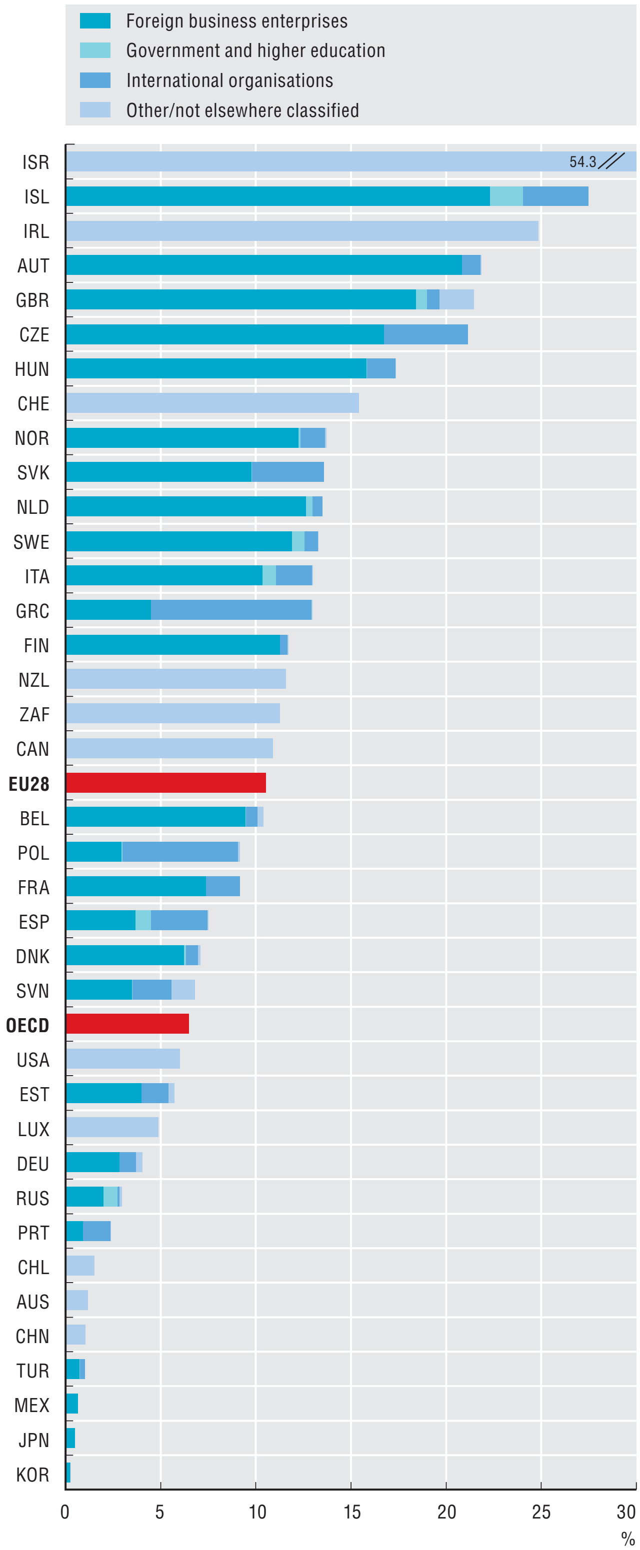
The designation of titles as OA is based largely on inclusion in the Directory of Open Access Journals (DOAJ), and as such, focuses on the Gold-Access model of open access. DOAJ maintains a database of over 8 000 OA journals. The inclusion criteria include free accessibility upon publication and some form of quality control. The use of alternative measures of journal impact (SNIP or SJR) does not result in qualitative differences in results.

The processes and outcomes of scientific production, peer-review and scientific publishing are closely intertwined with the way in which science is funded and scientists rewarded for their efforts. The OECD has recently undertaken an online survey of OA publication patterns by authors. The survey investigated author awareness of document access both through open registers (green OA) and journals (gold OA) in which they have been published. Non-response rates to online surveys can be significant and may impact on the representativeness of data. Results should be treated with caution. See *www.oecd.org/science/survey-of-scientific-authors.htm*.

5. Research across borders

Business enterprise R&D funded from abroad, by source of funds, 2013

As a percentage of BERD



Source: OECD, *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273920

Companies draw on a variety of domestic and international funding sources for their R&D projects and activities. These include resources obtained from parents or subsidiaries abroad, R&D undertaken under contract on behalf of companies based abroad or research grants and contracts from international organisations. Business R&D is reliant in a number of countries on funding from abroad. In 2013, funds from abroad represented 20% or more of total business R&D performed in Iceland, Ireland, Austria, the United Kingdom and the Czech Republic. In Israel, more than 50% of funds for business R&D were reported as coming from abroad.

Foreign-controlled affiliates play an important role in domestic R&D in several OECD countries. In 2011, they accounted for more than one fifth of total business R&D among a majority of countries for which data are available. In the case of Ireland, Belgium and Israel, more than 60% of BERD is accounted for by affiliates of foreign companies.

Governments also play an important role in the globalisation of R&D. Among a number of EU countries, a significant part of national budgets for R&D are dedicated to international R&D programmes and activities. The majority of these funds support joint programmes such as those carried out under the auspices of the European Space Agency, or constitute contributions towards international organisations performing R&D such as CERN or the European Southern Observatory (ESO).

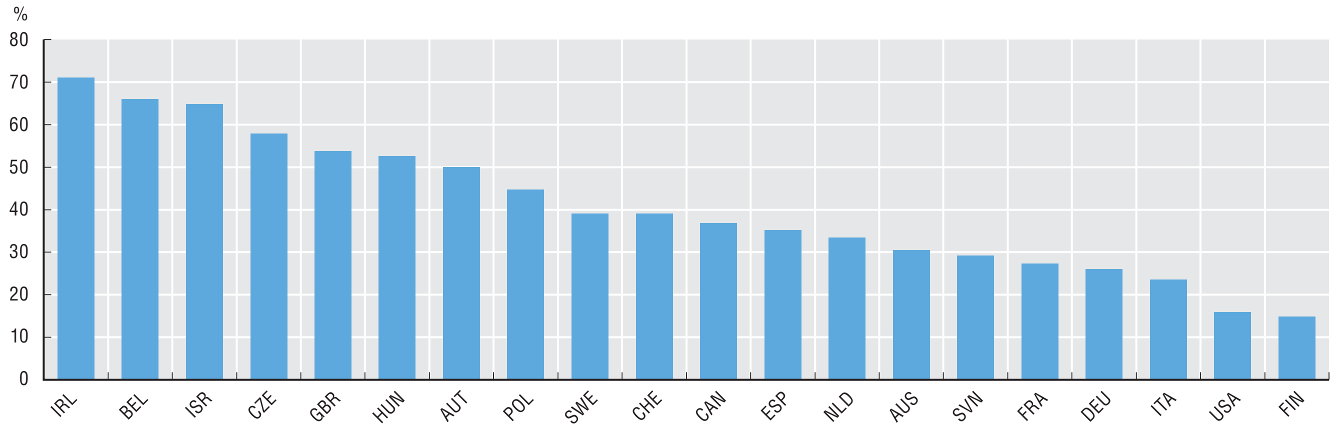
Definitions

R&D surveys collect information from R&D performers about the amounts received from another party for the performance of R&D over a specific period. Companies are asked to provide a breakdown of their R&D expenditures according to the sources of funds. These may be either internal or received from external units belonging to the different sectors specified in the *Frascati Manual* (OECD, 2015a), one of which is "*Abroad*". This consists of all non-resident institutions and individuals. It also comprises all international organisations including facilities and operations within the country's borders. *Affiliated enterprises* are enterprises in a direct investment relationship including their *subsidiaries*. The term "foreign-controlled affiliate" refers to affiliates under foreign control.

National public funding to transnationally co-ordinated research is measured as the "government budget appropriations or outlays for research and development (GBAORD)" directed towards: transnational public R&D performers located in Europe, Europe-wide transnational public R&D programmes and bilateral or multilateral public R&D programmes established between EU country governments or with EFTA and candidate countries. These funds do not include country contributions to the general EU budget from which some R&D programmes are funded, but include additional national matching funds for such programmes and initiatives.

R&D expenditures incurred by foreign-controlled affiliates, selected countries, 2011

As a percentage of R&D performed by business enterprises

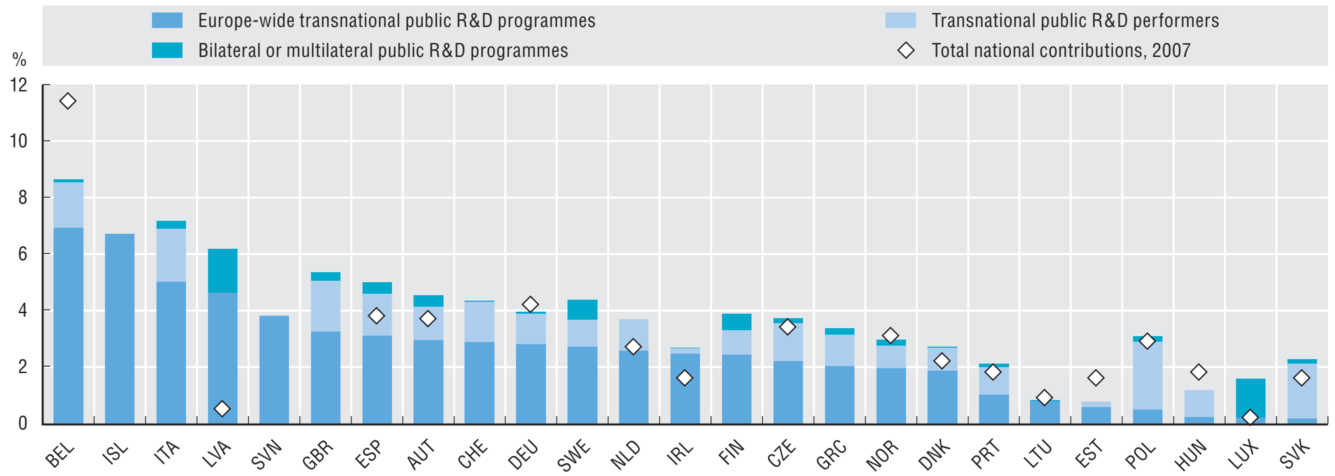


Source: OECD, *Activity of Multinational Enterprises Database*, *www.oecd.org/sti/ind/amne.htm*; and Eurostat, *Inward FATS Database*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273939

Government R&D funding for international programmes and activities, 2013

As a percentage of national government budgets for R&D



Source: OECD, based on the Eurostat, *Science and Technology Database*, *http://ec.europa.eu/eurostat/data/database*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273941

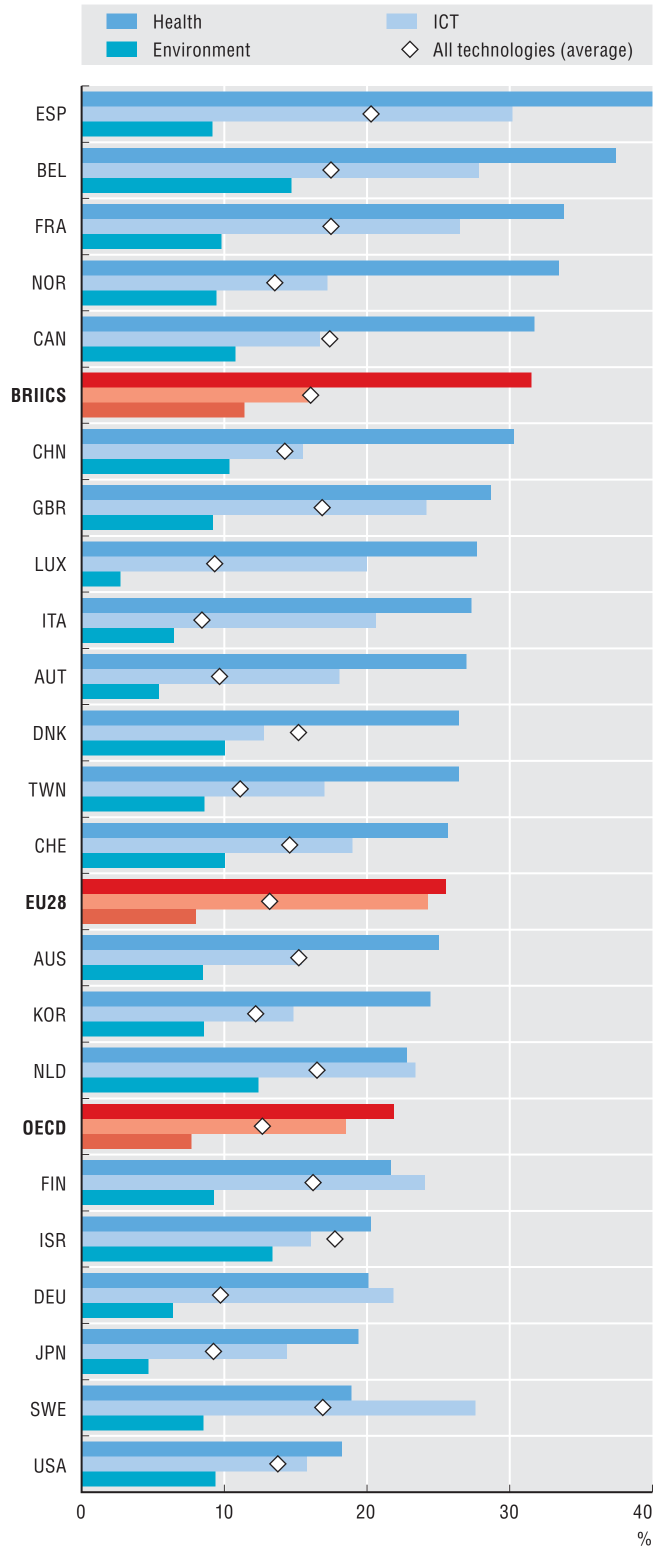
Measurability

The increasing internationalisation of R&D and other economic activities makes it difficult to accurately identify inflows and outflows of R&D funds between companies and the precise nature of these flows. R&D surveys are used to collect statistics on international flows of funds for R&D but they focus mainly on domestic intramural performance. Therefore, in most countries little or no information is collected on the foreign R&D activities of multinationals. Furthermore, the collection of accurate information on the size and economic nature of cross-border R&D flows between firms can be problematic, as the practices of multinationals regarding R&D, including funding and the exploitation of resulting intellectual outputs, tend to reflect strategies to minimise tax liabilities. The measurement of R&D globalisation among governments and other non-business institutions is also at a very preliminary stage and data comparability is still limited and concentrated in few countries. The new edition of the *Frascati Manual* (OECD, 2015a) has a new chapter dedicated to the measurement of various aspects of R&D globalisation.

6. Science and technology links

Patents citing non-patent literature (NPL), selected technologies, 2007-13

Share of citations to NPL in backward citations, average, EPO patents



Source: OECD, *STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273957

Prior knowledge on which patented inventions rely may encompass patents, scientific work and other sources. Information contained in references to scientific literature, conference proceedings, databases and other relevant literature, known as non-patent literature (NPL), can be used to shed light on the knowledge flows between science and innovation, and on the scientific pillars of technology.

The share of inventions building on NPL varies widely across key enabling technologies including ICTs and technologies related to societal challenges such as health provision and preservation of the environment. While the link appears strong for health and ICT-related technologies (27% and 20%, respectively, on average), environmental inventions seem less reliant on published science (9%). On average, 14% of patents in all technologies cite NPL, with values ranging between 20% in Spain and 8% in Italy.

Examination of the top three science fields cited in patents indicates that biology and biochemistry are driving advancements not only in health, biotechnology and environmental technologies, but also in ICTs. Similarly, scientific articles published in clinical medicine journals appear almost as important for biotechnology as for ICT-related technologies. This may reflect the cross-fertilisation of scientific fields and the enabling nature of ICTs.

Citations to non-patent literature help to identify the geographical roots of relevant science, as revealed by the affiliations of cited authors. The United States clearly emerges as the principal reference science source, with median citation shares of 36%, followed by the United Kingdom and Japan (with median shares of about 7%). With the exception of the United States, median and minimum share values are very close and maximum citation values are typically observed when citing and cited economies coincide.

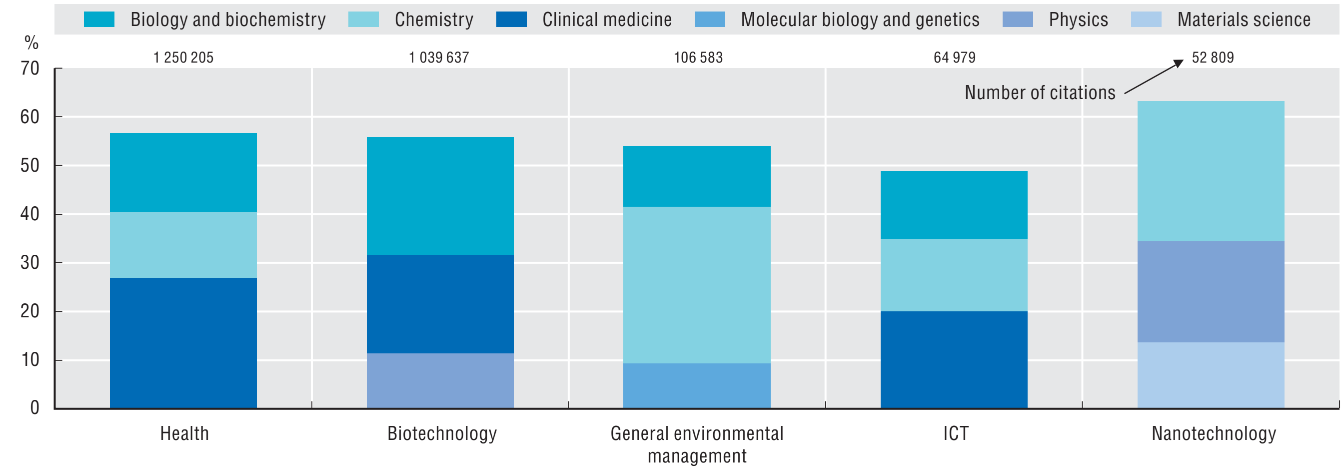
Definitions

Non-patent literature (NPL) encompasses peer-reviewed scientific papers, conference proceedings, databases (e.g. DNA structures, gene sequences, etc.) and other relevant literature, with the exception of patent abstracts and commercial patent databases. The share of NPL is calculated over the total number of citations contained in patent documents.

A field of science is described as relevant to a technology area if it accounts for a significant share of the peer-reviewed scientific literature in references to NPL in patents. Fields of science correspond to the Thomson Reuters Essential Science Indicators 22-field classification of journals. International Patent Classification (IPC) and Cooperative Patent Classification (CPC) codes provide the basis for defining the relevant technology areas. The geographic distribution of cited scientific publications is based on the institutional affiliation of authors.

The innovation-science link for major enabling technologies, 2003-13

Share of the top three scientific fields in non-patent literature cited in patents by technology

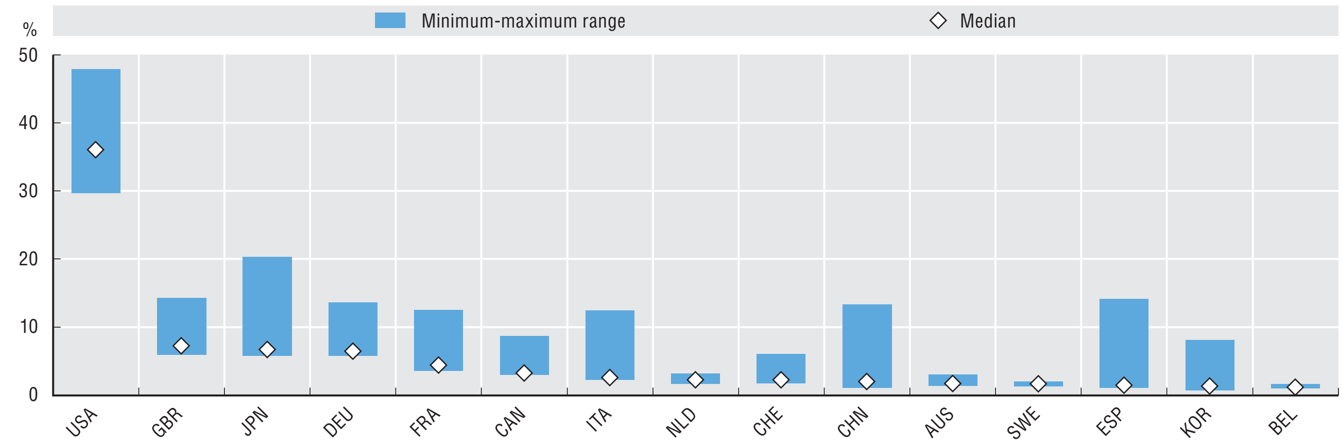


Source: OECD and Japan Science and Technology Agency (JST), based on Thomson Reuters Web of Science, Derwent World Patents Index and Derwent Patents Citation Index data, April 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273965

Affiliations of scientific authors cited in patents, 2007-13

Range of economies' share in citations made at selected patent offices



Source: OECD and Japan Science and Technology Agency (JST), based on Thomson Reuters Web of Science, Derwent World Patents Index and Derwent Patents Citation Index data, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273972

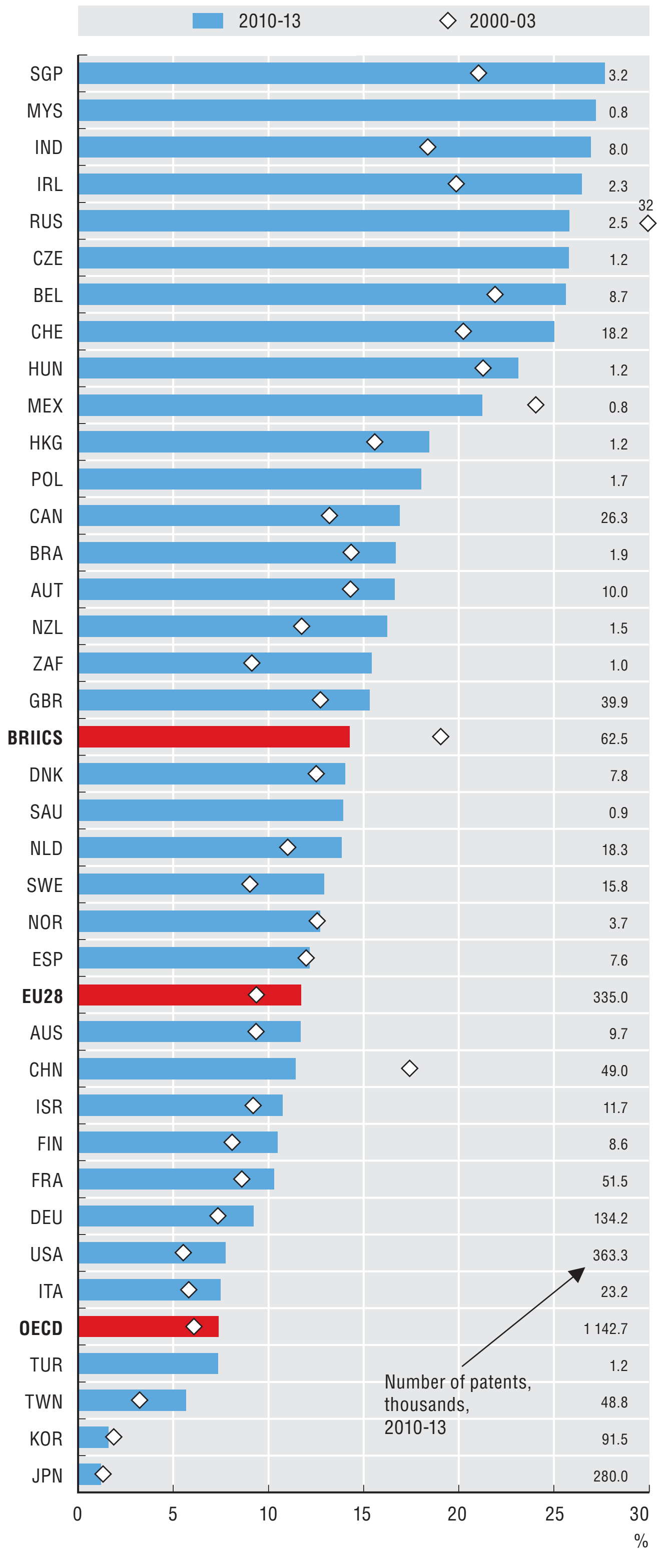
Measurability

The proportion of NPL in patent citations relies on patents published by the European Patent Office (EPO) only. Indicators on the sources of scientific knowledge in patent documents (e.g. fields of science and author affiliation) are based on the NPL cited in patent families, using the Thomson Reuters Derwent World Patents Index and Derwent Patents Citation Index database, for patents filed at major patent offices. Innovation-science links build on an algorithm developed by Thomson Reuters and Japan's Science and Technology Agency that matches NPL references to the Thomson Reuters Web of Science, a peer-reviewed scientific literature database. Only publications from 2007 to 2013 are considered to ensure a focus on recent scientific literature. The attribution of field of science and country of origin is based on unambiguously matched references. Estimates are made on a whole counts basis and give full credit to each combination of reference and contributing country. Results may reflect the choice of data sources, observation period, matching process and counting method used.

7. Inventions across borders

International co-inventions in patents, 2000-03 and 2010-13

As a percentage of the economy's total patents



Source: OECD, *STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933273980

Patented inventions often result from collaboration between inventors from different economies. Information about the country where inventors reside can be used to shed light on international R&D co-operation, the extent to which innovations result from cross-country collaborations, and the location of inventive activities in different technology fields.

Knowledge creation increasingly relies on cross-country collaborations allowing innovators to tap into the repository of competencies and skills that best meet their needs. The share of international co-inventions differs across economies, ranging between about 1% and 28% of all patents, with Korea and Japan on the bottom end. On average, the international co-invention of patents increased by 27 percentage points between 2000-03 and 2010-13. China, Mexico and the Russian Federation are among the few economies that saw the share of patents featuring foreign co-inventors decrease over the period. This may reflect increases in the domestic innovation capability and availability of skilled human capital in these countries.

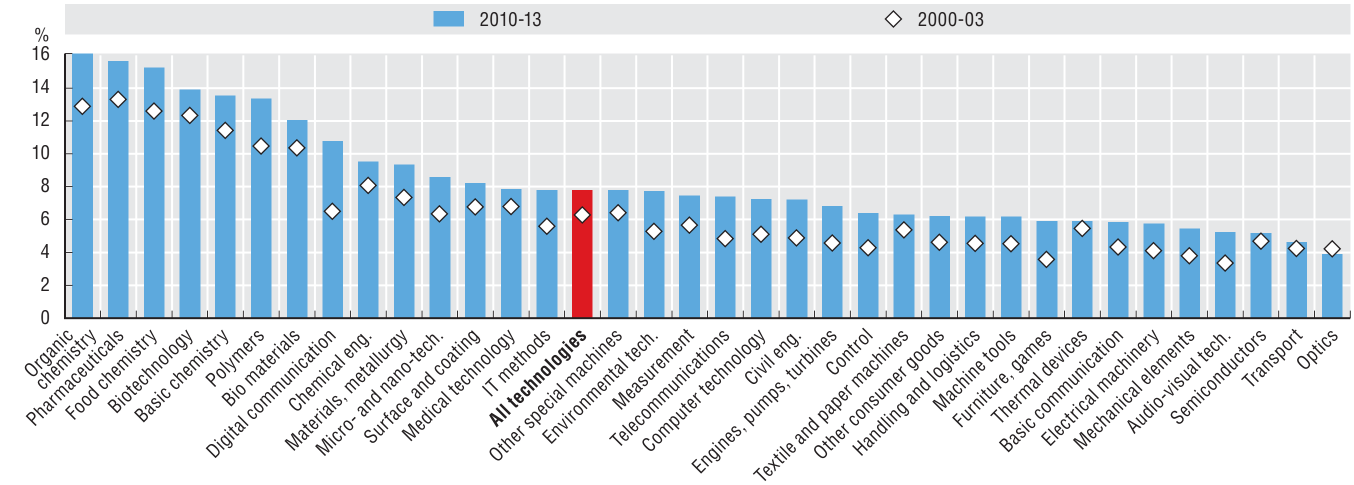
Marked differences also emerge regarding the extent to which patents in different technology fields result from collaborations among inventors in different economies. In organic and food chemistry and pharmaceuticals, international co-inventions account for more than 14% of patents, while in audiovisual technologies, semi-conductors, transport and optics, they generally account for less than 5.5%. Digital communications had a significant increase in collaboration over the decade (2000-03 to 2010-13). There are large differences across technology fields in the number of economies that have inventors contributing to patenting. In pharmaceuticals, patents originate from inventors located in 128 economies, whereas in basic communications and micro and nano-technologies the inventions contained in patents were developed in less than 70 economies. Inventors are involved in patents in all technology domains in only 44 economies.

Definitions

International co-inventions feature at least one foreign co-inventor in patents invented domestically. The co-invention indicator is calculated by dividing the number of international co-inventions by the total number of patents invented domestically in the same field. Patents are allocated to technology fields on the basis of International Patent Classification (IPC) codes, following the concordance provided by WIPO (2013). Inventors' location by technology field mirrors the total number of economies featuring inventors active in the field during the period considered. Data relate to patent applications filed at the European Patent Office (EPO) or at the US Patent and Trademark Office (USPTO) that belong to patent families within the *Five IP offices (IP5)*.

International co-inventions by technology fields, 2000-03 and 2010-13

As a percentage of total patents in the technology field



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

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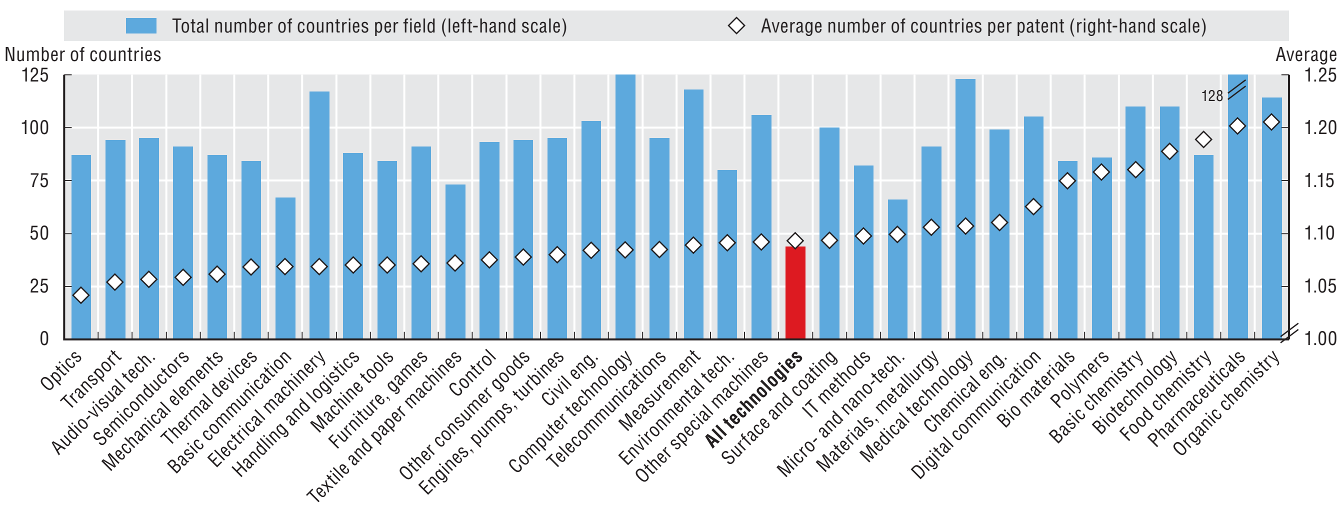
Location of inventors by technology field, 2010-13

Total number of countries active in technology field and average number of countries per patent family



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274007

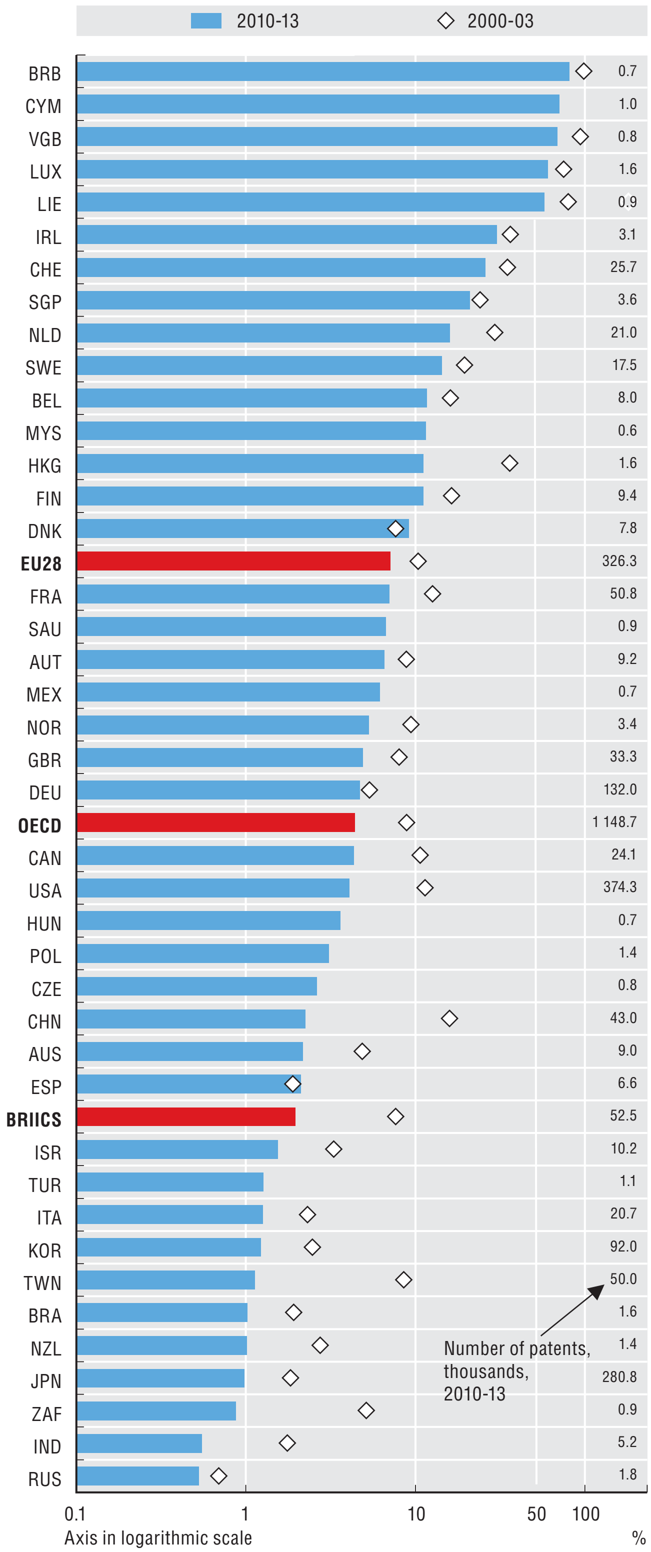
Measurability

Economies differ in the endowments of human capital and infrastructure needed to innovate. This can lead innovators to look for competencies elsewhere beyond their national borders. The resulting international collaborations take a variety of forms, including international co-inventions by a multinational corporation (with research and innovation facilities in other economies), joint research ventures by private and public entities (e.g. firms and universities or public research organisations), and formal and informal networks of scientists. In the case of multinational corporations, international collaboration often reflects the wish of companies to draw upon geographically dispersed knowledge and/or develop complementarities with foreign inventors. The degree to which inventors from different economies collaborate may be shaped by a wide array of factors, including the structure of the company or institution they belong to, as well as possible language barriers and the technology domain of the inventions. Using data from different patent offices may lead to different results.

8. International markets for knowledge

Foreign inventions owned by economies, 2000-03 and 2010-13

As a percentage of the economy's total patents



Source: OECD, *STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274012

Firms often tap into foreign repositories of knowledge and skills to acquire the R&D, patents and know-how they need to perform and compete, at home and abroad. The analysis of patent documents, comparing the country of residence of patent owners and the country of residence of inventors, sheds light on the international sourcing of knowledge. While less than 10% of patents owned by G7 economies have been invented abroad, this proportion rises to 30% in the case of small open economies (e.g. Ireland) and economies featuring a relatively high proportion of multinational enterprises (e.g. the Netherlands, Sweden) or a favourable tax regime (Barbados, Cayman Islands, British Virgin Islands).

Tax rules are thought to underpin some observed patterns of cross-country patent ownership and IPR-related trade. In September 2013, the OECD and the G20 countries adopted a 15-point Action Plan to address base erosion and profit shifting (BEPS). Transferring intellectual property to a lower-tax country is one channel facilitating BEPS, and occurs through cross-border royalty payments to low-tax jurisdictions (OECD, 2015b).

International trade in various forms of knowledge assets reflects differences in the location of inventive activity, ownership over its outcomes and final usage. This is particularly notable in the case of Ireland, Luxembourg and the Netherlands. In Ireland, for example, receipts amount to the equivalent of one quarter of GDP. Most OECD countries for which data are available are net exporters of this class of assets. Over the past decade, trade in knowledge assets grew faster than GDP in most countries for which data are available. In Luxembourg, Korea, Switzerland and Belgium, nominal receipts grew at an annualised rate of more than 10%.

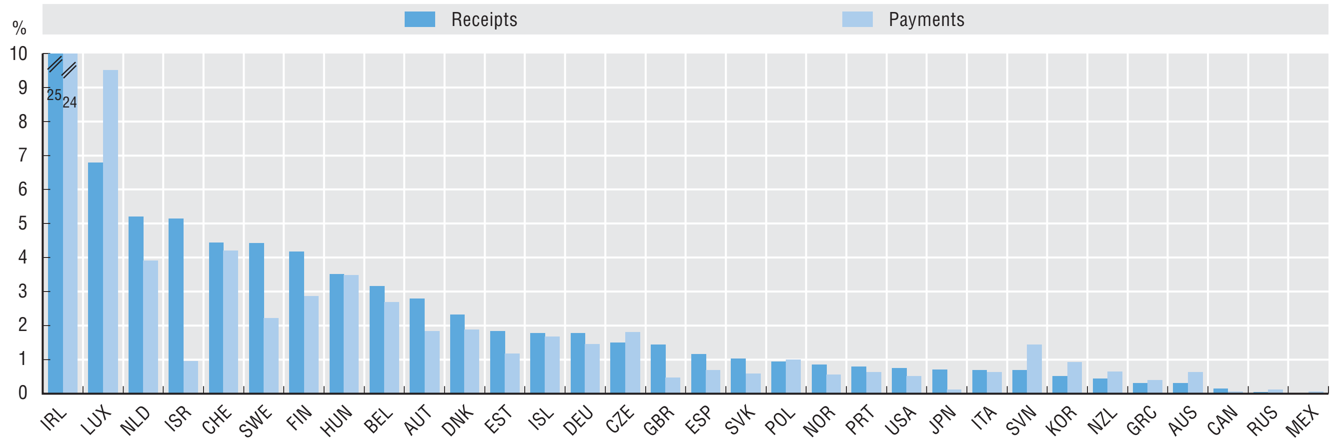
Definitions

Foreign inventions owned by economies relate to the share of patents owned by a resident of an economy for which no inventors reside in the given economy, as a share of total patents owned by that economy. Data refer to patents applications filed at the EPO or the USPTO that belong to IP5 families, by filing date and residence of applicants. Figures rely on fractional counts. Only economies with more than 500 patents in the periods considered are included.

Receipts and payments for knowledge-assets measure cross-border, disembodied trade in technology and related intellectual assets and include: transfer of techniques (through patents and licences, disclosure of know-how); transfer (sale, licensing, franchising) of designs, trademarks and patents; services with a technical content; industrial R&D. Licences to reproduce/distribute computer software and audio-visual products are excluded. This information is captured following the guidelines in the OECD manual on compiling Technology Balance of Payments data.

International trade in knowledge assets, 2013

Receipts and payments, as a percentage of GDP

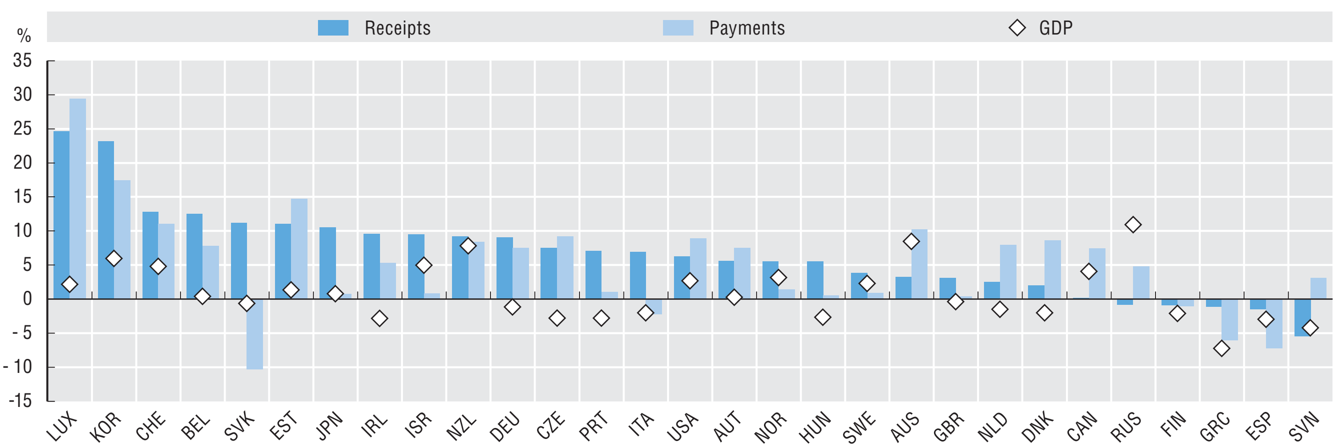


Source: OECD, *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274020

Trends in international flows of knowledge assets, 2009-13

Average annual growth rate, based on current USD, percentages



Source: OECD, *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274036

Measurability

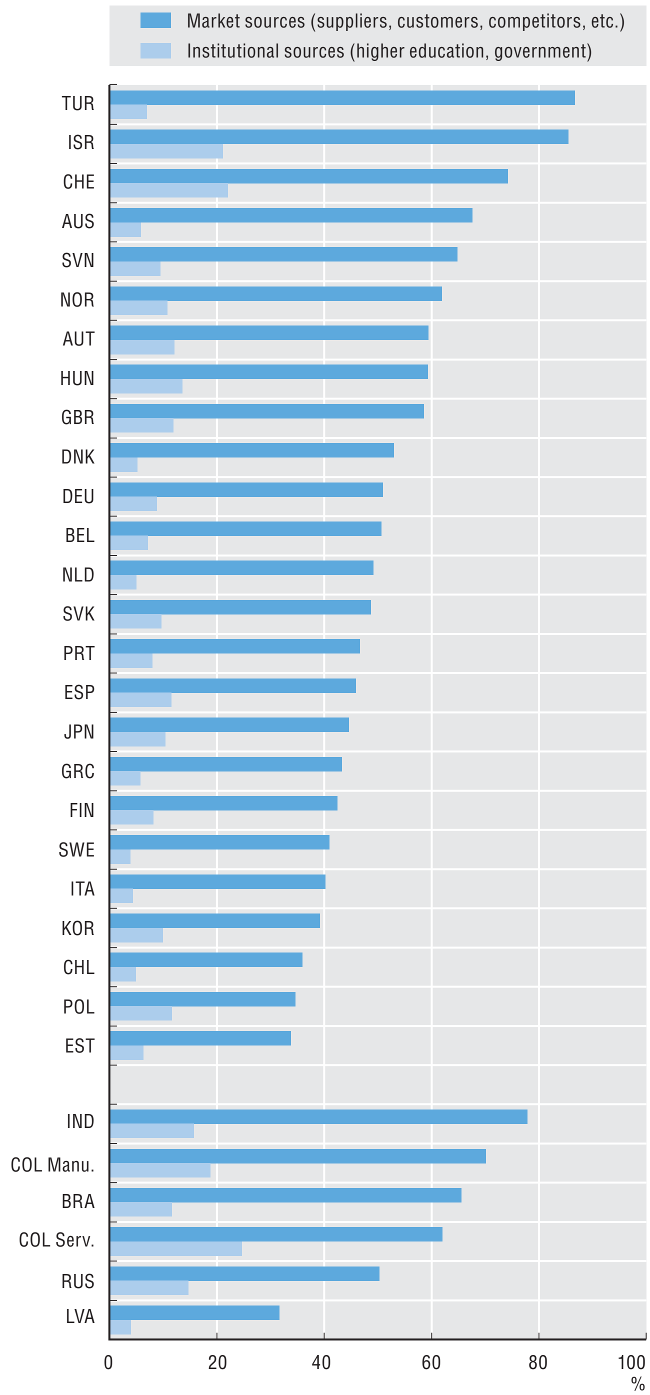
In the case of patent ownership and inventorship comparisons, using data from different offices may lead to different results. Measuring licensing flows, domestically and internationally, is challenging both on a conceptual and practical basis. Estimates may understate actual flows in the case of cross-licensing agreements if only net payments are reported. Companies may report some flows as property income (e.g. repatriated profits), rather than as payments for the use of knowledge assets. Licensing transactions may not involve the transfer of knowledge and may purely reflect tax planning strategies. The OECD-G20 action plan on BEPS prioritises improving the availability and analysis of data on BEPS. A discussion draft published in 2015 puts forward an assessment of data sources relevant for the analysis of BEPS (OECD, 2015b).

A compilers' guide for the *Manual on Statistics of International Trade in Services 2010* (United Nations et al., 2011) has been recently developed under the guidance from the Inter-agency Task Force on Statistics of International Trade in Services. The guide serves to harmonise and improve the ways in which statisticians at the national level collect, compile and disseminate statistics on trade in services.

9. Open innovation

External sources of knowledge for innovation, by type, 2010-12

Percentage of product and/or process-innovating firms citing source as "highly important"



Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey. See *www.oecd.org/sti/inno-stats.htm* for more details.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274043

Innovation is a complex process and often involves many actors and linkages for knowledge production and use. One way to capture its systemic dimension is to examine the information sources firms use for their innovation activities. Market sources predominate in all countries, while institutional sources play a much smaller role. Less than 10% of product and/or process-innovating firms rank them as "highly important".

The introduction of product innovations often involves a number of external actors. Firms may co-develop innovations with other companies, procure services such as R&D or design, license the rights to others' inventions or simply imitate innovations developed and adopted elsewhere. In the case of service innovation, more than 30% of innovating firms drew on some form of external development in the majority of countries during 2010-12. For product innovators, no significant differences were found by firm size in terms of reliance on external contributions to develop new goods and services. While larger firms may have more capacity to afford external inputs, small and medium-sized enterprises (SMEs) may face a bigger urge to look outside for inputs they do not possess themselves.

R&D active firms are far more likely than non R&D firms to engage in fully fledged innovation collaborations – another measure of innovation linkages. The United Kingdom and Belgium exhibit some of the highest collaboration rates among innovators, for both R&D and non-R&D active firms.

Definitions

The guidelines on innovation measurement, known as the *Oslo Manual* define *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" (OECD/Eurostat, 2005). *Product and/or process-innovating firms* are defined as companies that have implemented product or process innovations, or that have ongoing/abandoned innovation activities relating to product/process innovation.

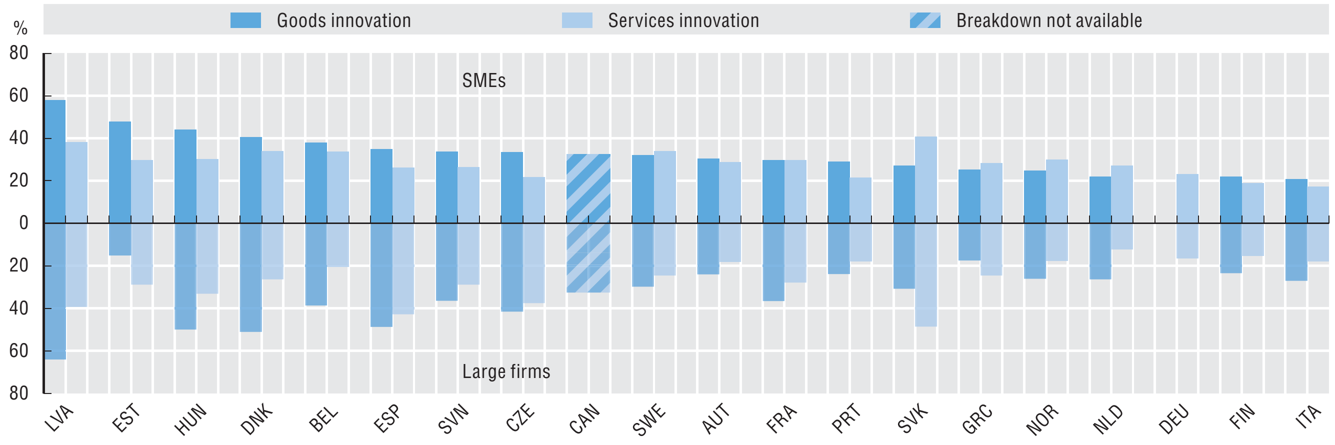
Market sources include suppliers of equipment, materials, components or software, clients or customers, competitors or other enterprises in the same sector and consultants, commercial labs or private R&D institutes. *Institutional sources* include universities or other higher education institutions and government or public research institutes.

R&D-active firms are those engaged in intramural or extramural R&D activities.

Collaboration involves active participation in joint innovation projects with other organisations but excludes pure contracting-out of work. It can involve the joint implementation of innovations with customers and suppliers, as well as partnerships with other firms or organisations.

Externally developed goods and services innovation, by size, 2010-12

As a percentage of firms introducing each type of innovation



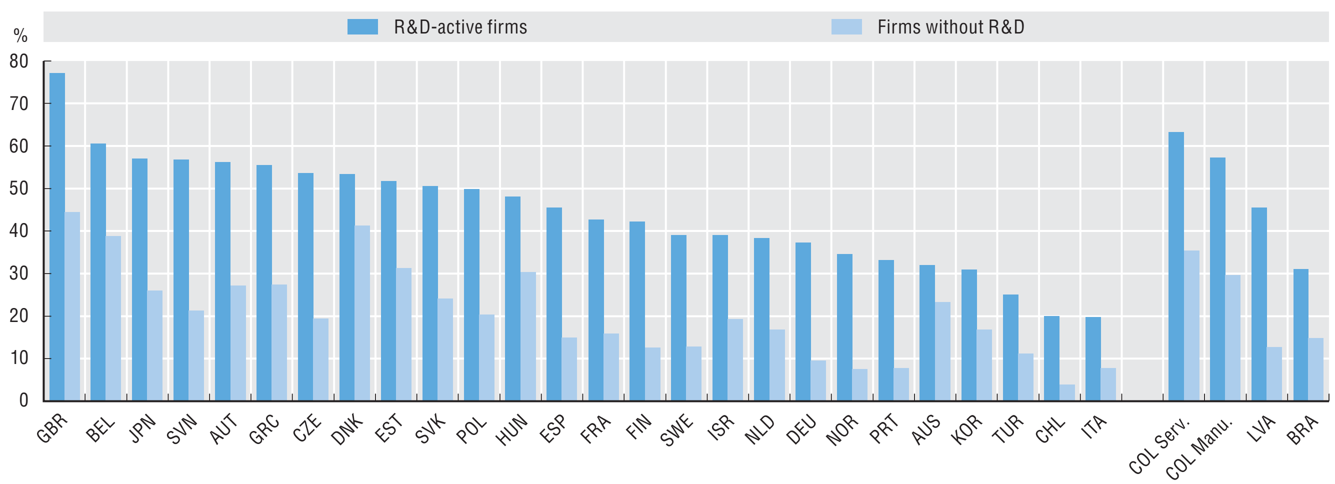
Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the CIS.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274055

Firms engaging in collaboration on innovation, by R&D status, 2010-12

As a percentage of R&D-active and non R&D-active firms



Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the CIS.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274065

Measurability

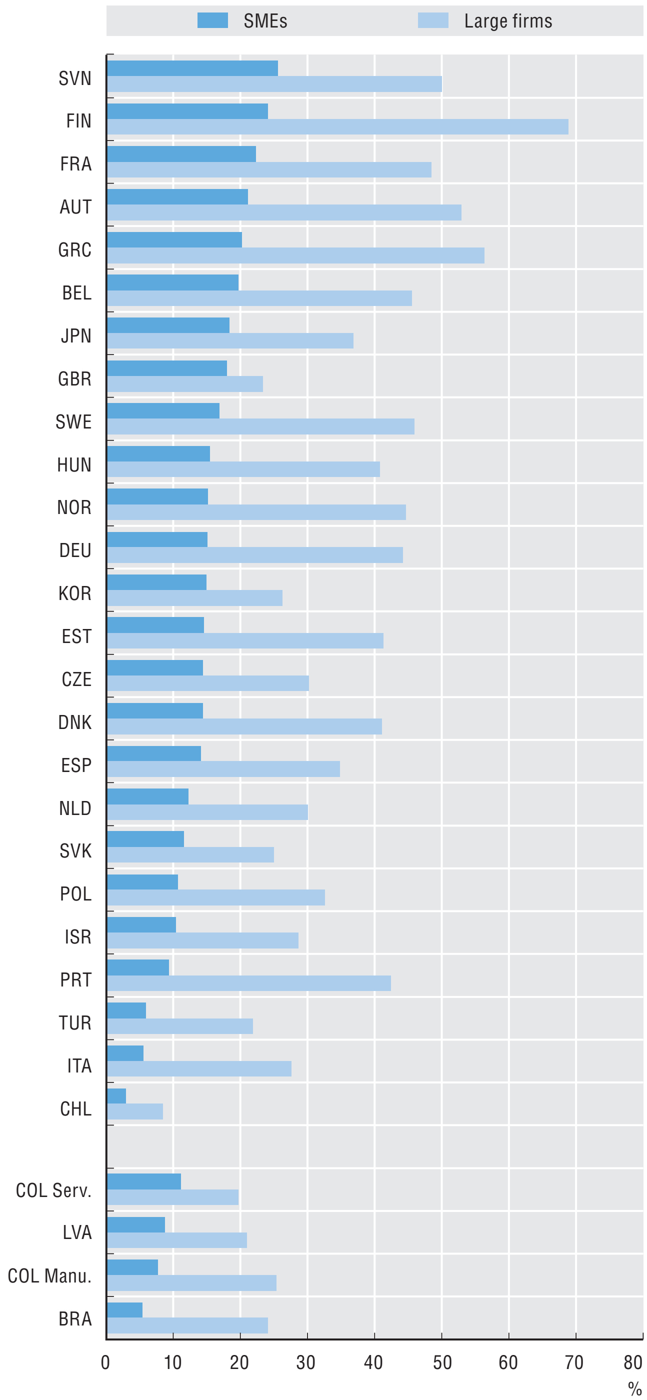
Indicators of external engagement in innovation reflect the existence of knowledge flows, but not their nature, frequency or intensity. Oslo-based surveys follow a "subject-based" approach (i.e. the unit is the firm, not the innovation) enquiring about a knowledge-sourcing strategy across one or more innovations.

The measure of externally developed innovation is based on firms that did not develop innovations themselves, excluding firms that developed innovations both internally and externally. Innovation surveys do not typically include measures of outbound open innovation (i.e. firms developing new products or processes implemented by others). This area is undergoing review as part of the revision of the OECD/Eurostat *Oslo Manual* (*www.oecd.org/sti/oslomanual*).

10. Collaboration on innovation

Firms collaborating on innovation with higher education or research institutions, by firm size, 2010-12

As a percentage of product and/or process-innovating firms in each size category



Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey. See *www.oecd.org/sti/inno-stats.htm* for more details.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274074

Collaboration is a key conduit for innovation-related knowledge flows both for firms that use R&D (either internally developed or externally acquired) and for those that are not R&D-active. Patterns of collaboration differ in terms of partners' characteristics. Collaboration with higher education or public research institutions constitutes an important source of knowledge transfer for large firms. In most countries such firms are usually two to three times more likely to engage in this type of collaboration than small and medium-sized enterprises (SMEs). Collaboration among SMEs with these types of institutions is more likely in Slovenia, Finland and France, and much less likely among innovating firms in Turkey, Italy, Brazil and Chile.

Collaboration is more frequent with other market actors, in particular suppliers and clients. Among large firms, suppliers play a key role as value chains become increasingly integrated. For some countries such as Slovenia, Finland, Estonia, Germany and Japan, collaboration with clients or customers is equally or more important for both large firms and SMEs. This may be an indication of the growing importance of users in driving innovation.

Collaboration with foreign partners can play an important role in the innovation process by allowing firms to gain access to a broader pool of resources and knowledge at lower cost and to share risks. International innovation collaboration rates vary widely across countries. In some small open economies collaboration is heavily skewed towards foreign partners. This may reflect factors such as sectoral specialisation, limited opportunities for domestic collaboration and, in some cases, proximity to external centres of knowledge. Size appears to be a strong determinant of foreign collaboration: large firms have a much higher propensity to collaborate internationally than SMEs, regardless of the overall rate of international collaboration. Among OECD countries, this is particularly true for Italy, Germany, Portugal and Spain. The size gap is also significant in the case of Brazil.

Definitions

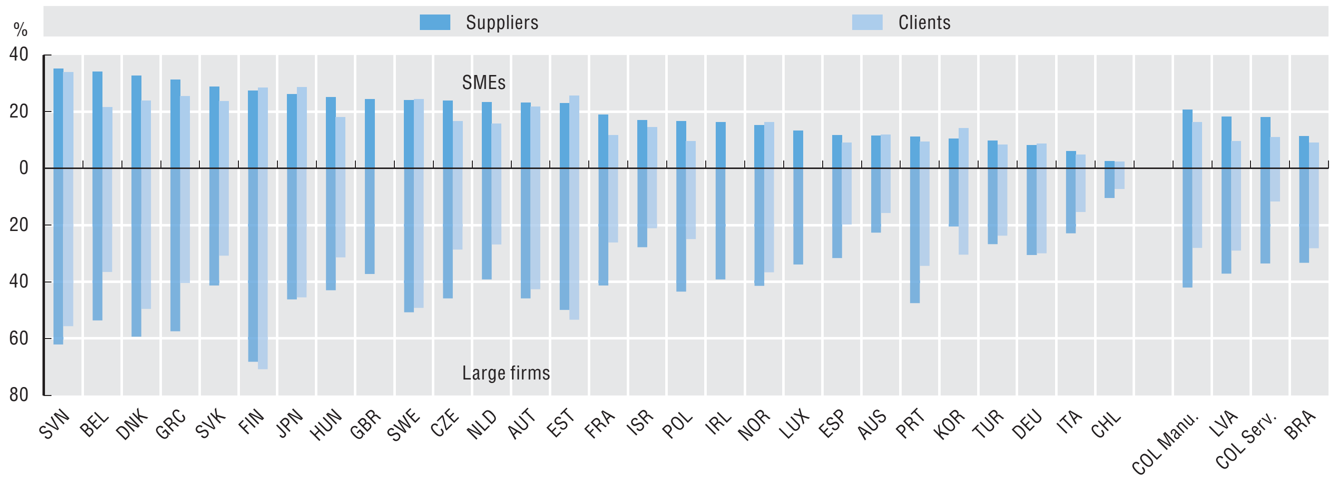
Collaboration involves active participation in joint innovation projects with other organisations but excludes pure contracting out of innovation-related work. It can involve the joint implementation of innovations with customers and suppliers, as well as partnerships with other firms or organisations.

International collaboration on innovation refers to active cross-border participation in innovation collaborations.

The classification of firms by size follows the recommendations of the *Oslo Manual*. In a majority of countries, size is calculated on the basis of employee numbers. SMEs are defined as firms with 10-250 employees, with certain exceptions as detailed in the chapter notes.

Firms collaborating on innovation with suppliers and clients, by firm size, 2010-12

As a percentage of product and/or process-innovating firms in each size category

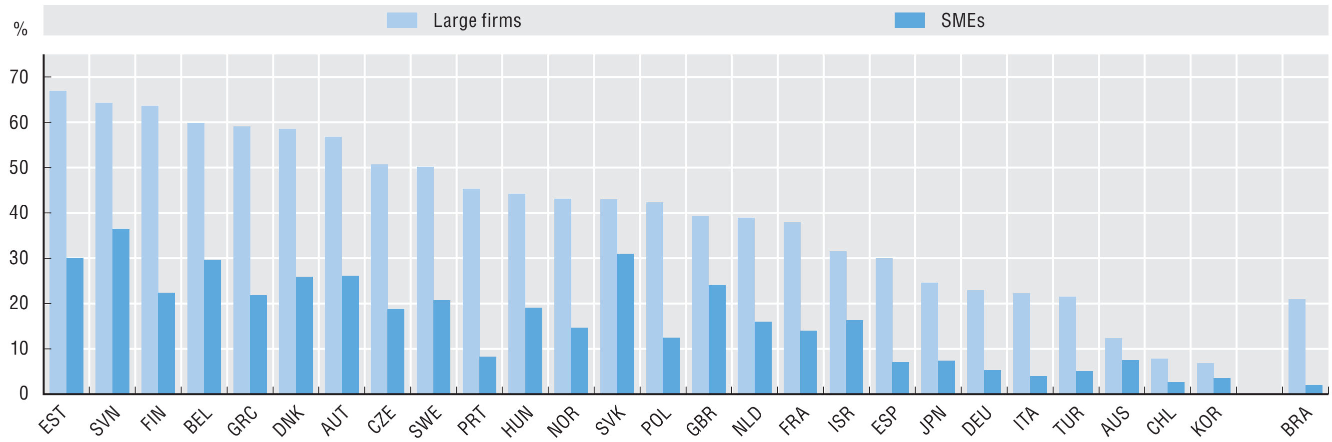


Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the CIS.
Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274082

Firms engaged in international collaboration for innovation, by firm size, 2010-12

As a percentage of product and/or process-innovating firms in each size category



Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the CIS.
Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274095

Measurability

In surveys adopting the CIS model, collaboration rates apply to firms with product or process innovations. In other innovation surveys this information applies to all types of innovative firms. The concept of innovation collaboration differs across different survey models when the group of firms for which collaboration is measured varies.

Results may also reflect survey design and features that impact on firms' responses. Design features such as question order, scope or combination with other types of surveys may influence answers to questions on innovation activity and collaboration with other parties. These practical comparability challenges are being reviewed as part of the revision of the OECD/Eurostat *Oslo Manual* (*www.oecd.org/sti/oslomanual*).

Notes and references

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 recognises 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 of the European Union Member States of the OECD and the European Union:

"The Republic of Cyprus is recognised 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."

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

3.1. International mobility of highly skilled individuals

International and foreign students enrolled in tertiary education, 2012

Data refer to foreign students for the Czech Republic, France, Israel, Italy, Poland, the Slovak Republic and Turkey. Foreign students are defined on the basis of their country of citizenship; these data are not comparable with data on international students and are therefore presented separately in the table and figure.

Total enrolments include all international or foreign students. The distribution is based on the number of students with a known field of education.

For Austria, Finland, Germany and Switzerland, data exclude tertiary-type B programmes.

For Canada, data refer to 2011.

For the Netherlands, data exclude programmes in private education.

Highly educated individuals in immigrant and native-born populations, 2013

Estimates refer to working age individuals (16-65) not in education, with the exception of Canada and New Zealand, where data include people still in education.

For Australia, data refer to 2013.

For Chile and Israel, data refer to 2011.

For Japan, data refer to 2010 and the country is not included in the OECD average.

In Japan and Korea, immigrant status is defined on the basis of nationality, not on the basis of country of birth.

For Mexico, data refer to 2012.

For the United States, data refer to 2012 and include people over 55 who are still in education. The share of highly educated individuals is calculated for the 16-64 age group.

The indicator is computed based on the following data sources: European Labour Force Survey (EULFS) 2012-13; United States Current Population Survey (CPS) 2012; Australian Survey of Education and Work (ASEW) 2013; Labour Force Survey 2012-13 (Canada and New Zealand); Labour Force Survey 2011 (Israel); *Encuesta de Caracterización Socioeconómica Nacional* (CASEN) 2011 (Chile); *Encuesta Nacional de Ocupación y Empleo* (ENOE) 2012 (Mexico); Population Census 2010 (Japan) and Foreign Labour Force Survey 2012-13 (Korea).

3.2. Scientists on the move

International bilateral flows of scientific authors, 1996-2013

Data are based on the main country affiliation for authors captured in at least two documents published and indexed in the Scopus database over the 1986-2013 period. Counts are based on the number of differences in affiliation between first and last recorded publication per author. Flows to and from interim affiliations are not taken into account in this figure.

General notes:

International mobility of scientific authors, 2013 and;
Expected citation impact of scientific authors, by mobility profile in 2013

This is an experimental indicator.

Only authors with two or more publications are considered. A mobility episode is identified when an author affiliated to an institution in a given economy, according to his/her last publication in 2013, was previously affiliated to an institution in another economy. In the case of multiple publications per author in a given year, the last publication in any given year is used as a reference, while others are ignored. Authors are assigned a given status based on their last affiliation in 2013. When the main affiliation for both 2013 and pre-2013 corresponds to the reference economy, the authors are designated "stayers". When authors move affiliation into the reference economy, but were previously affiliated to it for their first recorded publication they are designated "returnees". From the perspective of the previous economy of author affiliation, individuals can be computed as outflows, and the count incorporated into the data presentation.

Additional notes:

International mobility of scientific authors, 2013

Estimates are based on a comparison between the main affiliation of a given author with a Scopus ID publishing in 2013 and the closest available publication in a previous year.

The indicator is represented as the ratio between the number of authors in the relevant category, divided by the (absolute) sum of authors in the reference economy in 2013, plus the outflows from that economy recorded in 2013. The indicator can be adjusted to focus on the profiles of authors from the perspective of the final country of affiliation, as shown in additional variables.

Expected citation impact of scientific authors, by mobility profile in 2013

Estimates are based on a comparison of 2013 *SCImago Journal Rank (SJR)* scores for articles published by scientific authors, based on the journal rank corresponding to an author publishing in 2013. The indicator is represented as the median SJR2013 among authors in the relevant category and economy.

3.3. Excellence in scientific collaboration

International scientific collaboration, 2003 and 2012

International collaboration is defined as the proportion of publications involving institutional affiliations with other countries or economies, as a proportion of publications attributed to authors with an affiliation in the reference economy.

The citation impact of scientific production and the extent of international collaboration, 2003-12

Scientific production/Output/Number of documents is the total number of documents published in scholarly journals indexed in Scopus (all document types are included).

The normalised impact is derived as the ratio between the average number of citations received by documents published by authors affiliated to an institution in a given economy and the world average of citations, over the same time period, by document type and subject area.

The normalisation of citation values is item oriented (i.e. carried out at the level of the individual article). If an article belongs to several subject areas, a mean value of the areas is calculated. The values show the relationship of the unit's average impact to the world average, which is 1 (i.e. a score of 0.8 means the unit cited is 20% below average and 1.3 means the unit cited is 30% above average).

The international institutional collaboration indicator is based on the proportion of documents involving institutional affiliations with other countries or economies, as a proportion of documents attributed to authors with an affiliation in the reference economy. Single-authored documents with multiple affiliations across boundaries can therefore count as institutional international collaboration.

Top 10% most cited documents and scientific leading authorship, 2003-12

This figure indicates the amount (in percentage) of an institution's scientific output that is included in the set of the 10% most-cited papers in their respective scientific fields. It is a measure of the high-quality output of research institutions.

Leading authorship indicates the amount (in percentage) of an institution's output as "leading" contributor, that is, the number of documents for which the corresponding author is affiliated to the relevant institution. In this figure, leading authorship is used to distinguish between highly cited documents that have corresponding authors with foreign affiliations and those with domestic affiliations. In the case of multiple affiliations for a corresponding author, the affiliation for the correspondence address is used as the reference.

3.4. Open access to research

Open access journal (OA) publishing, by affiliation of corresponding author, 2011-13

Documents published between 2011 and 2013 have been entirely attributed to countries on the basis of the main affiliation reported by corresponding authors. The country affiliations of potential contributors are not taken into account in this case.

The open access status of documents is inferred solely on the basis of the journal's description (access from publisher), regardless of whether the document is available through other means. OA comprises DOAJ-registered publications as well as other journal titles marked by Elsevier as being open access.

Journal citation impact measures have been averaged across documents according to the open access status of the journals in which they are published, using the SNIP2013 indicator reported in Elsevier's *Scopus* journal title list file.

Open access to scientific documents by corresponding author's affiliation, selected fields, 2011

This is an experimental indicator, based on a stratified random sample of scientific authors.

Results are based on authors' self-reported measures of access to scientific documents published in 2011 and refer to their access status as of January 2015.

Data are based on scientific documents indexed in Scopus. Fields covered include Arts and Humanities, Business, Chemical Engineering, Immunology and Microbiology, Materials Science, Neuroscience and Physics and Astronomy.

Weighted estimates take into account sampling design and non-response patterns by fields, country affiliation and journal status.

3.5. Research across borders

Business enterprise R&D funded from abroad, by source of funds, 2013

When a breakdown by source of funds is not available, the global share of BERD funded from abroad is used to encompass all sources of funds.

For all countries except Belgium, "Other/not elsewhere classified" also includes the private non-profit (PNP) sector, which accounts at most for 2.26% of all BERD funded from abroad.

For Australia, Austria, Belgium, Germany, Greece, Mexico, Sweden and the United Kingdom, data refer to 2011.

For Denmark, the EU28 zone, France, Ireland, Israel, Italy, the OECD zone, Portugal, South Africa and Switzerland, data refer to 2012.

For Belgium, private non-profit funding is included in "Government and higher education".

For Denmark, BERD funded by international organisations only includes European commission funding.

For Japan and Mexico, information on funding from abroad from "other national government", "PNP" and "International organisations" is not available.

For Israel, defence R&D is partly excluded from available estimates.

R&D expenditures incurred by foreign-controlled affiliates, selected countries, 2011

Financial intermediation and community, social and personal services are excluded for the Czech Republic.

For Finland, Hungary, the Netherlands, Poland, Slovenia and Spain, only Sections B to F of ISIC Rev. 4 are covered.

For the Czech Republic and Hungary, figures refer to 2009.

For France, Italy, the Netherlands, Switzerland and the United States, figures refer to 2012.

For Canada, Sweden and the United Kingdom, figures refer to 2013.

Government R&D funding for international programmes and activities, 2013

Data are based on Eurostat's indicator on "National public funding to transnationally co-ordinated R&D".

2007 data are underestimated for Belgium, the Netherlands and the Slovak Republic.

Data for Switzerland refer to 2012 and are underestimated.

3.6. Science and technology links

Patents citing non-patent literature (NPL), selected technologies, 2007-13

Data refer to citations made in patent applications filed at the European Patent Office (EPO), according to the priority date of the citing patent and the applicant's residence.

Environment-related patents are defined on the basis of their International Patent Classification (IPC) codes or Cooperative Patent Classification (CPC) codes.

Patents in ICT are identified following a new experimental classification based on their International Patent Classification (IPC) codes.

Patents are allocated to health-related fields on the basis of their International Patent Classification (IPC) codes, following the concordance provided by WIPO (2013).

Only economies with more than 200 patents in the selected fields in 2010-13 are included.

The innovation-science link for major enabling technologies, 2003-13

Data refer to citations made in patent families with priority year in 2003-13. To identify whether non-patent literature (NPL) cited in patents corresponds to a scientific document, NPL references were matched to the *Thomson Reuters Web of Science Database*, an index of scientific literature. Counts reflect observations of the number of times a patent family with priority in the relevant office cites a scientific publication in a specific field. Patents are allocated to health-related fields on the basis of their International Patent Classification (IPC) codes, following the concordance provided by WIPO (2013). Biotechnology, ICT and nanotechnology patents are defined on the basis of their International Patent Classification (IPC) codes. Environment-related patents are defined on the basis of their International Patent Classification (IPC) codes or Cooperative Patent Classification (CPC) codes.

Affiliations of scientific authors cited in patents, 2007-13

This is an experimental indicator: international comparability may be limited due to different practices and procedures adopted by the selected patent offices.

Data refer to citations made in patent families with priority year in 2003-13. The analysis is restricted to patents filed at one of the following patent offices: IP Australia (IP AUS), the Canadian Intellectual Property Office (CIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the European Patent Office (EPO), Institut national de la propriété industrielle (INPI), Deutsche Patent- und Markenamt (DPMA), Ufficio Italiano Brevetti e Marchi (UIBM), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), Oficina Española de Patentes y Marcas (OEPM), Institut fédéral de la propriété intellectuelle (IGE), the Intellectual Property Office of the United Kingdom (IPO) and the United States Patent and Trademark Office (USPTO).

To identify whether non-patent literature (NPL) cited in patents corresponds to a scientific document, NPL references were matched to the *Thomson Reuters Web of Science Database*, an index of scientific literature. Counts reflect observations of the number of times a patent family with priority in the relevant office cites a scientific publication with an author affiliated to an institution in a given country.

3.7. Inventions across borders

International co-inventions in patents, 2000-03 and 2010-13

International co-inventions are measured as the share of patent applications with at least one co-inventor located in a different economy out of the total number of patents invented domestically. Data refer to patent applications filed at the EPO or the USPTO that belong to IP5 families, by filing date, according to the inventor's residence using fractional counts. Only economies with more than 500 patents over the reference periods are included. Data for 2013 are partial.

International co-inventions by technology fields, 2000-03 and 2010-13

International co-inventions are measured as the share of patent applications with at least one co-inventor located in a different economy out of the total number of patents invented domestically. Data refer to patent applications filed at the EPO or the USPTO that belong to IP5 families, by filing date. Data for 2013 are partial.

Patents are allocated to technology fields on the basis of their International Patent Classification (IPC) codes, following the concordance provided by WIPO (2013).

Location of inventors by technology field, 2010-13

Data refer to IP5 patent families with members filed at the EPO or the USPTO, by first filing date. Data for 2013 are partial.

Patents are allocated to technology fields on the basis of their International Patent Classification (IPC) codes, following the concordance provided by WIPO (2013).

3.8. International markets for knowledge

Foreign inventions owned by economies, 2000-03 and 2010-13

Foreign inventions owned by economies relate to the number of patents owned by a resident of an economy for which no inventors reside in the given economy, as a share of total patents owned by that economy. Data refer to patent applications filed at the EPO or the USPTO that belong to IP5 families, by filing date, according to the applicant's residence using fractional counts. Only economies with more than 500 patents over the periods are included. Data for 2013 are partial.

International trade in knowledge assets, 2013

Data are based on BPM6 for Australia, Austria, Belgium, the Czech Republic, Denmark, Finland, Germany, Hungary, Italy, Luxembourg, New Zealand, Poland, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. The categories included are: Licences for the use of outcomes of R&D; Franchises and trademarks licensing fees; Computer services; Architectural, engineering, scientific and other technical services; and Research and development services.

Data are based on BPM5 for Estonia, Greece, Iceland, Ireland, Israel, the Netherlands, Norway, the Russian Federation, the Slovak Republic and Slovenia. The categories included are: Royalties and licence fees; Acquisition/disposal of non-produced, non-financial assets; Computer services; Architectural, engineering, scientific and other technical services; and Research and development services.

Data for Canada, Japan, Korea and Mexico come from R&D surveys. Coverage may be limited by the scope of such surveys (R&D performers).

For Mexico, figures refer to 2011.

For Iceland, Israel, the Slovak Republic and Slovenia, figures refer to 2012.

Trends in international flows of knowledge assets, 2009-13

Data are based on BPM6 for Australia, Austria, Belgium, Hungary, Italy, Luxembourg, New Zealand, Portugal, Spain, Switzerland, the United Kingdom and the United States. The categories included are: Licences for the use of outcomes of R&D; Franchises and trademarks licensing fees; Computer services; Architectural, engineering, scientific and other technical services; and Research and development services.

Data are based on BPM5 for the Czech Republic, Finland, Germany, Estonia, Greece, Ireland, Israel, the Netherlands, Norway, the Russian Federation, the Slovak Republic, Slovenia and Sweden. The categories included are: Royalties and licence fees; Acquisition/disposal of non-produced, non-financial assets; Computer services; Architectural, engineering, scientific and other technical services; and Research and development services.

Data for Canada, Japan, Korea and Mexico come from R&D surveys. Coverage may be limited by the scope of such surveys (R&D performers).

For the Czech Republic, Denmark, Finland, Germany, Israel, the Slovak Republic, Slovenia and Sweden, figures refer to 2009-12.

3.9. Open innovation

General notes for all figures:

International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey. Please see *www.oecd.org/sti/inno-stats.htm* for more details.

For countries following the Eurostat CIS 2012, Industry core coverage includes ISIC Rev. 4 Sections and Divisions B, C, D, E, G46, H, J, K and M71-72-73. Only enterprises with 10 or more employees are covered.

For Australia, data come from the Business Characteristics Survey (BCS) and refer to financial year 2012/13. The sectoral and size coverage of enterprises matches the CIS scope.

For Brazil, data come from the Brazil Innovation Survey 2011 (PINTEC) and refer to 2009-11. The industries surveyed differ from the CIS core coverage. ISIC Rev. 4 Section E is not included and only a selection of services are covered (Divisions and Groups: 592, 61, 62, 631, 71 and 72).

For Chile, data come from the Chilean Innovation Survey 2013 and refer to 2011-12. The survey covers firms with more than UF 2 400 in annual revenue; no cut-off by size is applied. Sectoral coverage is larger for the industrial sector and in addition to CIS core activities includes: ISIC Rev. 3 Section A, Agriculture, hunting and forestry; B, Fishing; and F, Construction. The services covered are ISIC Rev. 3 (G, I, J and K).

For Colombia, data come from the Survey of Development and Technological Innovation in the Manufacturing Sector, 2011-12 and from the Survey of Development and Technological Innovation in the Service Sector, 2012-13. Data refer to 2011-12 for manufacturing and 2012-13 for services. The size of the enterprise surveyed varies according to the industrial sector. The industries surveyed differ from the CIS core coverage. Data for ISIC Rev. 4: Sections D and E are collected for firms with 20 employees or more. For Division 46, data are collected for firms with 20 employees or more. For Section H, Division 49 is not available and Divisions 51 and 53 are collected for firms with 20 and 40 employees or more, respectively. For Section J, Division 63, only 631 is surveyed. For Divisions 59, 60 and 61, data are collected for firms with 40 employees or more, while for Divisions 62 and 631 data are for firms with 75 employees or more. For Section K, only Groups 6411 and 6412 are available on a census basis. Divisions 71 and 73 are not surveyed. Division 72 is collected on a census basis.

For India, data come from the Indian National Innovation Survey and refer to 2010-11. The sample is drawn from the Indian Annual Survey of Industries 2009-10 database. The data do not include ongoing or abandoned innovative activities. The sectoral coverage is broader than that of the CIS and also includes: ISIC Rev. 4 Sections A, F and all service activities except for Sections T and U.

For Israel, data come from the Israel Innovation Survey, 2010-12. The sectoral and size coverage of enterprises matches the CIS scope.

For Japan, data come from the Japanese National Innovation Survey (J-NIS 2012). Data refer to the financial years 2009/10, 2010/11 and 2011/12. The sectoral and size coverage of enterprises matches the CIS scope.

For Korea, data come from the Korean Innovation Survey. The survey is carried out separately for manufacturing and services, but all data refer to the period 2011-13. The sectoral coverage is smaller than CIS for the industrial sector and includes ISIC Rev. 4 Section C, Manufacturing only. All services are covered except for Section (O) Public administration and defence; compulsory social security.

For the Russian Federation, data refer to 2011-13 and firms with 15 or more employees. The industries surveyed differ from the CIS core coverage. ISIC Rev. 3.1 Sections C, Mining and quarrying; D, Manufacturing; E, Electricity, gas and water supply; and Divisions 64, 72, 73 and 74 for services are covered.

For Switzerland, data come from the Survey of Innovation Activities in the Swiss Economy, 2013. Data refer to 2010-12. The sectoral and size coverage of enterprises matches the CIS scope.

Additional notes:

External sources of knowledge for innovation, by type, 2010-12

For countries following the Eurostat CIS 2012, Brazil, Israel, Japan, Korea, the Russian Federation and Switzerland, the data on sources of knowledge for innovation include product or process innovative firms (including ongoing or abandoned innovation activities).

For Australia and Colombia, data on sources of knowledge for innovation include product, process, marketing or organisational innovative firms (including ongoing or abandoned innovation activities). Marketing and organisational innovators are less likely to be engaged in relations with institutions. The Australian questionnaire asks only whether the relevant source was used, not the importance of the source.

For Chile, data on sources of knowledge for innovation include product, process, marketing or organisational innovative firms (ongoing or abandoned innovative activities are not identified). Marketing and organisational innovators are less likely to be engaged in relations with institutions.

Externally developed goods and services innovation, by size, 2010-12

For Canada, data come from the Survey of Innovation and Business Strategy (SIBS) 2012 and refer to 2010-12. For Canada, the indicator refers to all types of product innovation, as the question on product innovation is not broken down by goods and services innovation. The survey covered firms with 20 or more employees and with at least CAD 250 000 annual revenue in 2009. The industries covered are NAICS (2007) 31-33, 41, 48, 49, 51, 52 and 54.

Firms engaging in collaboration on innovation, by R&D status, 2010-12

For countries following the Eurostat CIS 2012, Brazil, Israel, Japan and Korea, the data on innovation collaboration include product or process innovative firms (including ongoing or abandoned innovation activities).

For Australia and Colombia, data on innovation collaboration include product, process, marketing or organisational innovative firms (including ongoing or abandoned innovation activities). Marketing and organisational innovators are less likely to be involved in collaboration.

For Chile, data on innovation collaboration include product, process, marketing or organisational innovative firms. Ongoing or abandoned innovative activities are not identified. Marketing and organisational innovators are less likely to be involved in collaboration.

For Spain, R&D status corresponds to 2012 only.

3.10. Collaboration on innovation

General notes for all figures:

See under 3.9 in addition to the following:

For countries following the Eurostat CIS 2012, Brazil, Israel, Japan, Korea and Switzerland, the data on innovation collaboration include product or process innovative firms (including ongoing or abandoned innovation activities).

For Australia and Colombia, data on innovation collaboration include product, process, marketing or organisational innovative firms (including ongoing or abandoned innovation activities). Marketing and organisational innovators are less likely to be involved in collaboration.

For Chile, data on innovation collaboration include product, process, marketing or organisational innovative firms. Ongoing or abandoned innovative activities are not identified. Marketing and organisational innovators are less likely to be involved in collaboration.

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man
success
innovation
bulb
glowing
technology
energy
graphic
work
white
design
plan
solution
inspiration
concept
sky
light
environment
electric
technical
creativity
intelligence
innovative
equipment
future
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lamp
image
hand
isolated
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human
background
business
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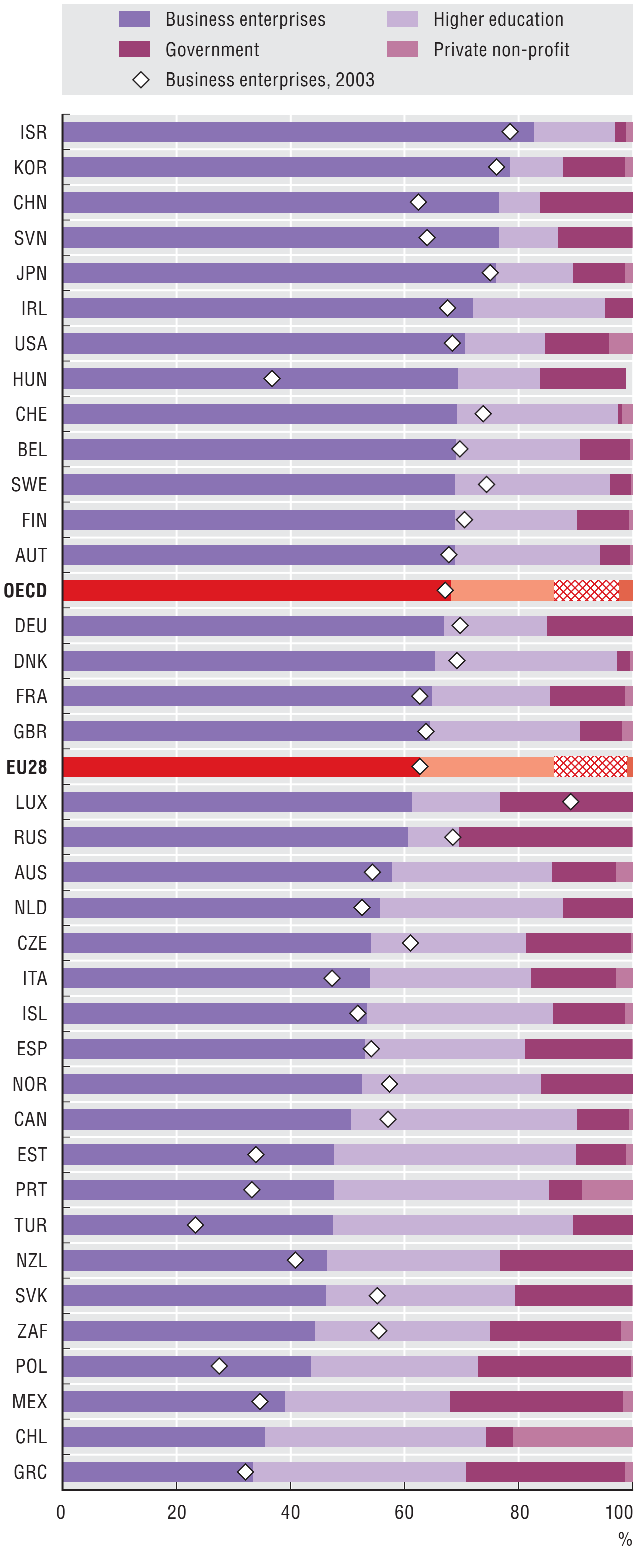
new
blue
environment
renewable
eco

4. UNLOCKING INNOVATION IN FIRMS

A dynamic business sector and favourable framework conditions are crucial to innovation and entrepreneurship. In their innovation strategies, firms tend to combine the introduction of new products with the adoption of new production, organisational and marketing methods. Although not all innovation is R&D-based, the propensity to introduce new product innovation among firms performing R&D is consistently higher. Identifying new-to-market product innovators provides a quality-adjusted measure of product innovation. R&D is typically concentrated among a limited number of global players at the technology frontier. For the first time, patents and trademarks are matched to R&D investment of these global players in order to characterise their technology specialisation and market penetration strategies. The intellectual property (IP) bundle points to the joint use of patents, trademarks and industrial designs by firms worldwide. New data on registered designs provide information on how creativity is protected in countries and a novel technique is also proposed to help track product areas where creative activities are emerging. Policy areas requiring particular attention are the financing of innovation, the fostering of start-ups and the growth of new firms. New estimates of R&D tax incentives are combined with direct funding of R&D to provide a more complete picture of efforts made by governments to promote business R&D. New indicators based on innovation surveys look at the participation of innovative firms in public procurement markets.

R&D expenditure by performing sectors, 2013

As a percentage of gross domestic expenditure on R&D



Source: OECD, *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274105

The business sector accounts for the largest share of R&D performed in most economies and more than 60% of expenditure on R&D (GERD) in the OECD area. This share has remained fairly stable over the past decade in the OECD and the European Union, and has increased significantly in China. Higher education R&D accounts for almost 20% of total OECD GERD. The government sector plays a relatively minor role as a performer of R&D but it is a major funder of R&D performed in the higher education and business sectors.

R&D is typically concentrated among a limited number of firms in which large ones are typically over-represented. In some countries, however, small and medium-sized firms (SMEs) account for a significant share of total business R&D. The share of SMEs in total BERD ranges from more than two thirds in Iceland and New Zealand to less than 15% in the United States and Germany, and below 5% in Japan. SMEs receive a relatively large share of government funding in several countries including Estonia, the Slovak Republic, Korea and Finland. In the case of the United Kingdom and the United States, SMEs receive a smaller share of funds for R&D compared to their overall contribution to BERD.

The distribution of business R&D by economic activity reveals a pattern of specialisation influenced, but not entirely determined, by a country's economic structure. In most OECD countries, a limited number of activities account for a large share of total business R&D. Three broadly defined economic activities, namely Chemicals (including pharmaceuticals, fuels, other chemicals and minerals), Information and Communication Services and Transport Equipment, constitute the main economic sectors where R&D is performed across OECD countries and other major economies.

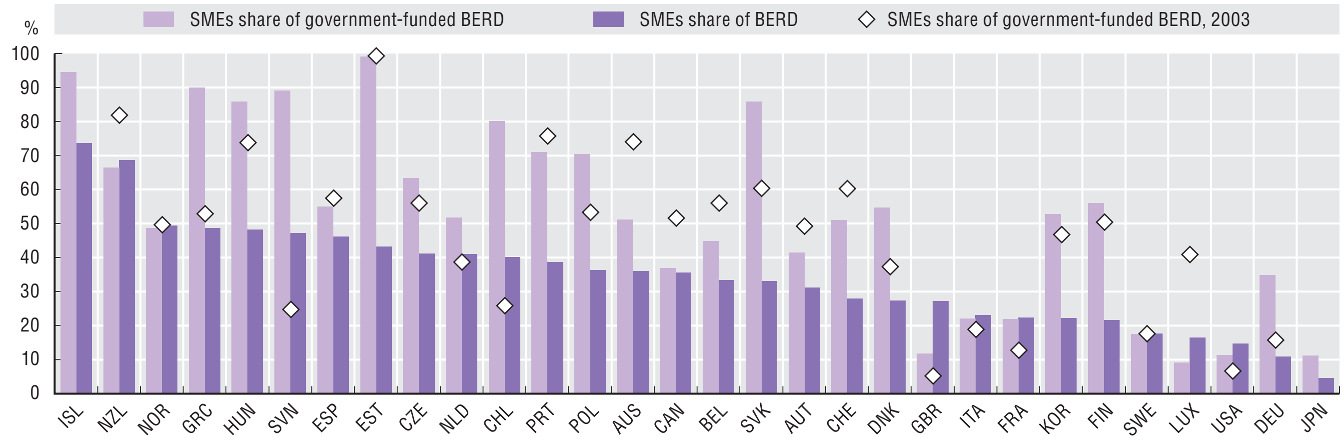
Definitions

Gross domestic expenditure on R&D is usually reported for sectors of performance: business enterprise, higher education, government and private not-for-profit institutions serving households (PNP). *Business enterprise expenditure on R&D* (BERD) records gross expenditures on R&D performed by all firms, organisations and institutions (public and private) whose primary activity is the production of goods and services (other than higher education) for sale to the general public at an economically significant price, and the private non-profit institutions mainly serving them.

Government-funded business R&D is the component of R&D performed by business enterprises attributed to direct government funding. It includes grants and payments for R&D contracts for procurement, but not R&D tax incentives, repayable loans or equity investments.

Business R&D and government support for business R&D, by size, 2013

Share corresponding to SMEs, as a percentage of the relevant category

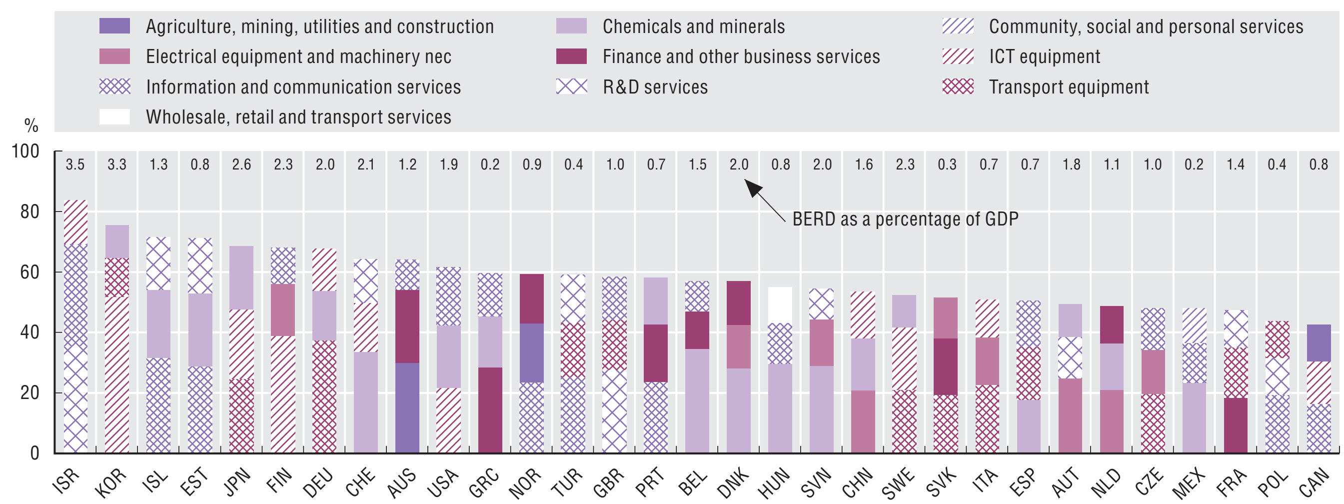


Source: OECD, *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274115

R&D specialisation, top three performing industries, 2013

Industry R&D expenditure as a percentage of total business enterprise R&D



Source: OECD, *ANBERD Database*, *www.oecd.org/sti/anberd*, and *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274128

Measurability

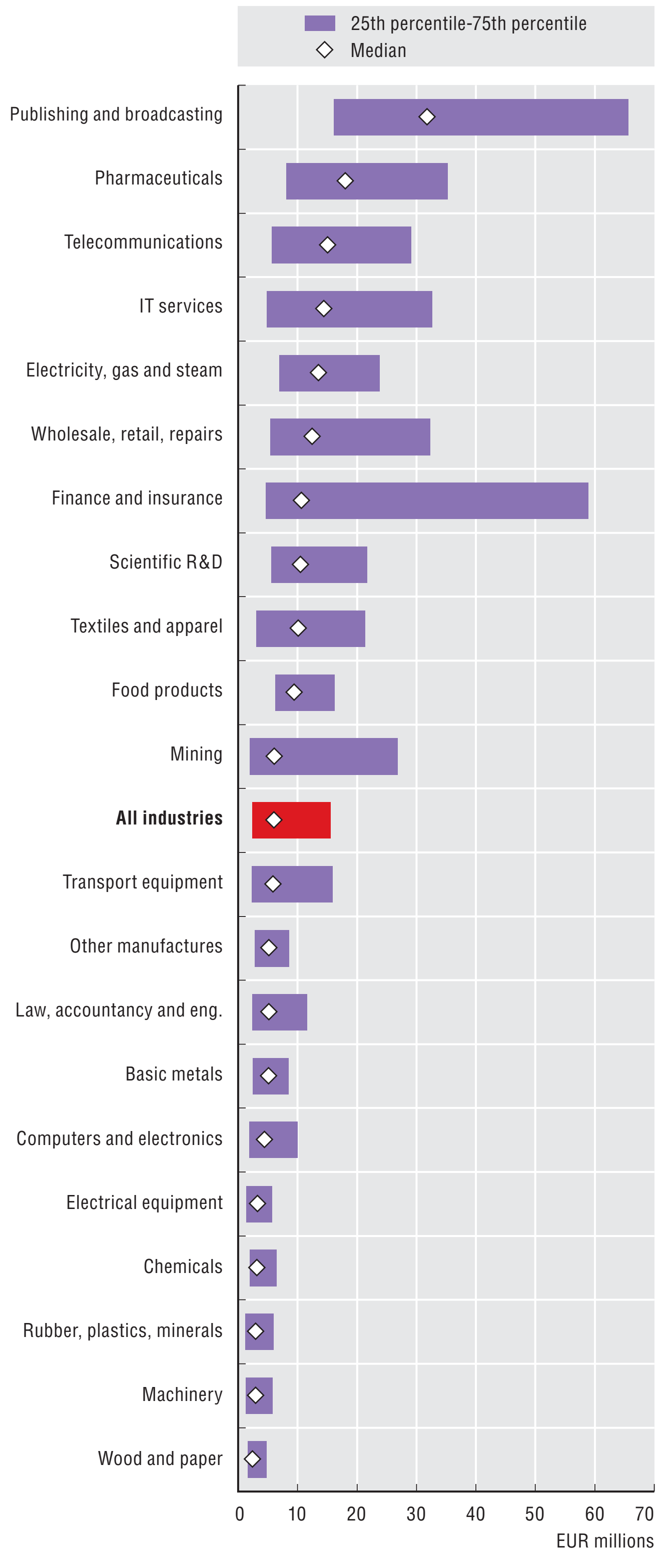
Data on government funding of BERD covers only direct support. For completeness, it should be complemented with additional information on indirect support (e.g. foregone revenue from R&D tax credits). Data on public support by firm size do not currently distinguish between SMEs that form part of a larger group and those that are independent.

There is considerable diversity in the methods countries use to report R&D by economic activity: on the basis of the enterprise's main activity, as reported above, the product for which the R&D is intended, or a mixture of both. To protect confidentiality, statistical agencies report BERD at different levels of aggregation. R&D data by activity are grouped as follows, using data in ISIC Rev. 4 or equivalent: Agriculture, mining, utilities and construction: 01-03, 05-09, 35-39 and 41-43; Chemicals and minerals: 19-23; Community, social and personal services: 84-99; ICT equipment: 26; Information and communication services: 58-63; Electrical equipment and machinery nec: 27-28; Transport equipment: 29-30; Finance and other business services: 64-66 and 69-82 exc. 72; R&D services: 72; Wholesale, retail and transport services: 45-47, 49-53 and 55-56.

2. Top R&D players

R&D investment per patent of top corporate R&D companies, 2010-12

EUR millions per IP5 patent family, median values by industry



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274131

World's top corporate research and development (R&D) investors are leading global players at the technology frontier. These two thousand companies account for over 90% of global business R&D spending and own 66% of all patent families filed at the five largest intellectual property offices worldwide (IP5).

Substantial heterogeneity emerges within and across industries with respect to the average size of R&D investments made per patent. *Publishing and broadcasting* and *Pharmaceuticals* exhibit median investments of EUR 32 million and EUR 18 million, respectively, while *Wood and paper* and *Machinery* present median investments of EUR 2.4 million and EUR 2.9 million, respectively. Top quartile investors spend from 3 to 14 times more than bottom quartile investors in the same industry. Dispersion is lowest in *Wood and paper* and *Food products*, where top quartile companies invest about three times more than bottom quartile ones, and highest in sectors such as *Finance and insurance*, with companies investing about 13 times more.

Technological and industrial specialisation goes hand in hand among top corporate R&D investors, however the technology portfolio of these companies is generally more diversified than their industrial activities at the level of aggregation considered. In addition, the median number of countries in which these corporations are located correlates positively with both industrial and technological diversification. These patterns may reflect the extent to which companies diversify their technological competencies and tap into specific knowledge repositories, as well as their market penetration strategies.

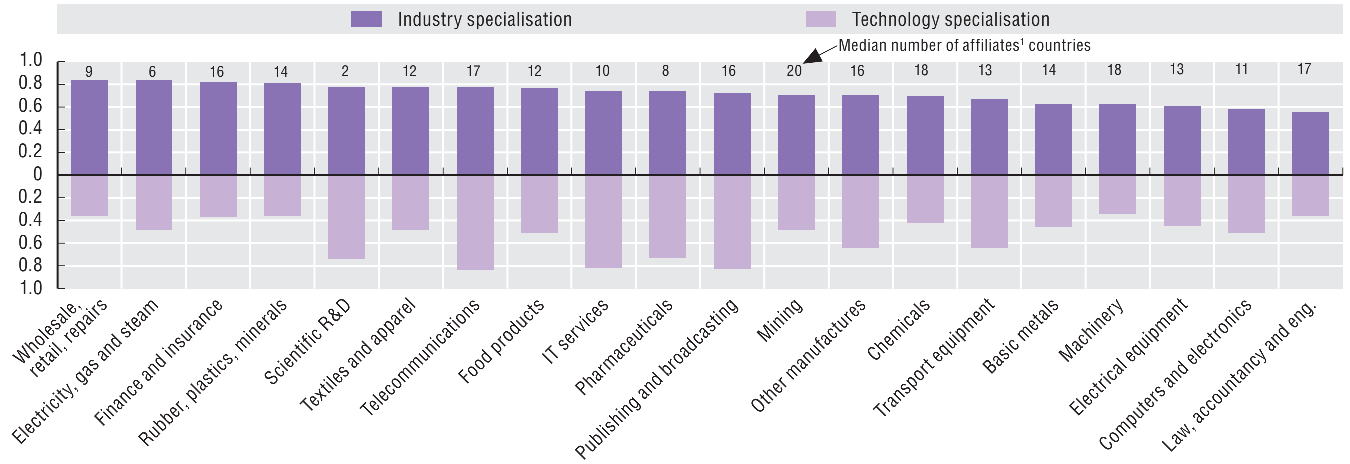
Top corporate R&D investors behave very differently when bringing new goods and services onto the market and branding them in such a way that consumers recognise and purchase them, as can be seen from sales obtained per trademark applied. This is true both within and across industries and markets. With the exception of *Finance and insurance*, the median level of sales obtained per registered trademark was higher in Europe (OHIM) than the United States (USPTO). Within industry top to bottom percentile ratios range between 4 (in *Law, accountancy and engineering*) and 16 (in *Wholesale, retail, repairs*) at USPTO, and between almost 4 (*Other manufactures*) and more than 17 (in *Wholesale, retail, repairs*) at OHIM.

Definitions

Industry specialisation ratios reflect the share of affiliates accounted for by the top four industries in which companies' affiliates operate over the total number of affiliates of these top R&D investors in a given industry *Technology specialisation ratios* reflect the share accounted for by the top four technology fields in which companies patent over the total number of patents filed by these R&D investors in a given industry.

Industrial and technological specialisation and affiliates' location of top R&D companies, 2010-12

Specialisation at the industry and technology level and median number of affiliates' countries



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

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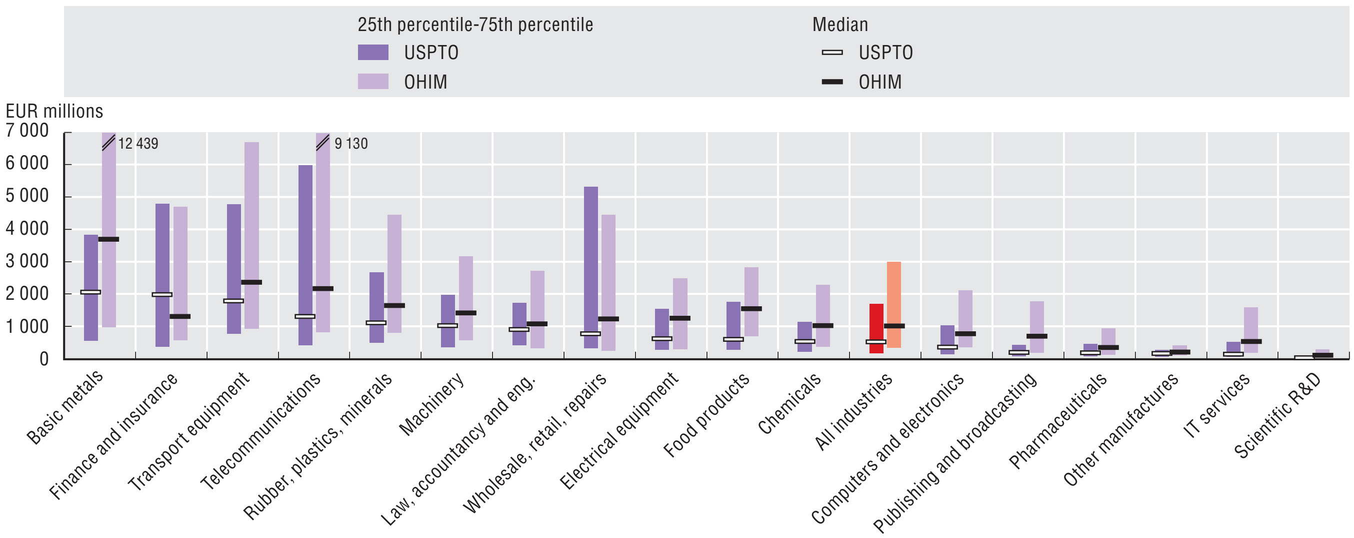
Net sales per trademark of top corporate R&D companies, 2010-12

EUR millions per trademark applications, median values by industry



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274150

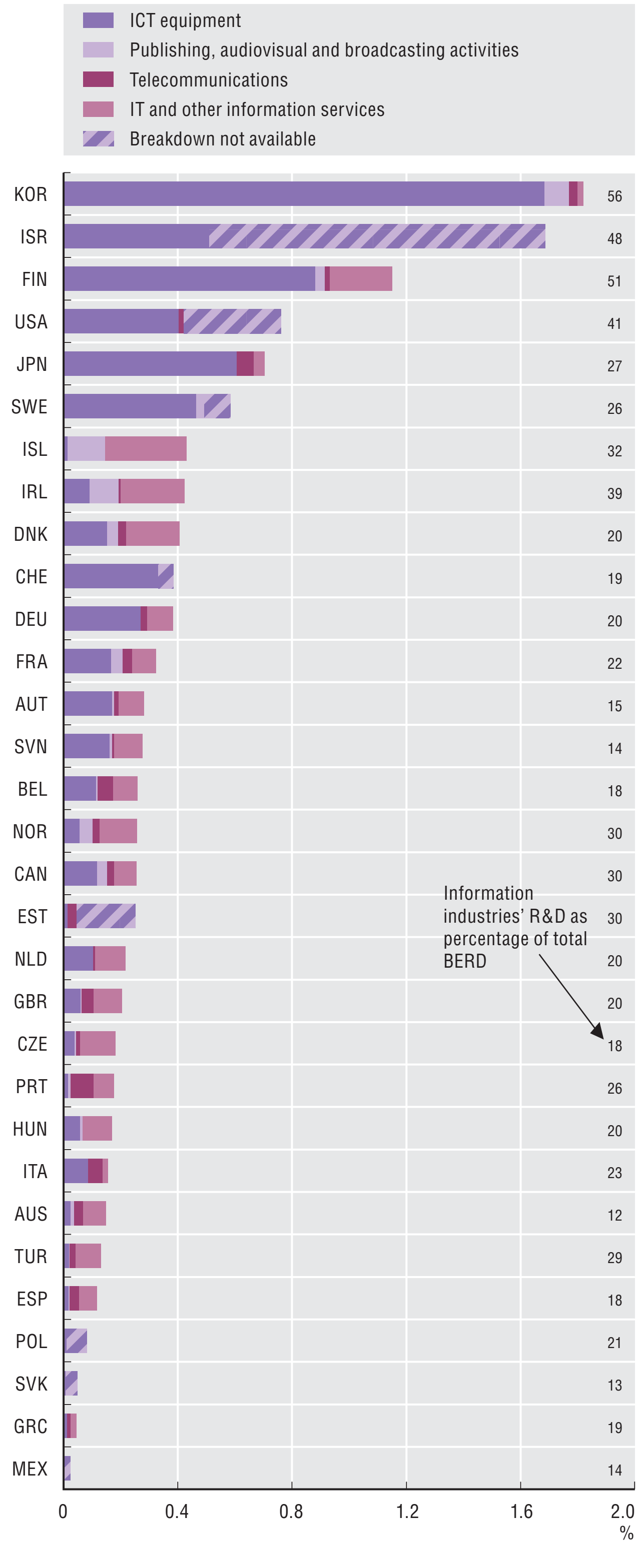
Measurability

Patent data refer to patent families filed at the top five intellectual property (IP) offices worldwide: the IP5 (*www.fiveipoffices.org*). IP5 families are identified based on a new methodology detailed in Dernis, Dosso et al. (2015). Trademark data refer to new trademark applications filed at the US States Patent and Trademark Office (USPTO) and the Office for Harmonization in the Internal Market (OHIM). R&D expenditures and net sales figures are presented in EUR millions at constant prices, calculated using the inflation rate of the euro area. Patent families are allocated by first filing date and trademarks on the basis of filing date. Patents and trademarks are allocated using information about the main industry of the applicant's headquarters and rely on fractional counts. Industries are defined according to ISIC Rev. 4. Figures may differ if different patent family types, IP authorities and/or time frames are considered. Comparisons across years are not provided, as the corporate structure of top R&D performers is likely to change over time, while data regarding the corporate structure of these conglomerates is only available for 2012.

3. ICT and innovation

R&D expenditure in information industries, 2013

As a percentage of GDP



Source: OECD, *ANBERD Database*, *www.oecd.org/sti/anberd*, and *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274169

Information and communication technologies (ICTs) are key enablers of innovation throughout the economy. In most OECD economies, information industries account for the largest share of business expenditures on research and development (BERD), amounting to about 25% of total BERD and 0.2% to 0.4% of GDP. In Finland, Israel, Korea and the United States, information industries account for 40% to over 50% of BERD, and ICT BERD alone represents between about 0.6% to more than 1.8% of GDP, reflecting the high research intensity of these economies and the sector itself.

While R&D provides a measure of innovation input, inventive output is reflected in patents. Patenting activities in ICT-related technologies grew by 66% between 2000-03 and 2010-13, with marked changes observed in the relative importance of different sub-fields. In particular, technologies related to high-speed networks, and large capacity and high-speed storage decreased in relative importance (from 17% to 11% and from 11% to 5%, respectively), whereas technologies related to mobile communication and human interface, i.e. enhancing operability by human beings, increased their share from 4% to 7% and from 4% to 8%, respectively. These dynamics mirror the growing importance of mobile devices and the development of the Internet of Things.

Innovation encompasses a broader array of activities than R&D. Innovative firms aim to improve their competitiveness by enhancing existing products and creating new ones, as well as by marketing and selling products more effectively. On average, 74% of firms in ICT manufacturing introduced innovations, against an average of 51% for total manufacturing according to the results of the 2012 Community Innovation Survey. ICT services also account for a larger share of innovative firms than *innovation core* services (63% against 47%).

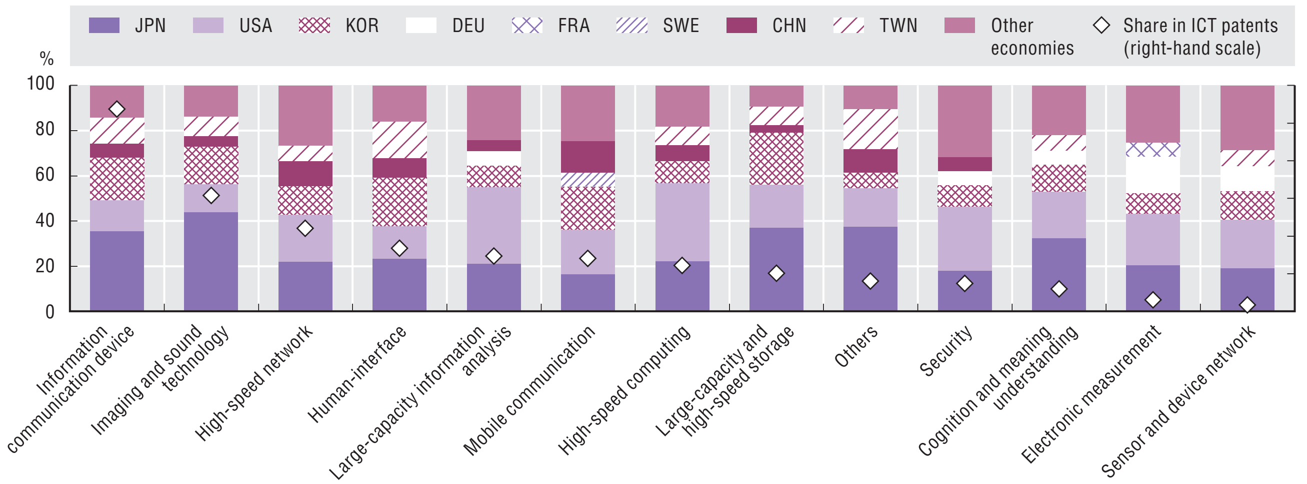
Definitions

Business expenditure on R&D (BERD) includes all expenditures performed by enterprises, irrespective of the sources of funding. Expenditures are classified according to the main economic activity of the enterprise in terms of turnover. Information industries are defined as the aggregate of ICT and digital media and content industries. ICT trade and repair activities are excluded here due to data availability.

ICT manufacturing refers to the International Standard Industrial Classification (ISIC) Rev. 4 Division 26 (Manufacture of computer, electronic and optical products). *Information technology (IT) services* include Publishing, Computer programming and consultancy, and Information service activities (Div. 58, 62 and 63). *Innovation core service activities* include Div. G46, H, J, K and M71-72-73.

Patents in ICT-related technologies and major players, 2010-13

Share of the top five players in the field

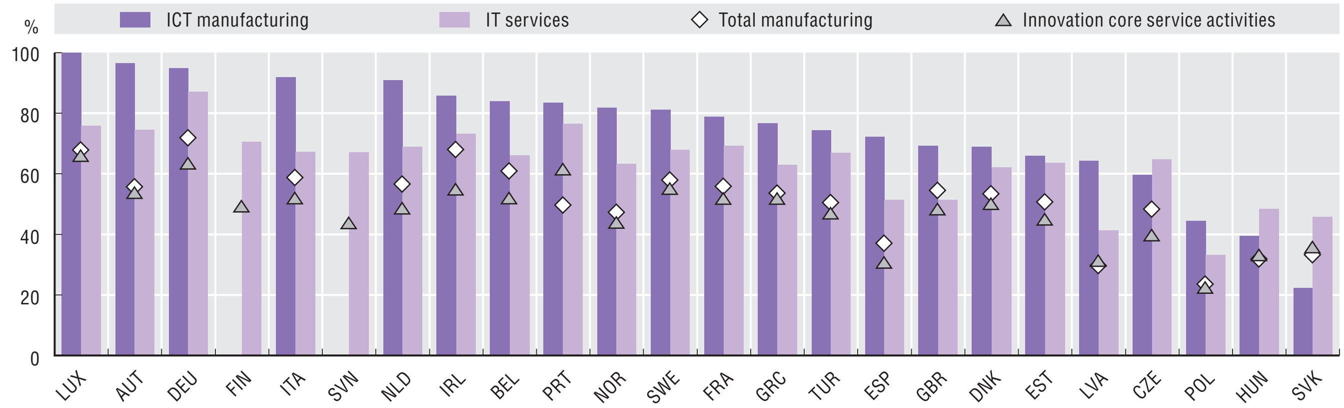


Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, http://oe.cd/ipstats, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274171

Innovative enterprises in ICT manufacturing and IT services 2010-12

As a percentage of enterprises with ten or more persons employed



Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012), June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274183

Measurability

Economies differ in the way they report R&D by economic activity. The interpretation of indicators may vary depending on whether data are provided on the basis of the main activity of the R&D performer or the industry or product at which the R&D is targeted. Given their broad enabling nature, ICT services pose particular challenges. The new edition of the *Frascati Manual* (OECD, 2015a) aims to increase convergence among reporting practices. Furthermore, BERD by industry statistics are not always available at the required level of detail because of confidentiality restrictions.

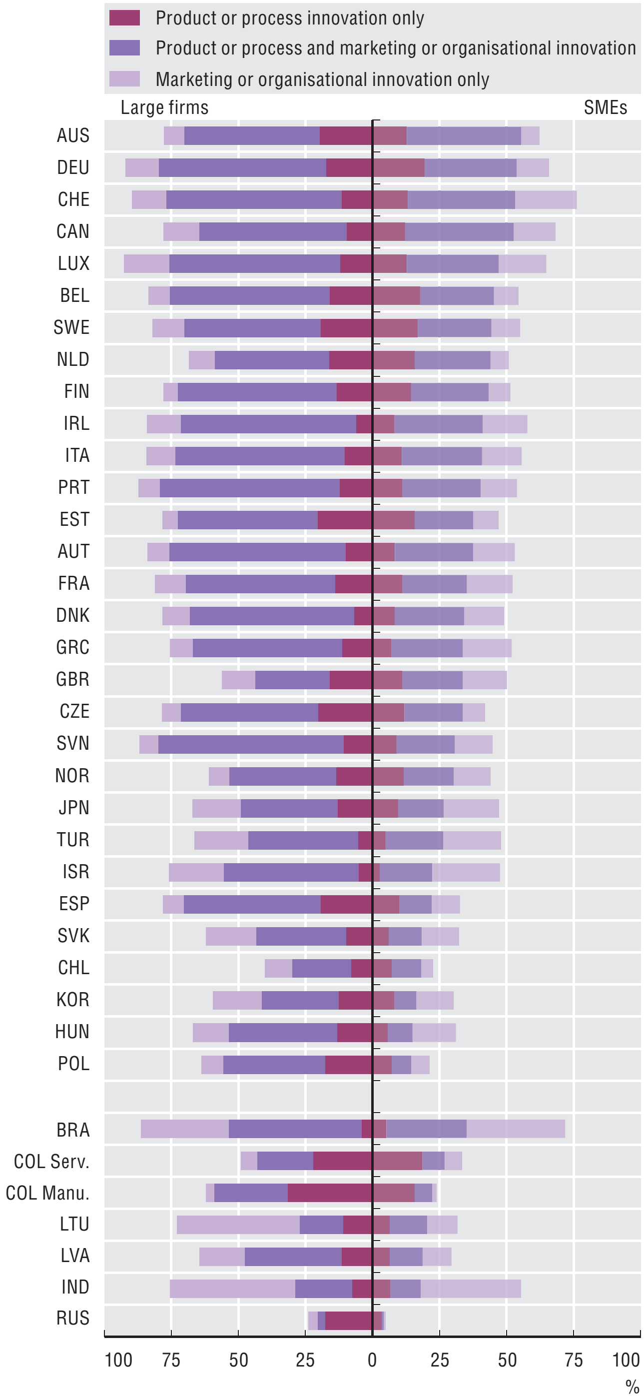
ICT-related patents are classified by 13 sub-fields following an experimental taxonomy, based on the International Patent Classification (see Squicciarini and Inaba, 2015).

Innovative enterprises are defined in the European Community Innovation Survey as firms that have introduced a new or significantly improved product or process over the reference period (including ongoing or abandoned innovations), or firms with new marketing or organisational methods. The main features of innovation surveys are described in dedicated sections within this chapter.

4. Mixed modes of innovation

Innovation types by firm size, 2010-12

As a percentage of all SMEs and large firms within the scope of national innovation surveys



Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey. See *www.oecd.org/sti/inno-stats.htm* for more details.

Source: OECD, based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888933274196*

Firm-level data reveal that firms adopt innovation strategies that combine different types ("mixed modes") of innovation: the most innovative firms, large firms and SMEs, introduce new marketing or organisational methods alongside product or process innovations. This suggests they are complementary within the innovation process. Innovation performance is fairly similar across countries for large firms, while differences between SMEs are more pronounced.

Germany, Luxembourg, Australia and Switzerland exhibit the highest average product/process innovation rates among SMEs. The data point to a large innovation gap between SMEs and large firms across all countries, which is particularly pronounced in countries such as Spain and Poland. Product or process innovation rates are generally lower in services than in manufacturing firms.

Definitions

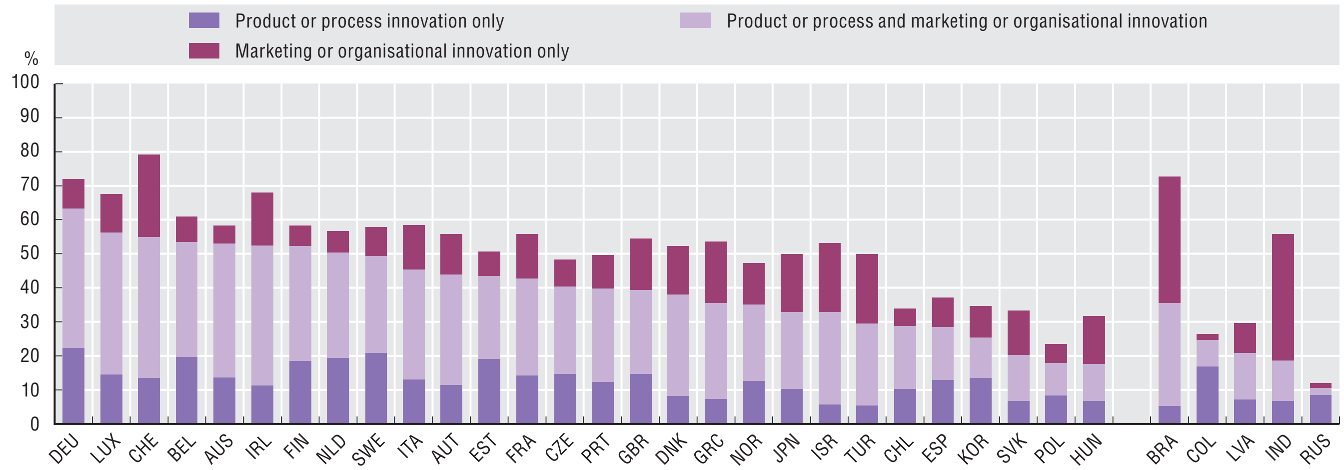
The 2005 edition of the *Oslo Manual*, currently undergoing revision by the OECD and Eurostat, identifies four types of innovation:

- *Product innovation:* the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.
- *Process innovation:* the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.
- *Marketing innovation:* the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
- *Organisational innovation:* the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

Innovation statistics reported in this publication are, unless otherwise specified, based on a common sectoral coverage, defined on the basis of the "core" list of industries included in the CIS-2008.

Innovation in the manufacturing sector, 2010-12

As a percentage of all manufacturing firms within the scope of national innovation surveys



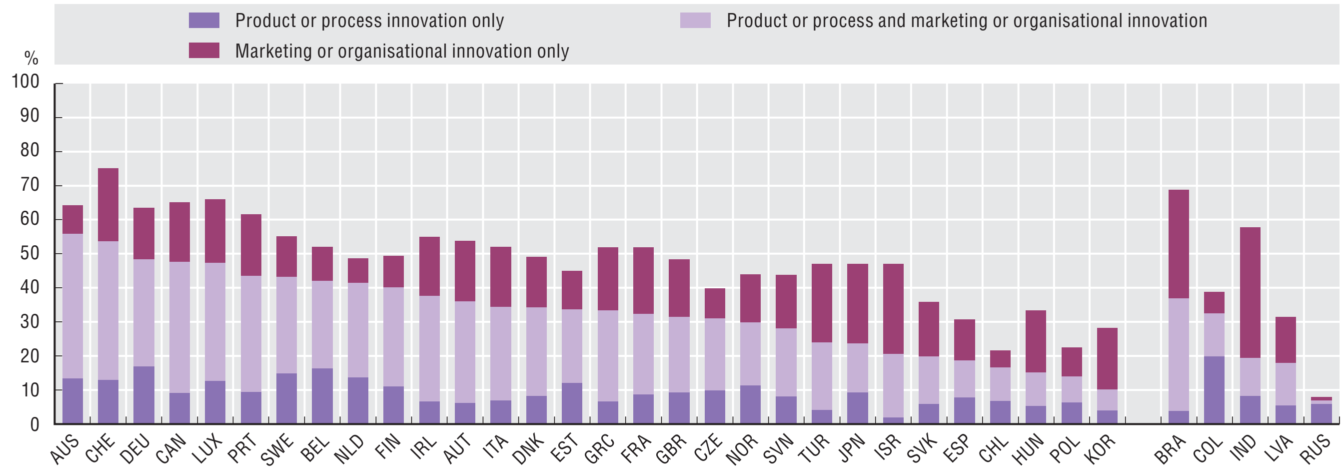
Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274202

Types of innovation in the services sector, 2010-12

As a percentage of all service firms within the scope of national innovation surveys



Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274211

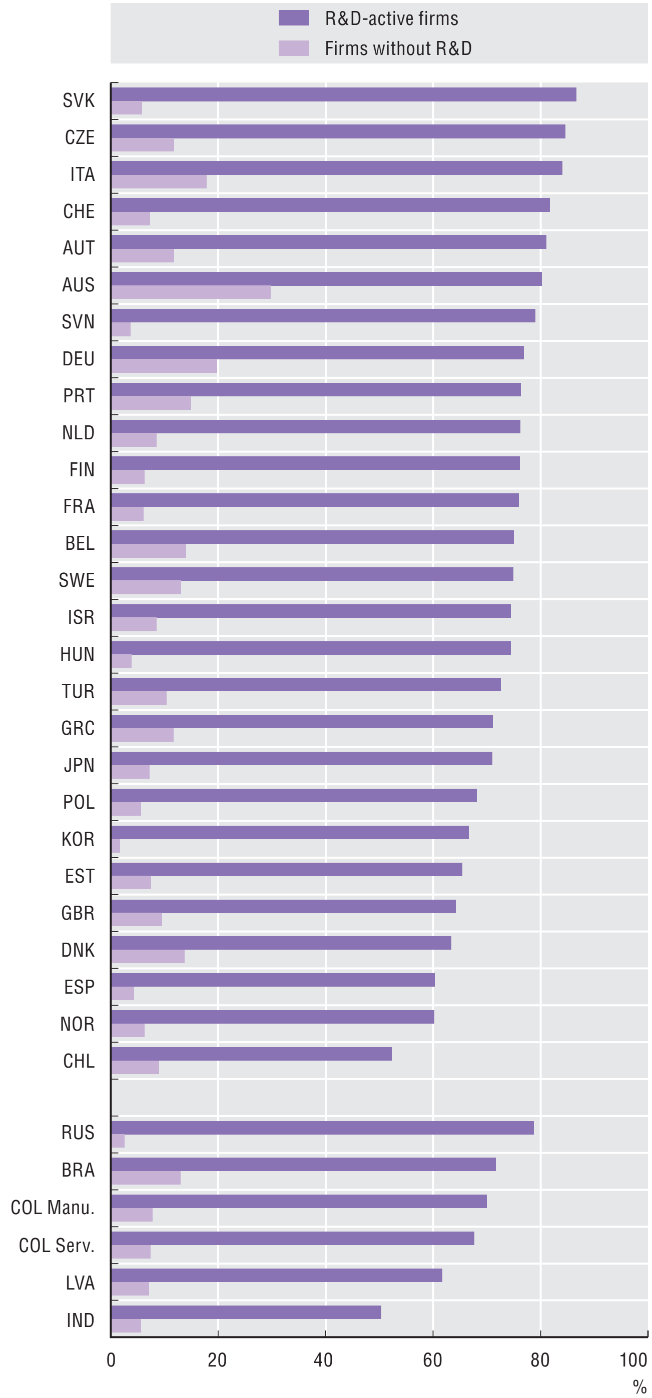
Measurability

A wide range of methodological features, including differences in the sectoral coverage of innovation surveys across countries, may impact on the comparability of innovation indicators. Although an effort has been made to align the data for non-European countries with the "core" coverage of the Community Innovation Survey (CIS), this was not always possible owing to survey and sample design. The treatment of on-going/abandoned innovation activities cannot be made fully uniform as some countries, especially EU-CIS countries, include these activities in their population of products and process innovators.

5. New-to-market innovation

Product innovation by R&D status, 2010-12

As a percentage of all R&D-active and non R&D-active firms within the scope of national innovation surveys



Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey. See *www.oecd.org/sti/inno-stats.htm* for more details.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274225

R&D is an activity often associated with a higher likelihood and degree of novelty of innovations. However, not all innovative companies perform R&D and not all companies that perform R&D necessarily introduce new products or process to the market.

Data show that firms performing R&D are more likely to introduce new or significantly improved products. Within Europe, non-R&D firms are most likely to introduce new products if based in Germany (although this is less than 20% of such firms). In Australia, the corresponding figure is close to 30%, which is significantly lower than the 80% product innovation rate for R&D firms. As a majority of firms in an economy are not R&D active, non-R&D firms are the main driver of observed average innovation rates. Countries greatly differ on the propensity of non-R&D firms to innovate, which makes enhancing such performance a potential target for policies.

Not all product innovations are equal. While in some cases firms introduce products already in existence in the market, identifying the subset of new-to-market product innovators can help distinguish the innovation performance of countries, providing a quality-adjusted measure of product innovation. Overall, new-to-market product innovations are more common for manufacturing than for services, with some exceptions. In Germany, new-to-market product innovation rates for manufacturing are almost twice as large as for services.

Differences in new-to-market product innovation rates are very marked between large firms and SMEs. For many countries, new-to-market innovation is practically inexistent among SMEs. This may reflect challenges to the scaling up of such firms, which affects their ability to transform or disrupt markets.

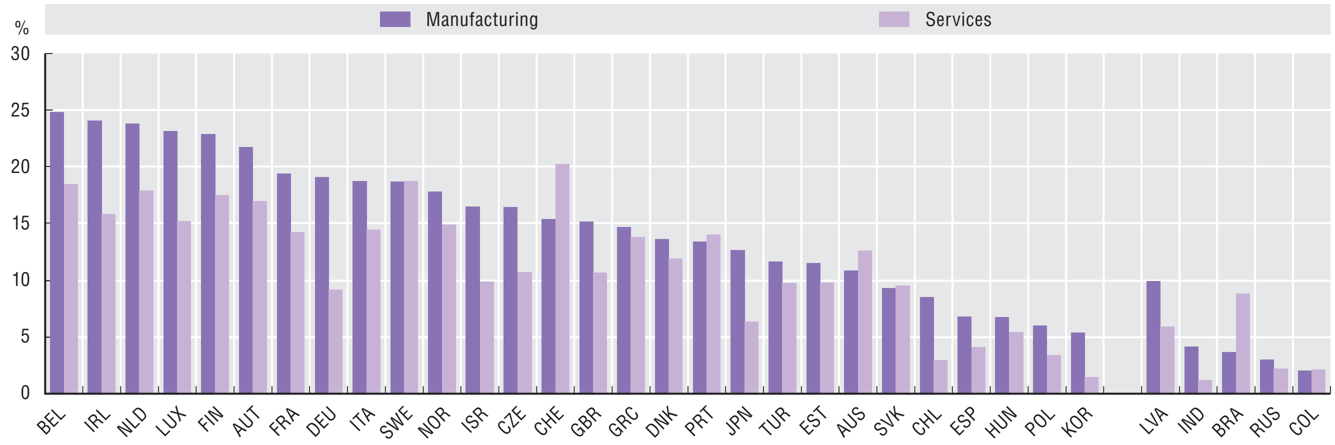
Definitions

Product innovations include both the introduction of new goods and services and significant improvements in the functional or user characteristics of existing goods and services. *R&D-active firms* are those engaged in intramural or extramural R&D activities.

New-to-market product innovation refers to the introduction of a new or significantly improved product onto the firm's market before any other competitors (the product may have already been available in other markets). The concept of market is generally not defined in innovation surveys and business perception of it may vary by industry and other business characteristics. For example, a firm operating in international markets may have a different perspective of novelty-to-the-market compared to other firms.

Firms introducing products new to the market, manufacturing and services, 2010-12

As a percentage of all firms in each sector within the scope of national innovation surveys



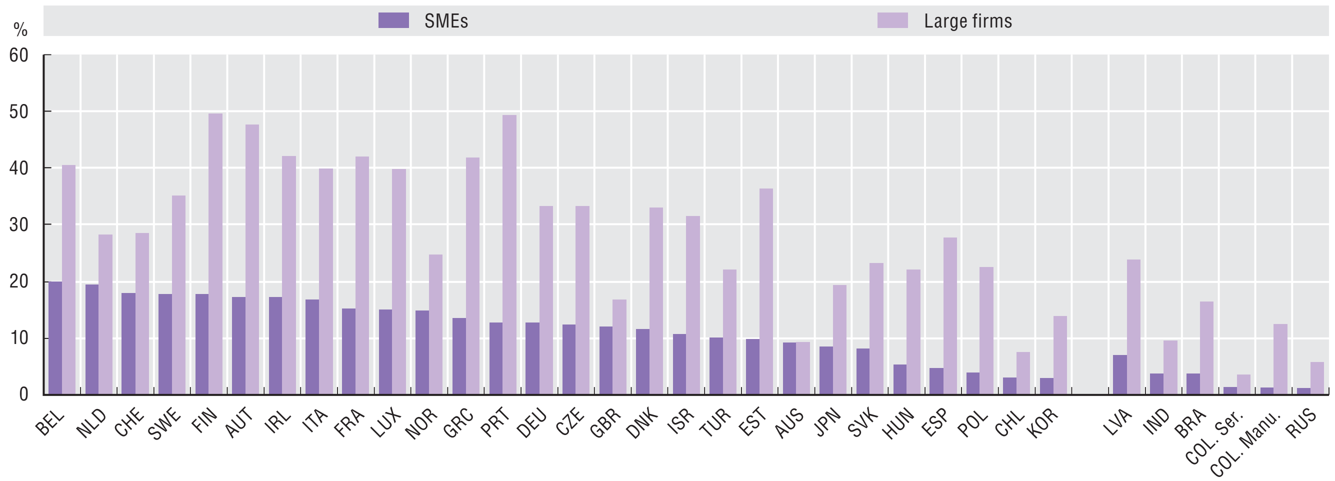
Note: International comparability may be limited due to differences in methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the CIS.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274231

Firms introducing products new to the market, by firm size, 2010-12

As a percentage of all firms in each size category



Note: International comparability may be limited due to differences methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the CIS.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274248

Measurability

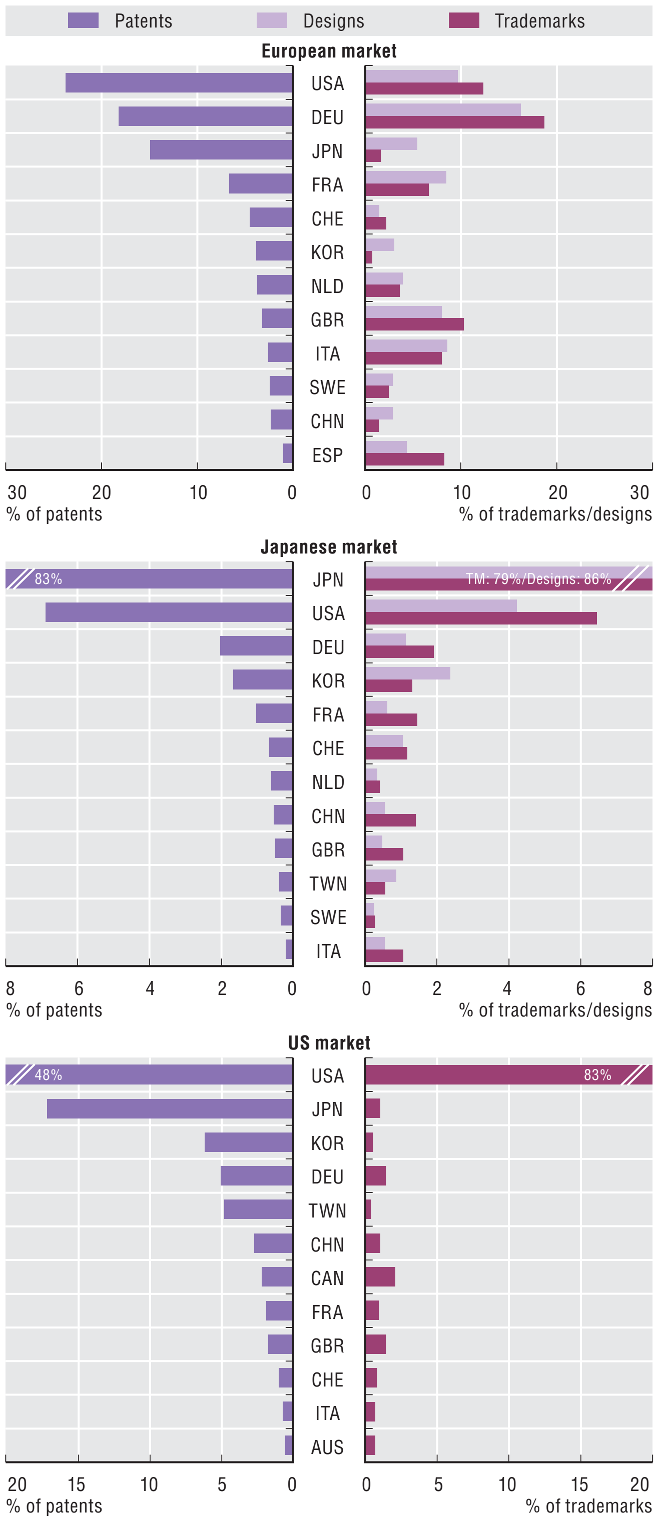
Because R&D and innovation are highly related phenomena, some countries collect information on innovation as part of business R&D surveys. While R&D surveys target R&D performers, innovation surveys have a much wider target population. Some non-CIS surveys cover less R&D-intensive industries more extensively. Ensuring that survey respondents accurately assess their innovation performance regardless of their use of R&D can be challenging. Combined innovation-R&D surveys appear to result in lower reported innovation rates.

No reliable counterpart novelty measure for process innovation has been widely adopted across countries. These comparability challenges are being reviewed as part of the ongoing OECD/Eurostat revision of the *Oslo Manual* (*www.oecd.org/sti/oslomanual*).

6. The IP bundle

IP bundle of top 12 applicants on the European, Japanese and US markets, 2011-13

As a percentage of all patents, trademarks and designs filed in the corresponding IP offices



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015; EPO and JPO annual reports, 2012-14. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888933274256*

Products that embody the latest technologies and have an appealing design and brand are very likely to meet with success on the market. For this reason, firms often rely on a combination of intellectual property (IP) tools, the "IP bundle", to better appropriate the results of their inventive and creative activities and differentiate their products from those of their competitors. Analysis of the composition of IP bundles can provide information about the extent to which companies diversify their branding, design and innovation strategies depending on the target market.

Patenting, trademarks and designs seemingly go hand in hand on the Japanese market, with companies displaying high inventive activities also relying to a greater extent on trademarks and designs. In Europe, companies from the United States, Japan, China and Korea rely heavily on patent protection, but less on trademarks and designs. Conversely, for companies located in the five biggest European economies product differentiation and marketing strategies seem to play a comparatively more important role. In the United States – where designs cannot be registered as such – patents are by far the most used IP tool and Canadian companies are the only ones relying on patents and trademarks to a similar extent. The co-existence of national and Europe-wide IP authorities; the fact that European countries, while being economically integrated, differ in a number of important respects, including culture and language; and the need to prove the use of a trademark to ensure its validity in the United States, may contribute to explain the patterns observed.

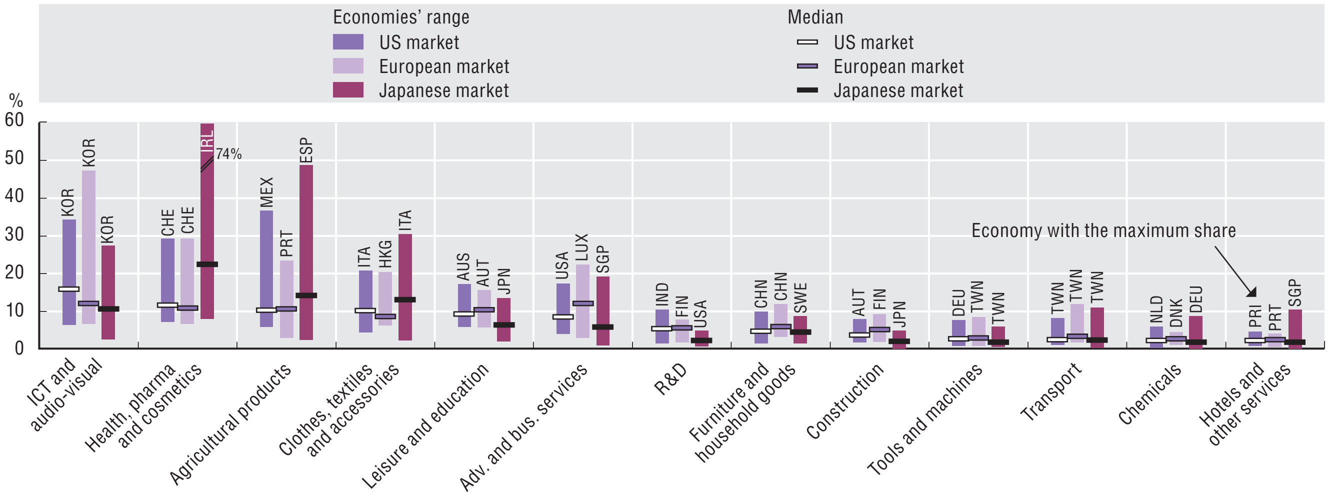
While the extent to which companies rely on different IP tools varies depending on the target market, the product fields in which they specialise are highly similar across markets. Korea's performance in relation to information and communication technologies is notable, both in terms of trademarks and designs, whereas specialisation among companies based in other countries is less straightforward and no global leaders emerge.

Definitions

Patents protect technological inventions, i.e. products or processes that provide new ways of doing something or new technical solutions to problems. *Trademarks* protect distinctive signs (i.e. words, symbols, images or a combination thereof) used to identify the goods or services of a firm from those of its competitors. They help customers to select products or services that meet their needs and expectations (e.g. in terms of quality or price) and are closely linked to the brand strategies of firms. *Industrial designs* protect new and/or original shapes, configurations or ornament aspects of products rather than their technical features. Industrial designs cannot be registered in all IP offices, notably in the United States.

Trademark specialisation in European, Japanese and US markets, 2012-14

Percentage share of each product field in economies' trademark applications



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

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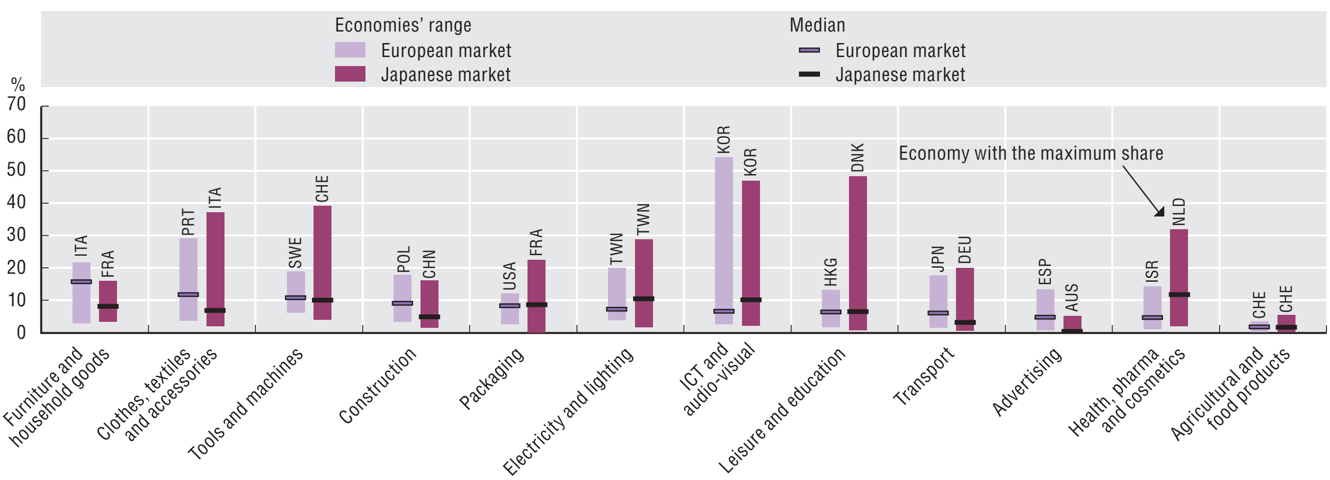
Design specialisation in European and Japanese markets, 2011-13

Percentage share of each product field in economies' design applications



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274271

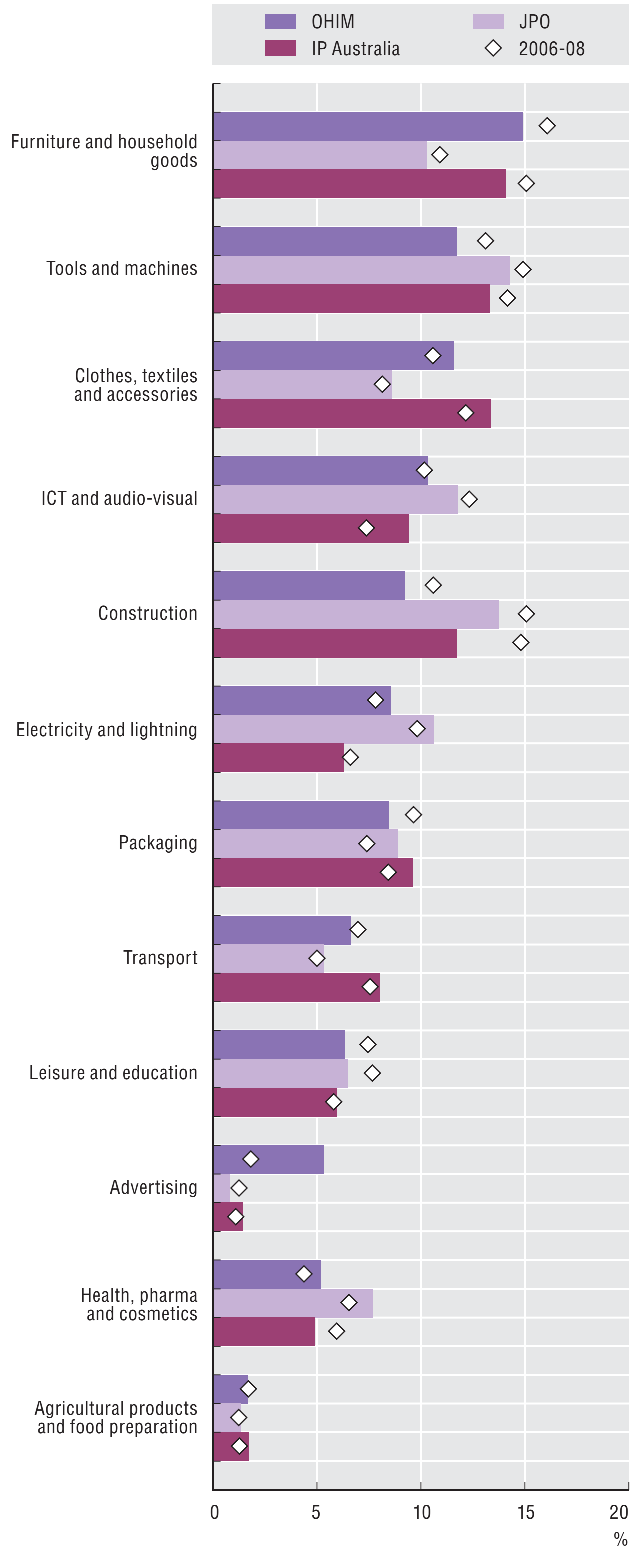
Measurability

According to the territoriality principle, IP rights are protected only in the countries where they are registered, e.g. at the Japan Patent Office (JPO) in the case of Japan and at the US Patent and Trademark Office (USPTO) in the case of the United States. In Europe, two options co-exist: IP users may file applications at the European Patent Office (EPO) and the Office for Harmonization in the Internal Market (OHIM) and seek Europe-wide protection, or protect their IP rights in each European country. Moreover, differences exist in the territorial coverage of EPO patents and OHIM trademarks and designs. EPO patents may be requested for one or more contracting states (38 since 2010), whereas OHIM trademarks and registered designs have a unitary European character whereby their geographic scope cannot be restricted. IP rights counts may be subject to home bias, as applicants tend to register in their home countries first. In Germany and Spain, the proximity and accessibility of the EPO (Munich) and the OHIM (Alicante) may affect the statistics. Differences in procedures and costs may also affect the extent to which IP systems are used and the type of users.

7. Registered designs

Design applications by application field, 2006-08 and 2011-13

As a percentage of total design applications in each office



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274288

Firms' competitiveness and success increasingly depend on their ability to innovate and create, to diversify their products from those of their competitors and to identify and exploit new opportunities in different markets. Design differentiates products in a unique manner that makes them visually appealing to consumers and is at the heart of creative industries. Industrial design protects the aesthetic aspects of products, not their functionalities, and is increasingly used in information and communication technologies (ICT) to protect the appearance of new smartphones and media players.

Design registration activities vary across fields and offices. The paths taken by applications at the European Office for Harmonization in the Internal Market (OHIM) and Australia's Intellectual Property office (IP AUS) are similar and differ from those at the Japan Patent Office (JPO). Between 2006-08 and 2011-13 registration of industrial designs grew by 18% in Europe and 10% in Australia, but decreased by 10% in Japan. Clothes, textiles and accessories were the only field to grow across all markets between the periods considered (by about 1% of total design applications), whereas construction experienced the greatest decrease in design activities (by up to 3 percentage points of total applications).

The strongest acceleration in registration activities during the period 2005-13 were related to ICT. A marked increase in registration of design activities was observed in screen displays and icons both at OHIM and at IP AUS. Registrations for office machinery, printer and photocopier-related designs accelerated at OHIM and JPO, whereas registrations for sound and picture recording and communication and wireless equipment increased at IP AUS.

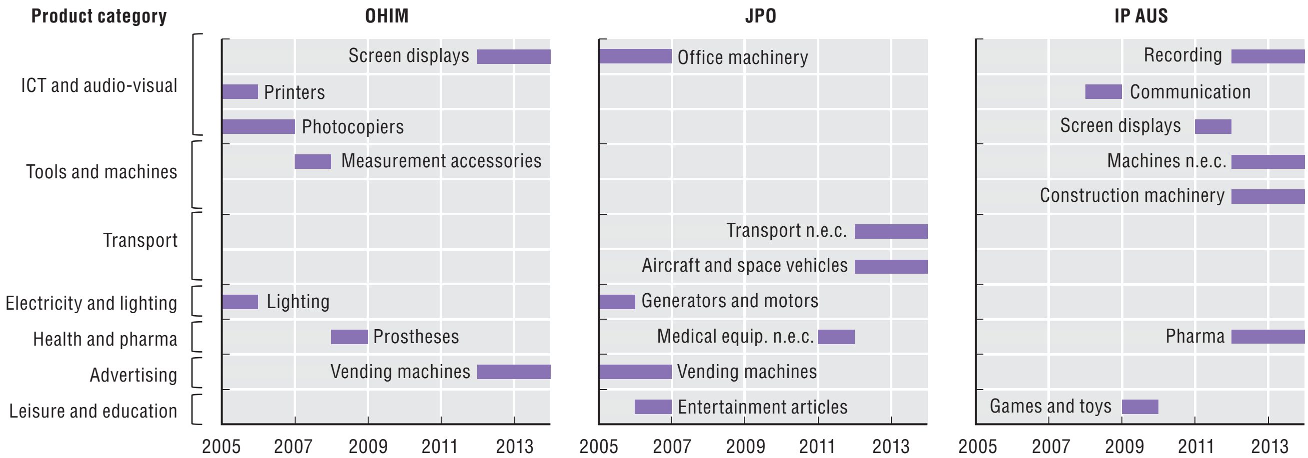
Korea, the United States, Japan and Germany emerged as top ICT applicants in all the markets considered, while China's ICT design applications were best observed in Europe and Japan. Canada exhibited contrasting patterns in Europe and Australia. In the latter market, Finland showed a marked decline in design activities.

Definitions

Industrial designs are intellectual property rights protecting the ornamental or aesthetic aspects of an article or its parts against copying or the independent development of similar designs. Design owners can use, licence or commercialise the design and can act against infringement. The maximum length of Industrial design protection differs across jurisdictions: in Japan it is 20 years since registration (subject to the payment of annuities); it runs up to 25 years at OHIM; and in Australia the maximum length is ten years. *Bursts* correspond to sudden and persistent increases in the number of registered designs and are detected following the methodology of Dernis, Squicciarini and de Pinho (2015).

Acceleration in the development of registered design fields, 2005-13

Selected Locarno subclasses bursts at OHIM, JPO and IP AUS

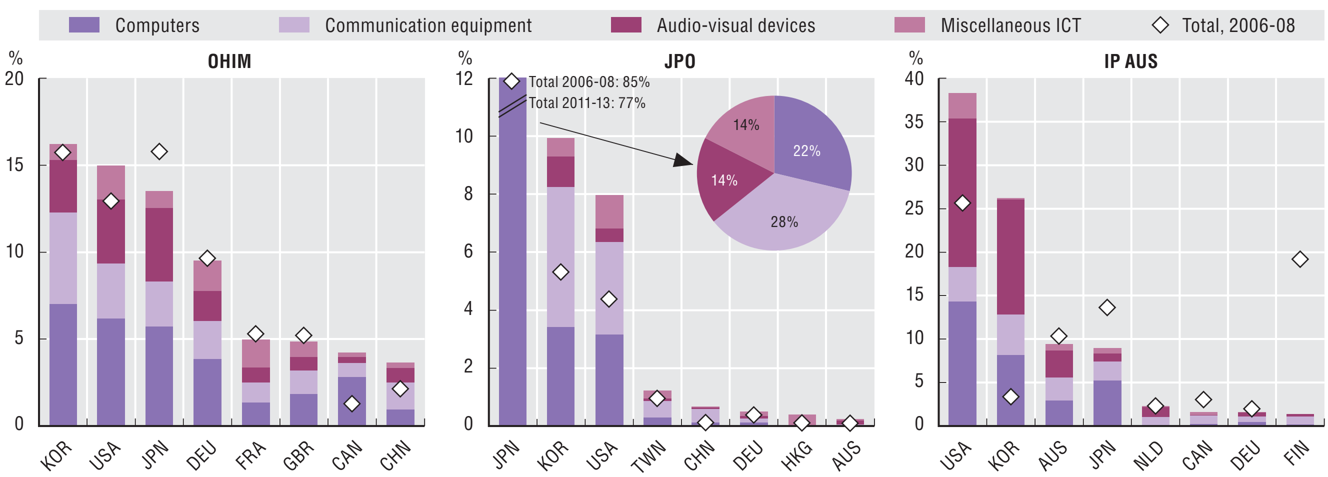


Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274298

Top applicants' share in ICT and audio-visual-related design applications, 2006-08 and 2011-13

Percentage share of top 8 applicants at OHIM, JPO and IP AUS



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274301

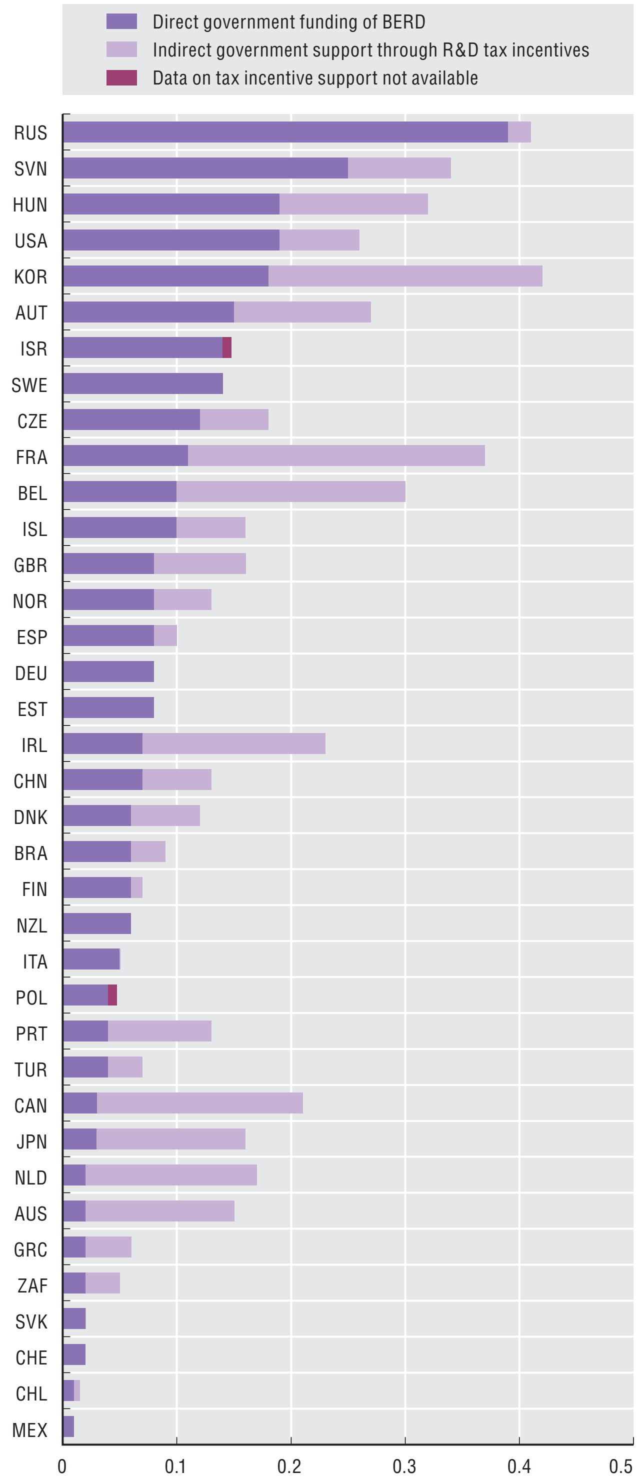
Measurability

Registered industrial design data can be used to proxy firms' creative activities. The data contain a variety of information including the identity of the design owner, the part of products they correspond to and the associated Locarno class. Differences in design systems, such as the maximal length of protection, the amount and structure of the fees, and whether several designs can be included in the same application, may affect the comparability of data across offices. Registered industrial design data may suffer from truncation because of possible delays in making administrative data public. Applicants have the right to keep designs confidential for up to 30 months at OHIM and up to three years at JPO. Industrial designs cannot be registered everywhere in the world (e.g. in the United States designs are protected through the concurrent use of patents, trademarks and copyrights). Industrial designs follow the Locarno Classification. Established in 1968, its tenth edition (in force since 2014) contains 32 classes and 219 subclasses of goods. Application fields are defined using an experimental taxonomy based on Locarno classes (see chapter notes).

8. R&D tax incentives

Direct government funding of business R&D and tax incentives for R&D, 2013

As a percentage of GDP



Source: OECD, R&D Tax Incentive Indicators, *www.oecd.org/sti/rd-tax-stats.htm* and *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274317

In addition to providing direct R&D support such as grants or contracts, many governments also incentivise firms' R&D through tax relief measures. In 2015, 28 OECD countries gave preferential tax treatment to business R&D expenditures. Korea, the Russian Federation and France provided the most combined support for business R&D as a percentage of GDP in 2013, while the United States, France and China provided the largest volumes of tax support.

A comparison of public support provided in 2013 and 2006 shows an increase in the relative importance of tax incentives among 16 out of 28 countries for which data are available. Canada and Portugal, starting from a high share of tax support, rebalanced their support mix by increasing their reliance on direct funding. Overall tax support increased across most countries, with the exception of Italy, which significantly reduced its level of support, and Mexico and New Zealand which abolished their schemes. Finland introduced a temporary scheme in 2013, and Sweden introduced tax incentives for the first time in 2014.

Differences in the cost of R&D tax relief reflect not only applicable credit or allowance rates but also eligibility rules and application decisions by firms. It is possible to calculate the notional level of tax support per additional unit of R&D to which firms with defined characteristics are in principle entitled. This level is largest for France, Portugal and Spain in the case of SMEs. Refunds and carry-forward provisions are sometimes used to promote R&D in firms that may not otherwise use their credits or allowances. Such provisions tend to be more generous for SMEs and young firms *vis-à-vis* large enterprises, as in Australia, Canada and France.

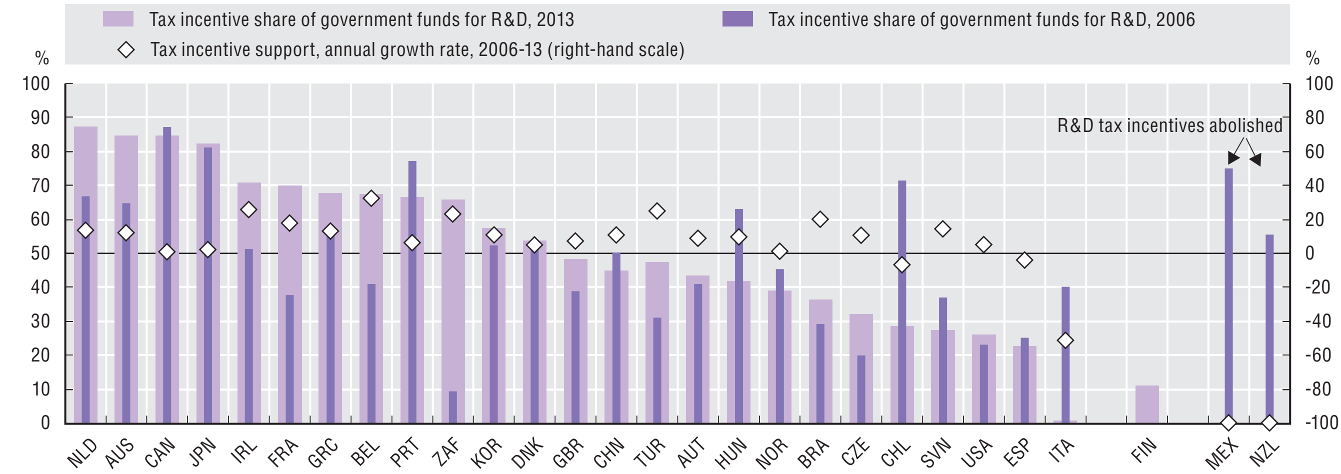
Definitions

Tax incentives for business R&D include allowances and credits, as well as other forms of advantageous tax treatment of business R&D expenditure. Estimates exclude income-based incentives (e.g. preferential treatment of incomes from licensing or asset disposal attributable to R&D or patents) and incentives to taxpayers other than firms. While typically non-discretionary and demand-driven, some countries require pre-approval of R&D projects or accreditation. Budget limits may apply at the country level.

The tax subsidy rate is calculated as 1 minus the B index, a measure of the "before-tax income needed to break even on an additional unit of R&D outlay" (Warda, 2001). This marginal measure of tax support may differ from the average tax subsidy rate if ceilings and thresholds apply and some firms are prevented from claiming extra support. Each measure can be relevant for R&D investment decisions: the average at the extensive (whether to invest in a country), the marginal one at the intensive margin (how much to invest within a country).

Change in government funding of business R&D through direct funding and tax incentives, 2006-13

As a percentage of total support, and annualised growth rates

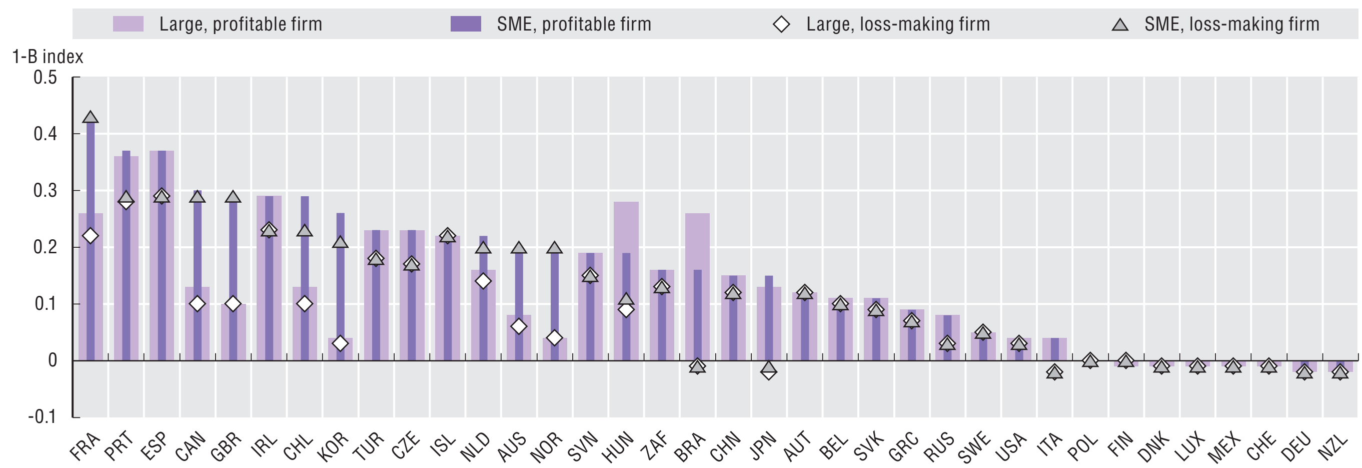


Source: OECD, R&D Tax Incentive Indicators, *www.oecd.org/sti/rd-tax-stats.htm* and *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274322

Tax subsidy rates on R&D expenditures, 2015

1-B index, by firm size and profit scenario



Note: This is an experimental indicator. International comparability may be limited.

Source: OECD, R&D Tax Incentive Indicators, *www.oecd.org/sti/rd-tax-stats.htm*, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274335

Measurability

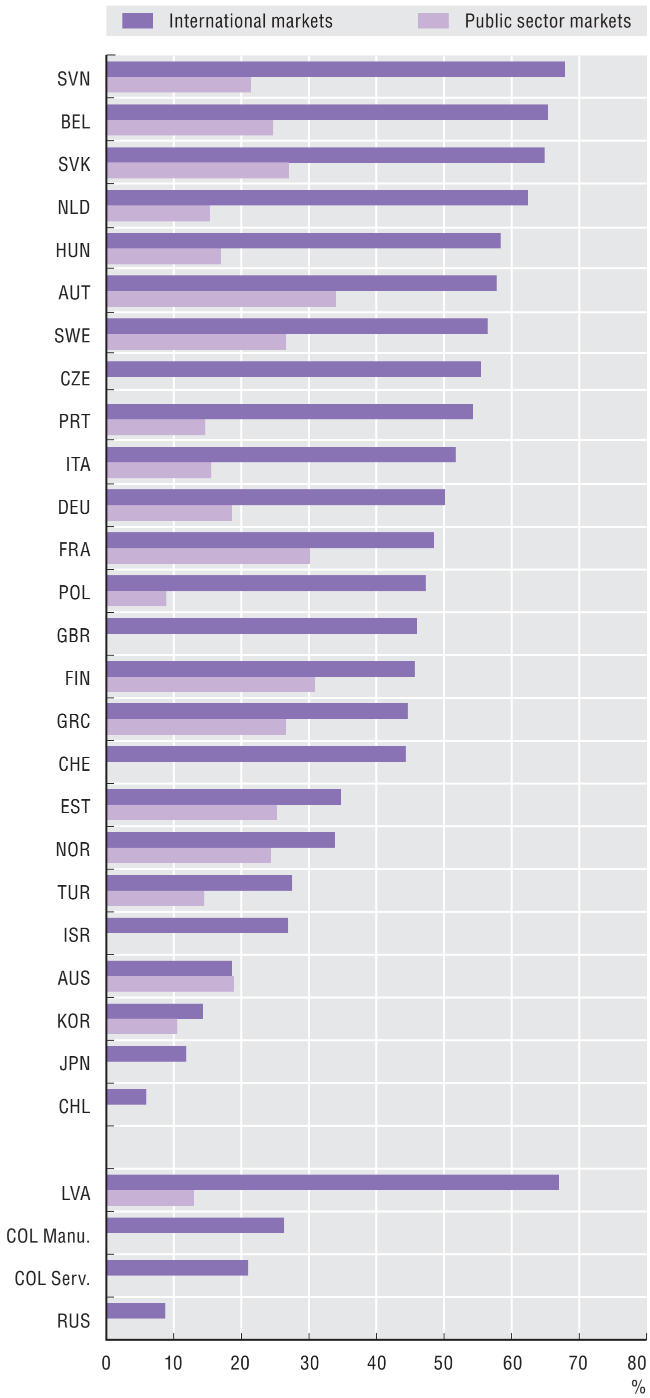
There are several ways to measure the value of R&D tax relief, as tax expenditures represent deviations from a benchmark tax system (OECD, 2010). These indicators adopt a common reference framework based on full deductibility of current R&D and a country's treatment of capital investments. Estimates are typically based on tax records and calculated in terms of initial revenue loss with no or minimal adjustments for behaviour effects. The latest edition of the *Frascati Manual* (OECD, 2015a) summarises the guidance on reporting data on tax relief for R&D.

To provide a more accurate representation of different scenarios, B-indices are calculated for "representative" firms according to whether they can claim tax benefits against their tax liability in the reporting period. When credits or allowances are fully refundable, the B-index of a firm in such a position is identical to the profit scenario. Carry-forwards are modelled as discounted options to claim incentives in the future. Adjustments for ceilings on claimable R&D or tax relief are modelled whenever possible (see chapter notes).

9. Demand and support for innovation

Enterprises operating in international and public sector markets, 2010-12

As a percentage of all firms within the scope of national innovation surveys



Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey. See *www.oecd.org/sti/inno-stats.htm* for more details.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274347

Business innovation depends on supply and demand factors. Innovation surveys increasingly collect more detailed information on the demand side, focusing on the types of markets on which firms operate. More recently, a number of countries have introduced experimental questions on whether businesses are engaged in public procurement contracts.

Data show considerable differences between countries with regard to the propensity to engage in international markets, with a number of small European economies, such as Slovenia, Latvia and Belgium, the most likely to sell abroad. Among countries for which data are available, Austria, Finland and France have the largest reported public procurement rates.

Participation in international and public procurement markets is more common among large firms than among SMEs, and, with remarkably few exceptions, is far more likely among innovative than non-innovative firms. This is even more clearly the case for SMEs.

In addition to providing a source of demand for new products and helping to demonstrate innovations to other customers, governments can support innovation in a number of ways that contribute to lower the cost and risk of innovation to firms. Questions included in innovation surveys provide evidence on the proportion of innovation-active firms that benefit from different types of support such as tax credits or deductions, grants, subsidised loans and loan guarantees. In Europe, large innovating firms are more likely to receive public support for innovation than their SME counterparts. In countries such as Brazil, Canada and the Netherlands, the proportion of innovation-active firms receiving public support for innovation has increased over the last few years as opposed to Italy and Turkey. In the case of Italy, there is a marked reduction in the absolute number of firms receiving public support for innovation.

Definitions

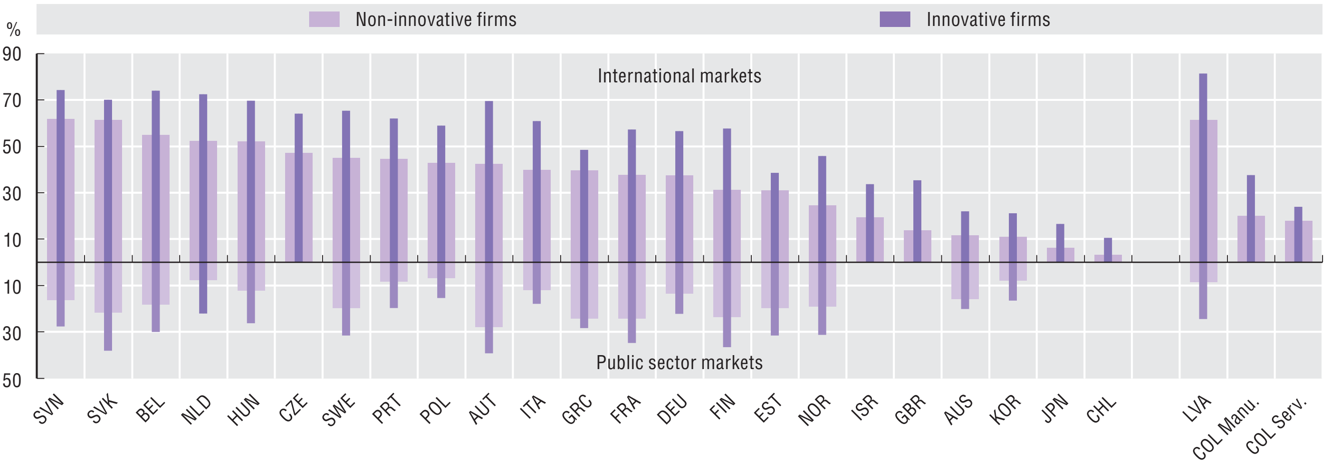
Participation in international markets is defined as firms selling goods or services abroad. *Public sector markets* refer to government owned organisations such as local, regional and national administrations and agencies, schools, hospitals and government service providers.

Public support for innovation includes financial support via tax credits or deductions, grants, subsidised loans, and loan guarantees. Countries use slightly different formulations of this question.

The classification of firms by size follows the recommendations of the *Oslo Manual*. In a majority of countries, this is calculated on the basis of the number of employees. SMEs are defined as firms with 10 to 250 employees, with some exceptions (see chapter notes).

SMEs participating in international and public sector markets, by innovation status, 2010-12

As a percentage of firms in the relevant group



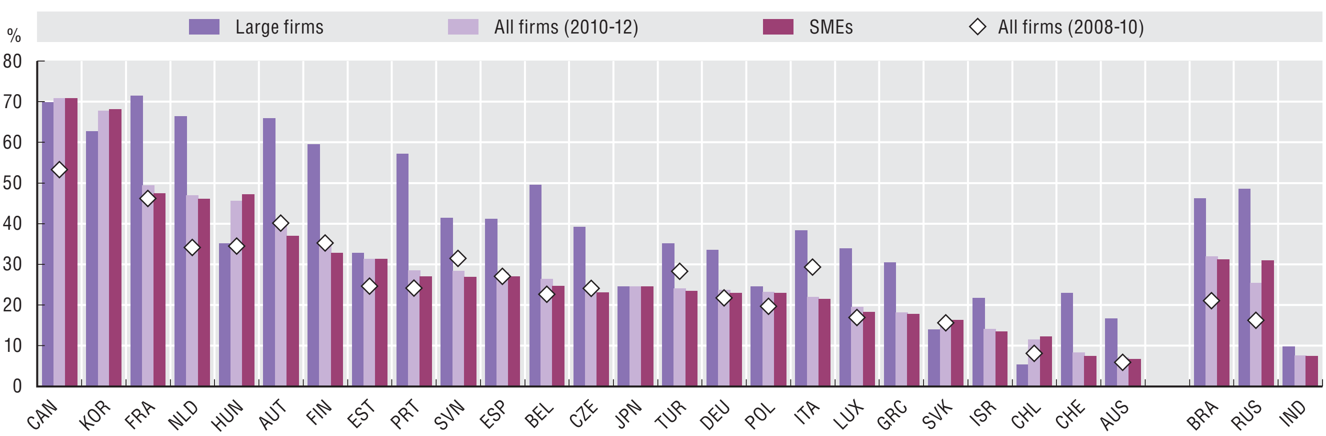
Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the CIS.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012) and national data sources, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274354

Firms receiving public support for innovation, by firm size, 2008-10 and 2010-12

As a percentage of product and/or process-innovating firms



Note: International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the CIS.

Source: OECD based on Eurostat, Community Innovation Survey (CIS-2012 and CIS-2010) and national data sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274364

Measurability

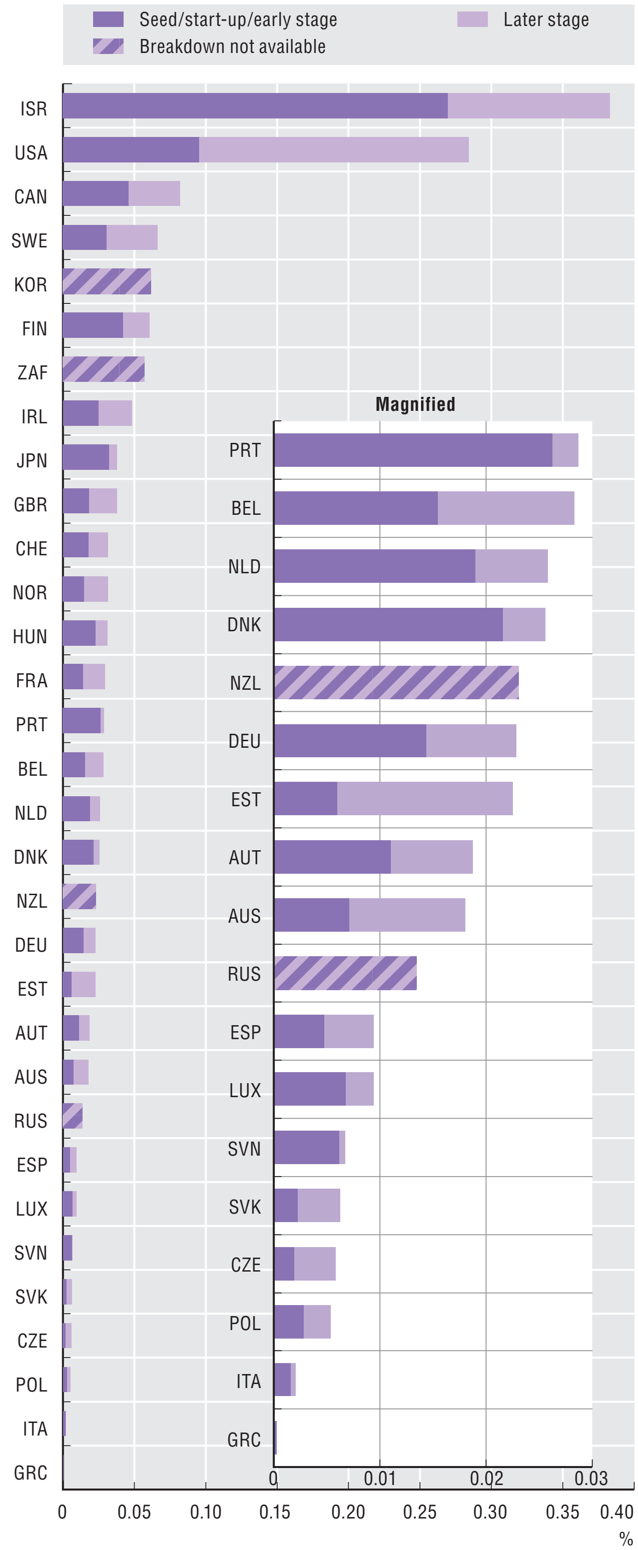
Data on the geographical dimension of markets served by firms have been present in innovation surveys for several years, while data on public sector markets are a more recent addition. The OECD has explored the link between public procurement and innovation (*www.oecd.org/science/inno/procurement-for-innovation.htm*), recommending the use of targeted questions and the use of innovation survey micro-data to investigate the relationship between demand and innovation.

Data on public support by firm size do not distinguish between SMEs that form part of a group and those that are independent. Countries differ in the application of SME independence tests with regard to the provision of public support for innovation, sometimes on more generous terms for SMEs.

10. Policy environment for innovation

Venture capital investment, 2014

As a percentage of GDP



Source: OECD (2015b), *Entrepreneurship at a Glance 2015*, OECD Publishing, Paris. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274374

The policy environment plays an important role in encouraging the creation of new firms and promoting healthy competition in the economy. Less red tape facilitates business creation while good insolvency regimes reduce the stigma of bankruptcy for firms and individuals, encouraging entrepreneurs to take risks and innovate. Young innovative firms are particularly crucial for economic growth and job creation especially during the post-crisis recovery period. However, they encounter obstacles when seeking financing as they generally lack collateral or a business track record. While not all start-ups require (or deserve) external capital, they often encounter difficulties in obtaining seed and early-stage financing because of uncertain profit expectations and riskier growth perspectives.

The crisis severely affected the venture capital industry with seed and start-up stage financing holding up better than later-stage financing. Today, pre-seed and seed stage investments represent a considerable portion of total venture capital in countries such as Denmark, Israel, Japan, Portugal and Slovenia.

A high-quality regulatory framework facilitates market entry and growth for businesses. During the last decade, barriers to entrepreneurship have been lowered in most OECD countries, especially in Poland and the Slovak Republic.

The decision to start a business is also affected by taxes and tax policy, in particular, general taxes (personal income, corporate and capital gain tax rates, and social security contributions) and targeted tax policies (tax incentives for start-ups, young firms, and small and medium-sized enterprises). OECD analysis (Johansson et al., 2008) finds that reducing top marginal personal income tax rates raises productivity in industries with potentially high rates of enterprise creation.

Definitions

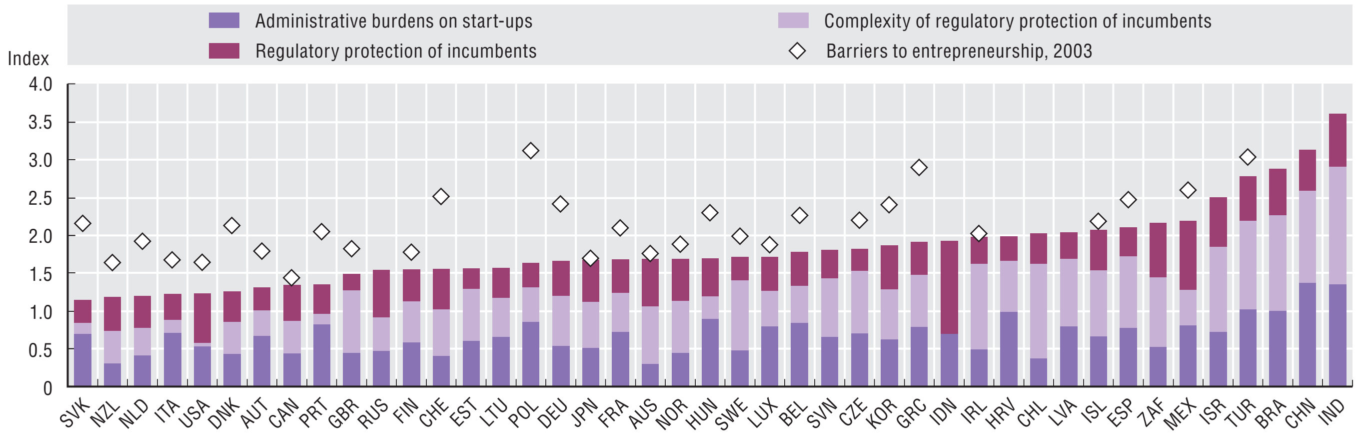
Venture capital is private capital provided by specialised firms acting as intermediaries between primary sources of finance (insurance, pension funds, banks, etc.) and private start-up and high-growth companies whose shares are not freely traded on any stock market.

The *barriers to entrepreneurship* indicator measures the regulations affecting entrepreneurship on a scale of 0 to 6, with lower values suggesting lower barriers. The index includes the administrative burden for creating new firms, the regulatory protection of incumbents (legal barriers, antitrust exemptions, barriers in network sectors), and the complexity of regulatory procedures (licences, permits, simplicity of procedures).

The *marginal tax rate* covers employees' and employers' social security contributions and personal income tax. The *corporate income tax rate* is the statutory tax rate applicable to incorporated businesses. It combines the central and sub-central (statutory) corporate income tax rate.

Barriers to entrepreneurship, 2013

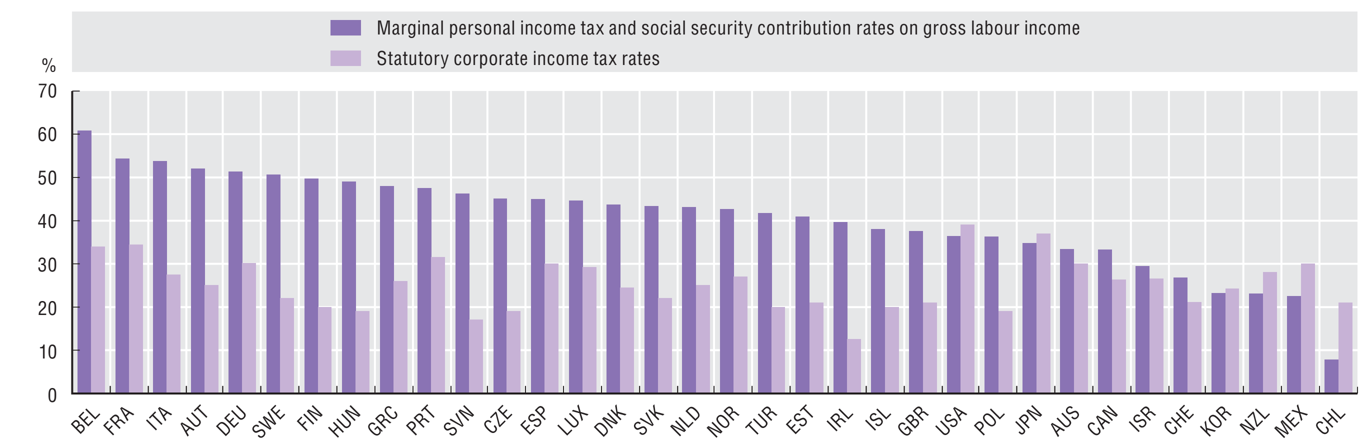
Scale of 0 to 6 from least to most restrictive



Source: OECD, *Product Market Regulation Database*, *www.oecd.org/economy/pmr*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274385

Taxation on corporate income and personal income, 2014



Source: OECD (2015c), *Taxing Wages 2013-2014*, OECD Publishing, Paris. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274393

Measurability

Data on venture capital are drawn from national or regional venture capital associations and commercial data providers. There is not a standard international definition of venture capital or the breakdown by stage of development. The OECD *Entrepreneurship Financing Database* aggregates original data to fit the OECD classification of venture capital by stages.

The OECD's *Product Market Regulations (PMR) Database* contains quantitative indicators derived from qualitative information on regulations that can affect competition. The information is collected from national administrations. Higher-level (composite) indicators, such as the barrier to entrepreneurship indicator, are calculated as weighted averages of lower-level indicators using equal weights for aggregation. The database is updated every five years starting from 1998.

Factors affecting individuals' decision to start a business include personal income taxes and the difference between the treatment of self-employment income and wage income. Corporate taxes determine after-tax returns on investment and therefore drive firms' investment decisions. Personal income tax rates on gross wage income are calculated in the OECD Taxing Wages framework.

Notes and references

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 recognises 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 of the European Union Member States of the OECD and the European Union:

"The Republic of Cyprus is recognised 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."

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

4.1. Business R&D

R&D expenditure by performing sectors, 2013

For Australia, data refer to 2004 and 2011.

For Austria, data refer to 2004 and 2013.

For Ireland and South Africa, data refer to 2012.

For Mexico, data refer to 2011.

For Switzerland, data refer to 2004 and 2012.

For China, Ireland and Turkey, no estimates are available for the PNP sector.

For Germany, Luxembourg, the Netherlands and Norway, the PNP sector is reported as included in the government sector.

For Hungary, a small part of R&D expenditure (1.3%) is not allocated by performing sector.

For Israel, defence R&D is partly excluded from available estimates.

For New Zealand, the PNP sector is reported as included in the business sector.

Business R&D and government support for business R&D, by size, 2013

For a number of countries, methodological improvements were adopted over the period 2003-13, which may hinder data comparisons over time.

For Australia, Belgium, France, Italy, Germany, Greece, Sweden and the United States, data refer to 2003 and 2011.

For Austria, data refer to 2002 and 2011.

For Chile and New Zealand, data refer to 2007 and 2013.

For Denmark, data refer to 2003 and 2009.

For Estonia, data refer to 2005 and 2013.

For Japan, firms with less than JPY 10 million in capital are excluded from the scope of R&D surveys. This leads to overstating the share of R&D accounted for large firms.

For Luxembourg, data refer to 2005 and 2009.

For Portugal and the United Kingdom, data refer to 2003 and 2012.

For Switzerland, data refer to 2004 and 2012.

For the United States, figures reported refer to current expenditures, but include a depreciation component which may differ from the actual level of capital expenditure.

R&D specialisation, top three performing industries, 2013

Figures are based on estimates of business R&D by sector reported on a main activity basis, in ISIC Rev. 4.

ISIC Rev. 4 divisions are as follows: Agriculture, mining, utilities and construction: 01-03, 05-09, 35-39 and 41-43; Chemicals and minerals: 19-23; Community, social and personal services: 84-99; Electrical equipment and machinery nec: 27-28; Finance and other business services: 64-66 and 69-82 excluding 72; ICT equipment: 26; Information and communication services: 58-63; R&D services: 72; Transport equipment: 29-30 and Wholesale, retail and transport services: 45-47, 49-53, 55-56.

For Australia, Denmark, France, Germany, Hungary, Israel, Italy, Portugal, the Slovak Republic, Switzerland, the United Kingdom and the United States, data refer to 2012.

For Austria, Belgium, Greece, Iceland and Mexico, data refer to 2011.

4.2. Top R&D players

General note for all figures:

Industries are defined according to ISIC Rev. 4.

Additional notes:

R&D investment per patent of top corporate R&D companies, 2010-12

Data relate to industries featuring at least 20 companies' headquarters in the top 2000 corporate R&D sample having filed for patents in 2010-12. R&D expenditures are presented in EUR million at constant prices, using the inflation rate of the euro area. Patent data refer to IP5 patent families by first filing date owned by the top R&D companies.

Industrial and technological specialisation and affiliates' location of top R&D companies, 2010-12

Industry specialisation (concentration ratio – CR4) reflects the share of the top 4 industries of companies' affiliates in the total number of affiliates of top R&D companies performing in a given industry.

Technology specialisation (concentration ratio – CR4) reflects the share of companies' patent portfolio filed in the top 4 technology fields in which they patent in the total number of patents filed by top R&D companies performing in a given industry. Data refer to IP5 patent families by first filing date owned by the top R&D companies. Patents are allocated to technology fields on the basis of their International Patent Classification (IPC) codes, following the concordance provided by WIPO (2013).

Data relate to industries featuring at least 25 companies' headquarters in the top 2000 corporate R&D sample.

Net sales per trademark of top corporate R&D companies, 2010-12

Data refer to new trademark applications filed at the USPTO and the OHIM, by filing date and main industry of the applicant's corporate group using fractional counts. Industries are ranked according to USPTO median figures. Data relate to industries featuring at least 20 companies' headquarters in the top 2000 corporate R&D sample having filed for trademark applications in 2010, 2011 or 2012 and sales information in 2010, 2011 and 2012 in the top 2000 corporate R&D sample. Net sales figures are presented in EUR million at constant prices, using the inflation rate of the euro area.

4.3. ICT and innovation

R&D expenditure in information industries, 2013

The "information industries" aggregate comprises ISIC Rev. 4 Divisions 26 and 58-63. The terms "ICT equipment", "Publishing, audio-visual and broadcasting activities", "Telecommunications" and "IT and other information services" refer to ISIC Rev. 4 Divisions 26, 58-60, 61 and 62-63 respectively.

For Australia, Austria, Belgium, Greece, Ireland and Mexico, data refer to 2011.

For Denmark, France, Germany, Hungary, Iceland, Israel, Italy, Portugal, Switzerland, the United Kingdom and the United States, data refer to 2012.

R&D ratios are normalised using official GDP figures. These are compiled according to the *System of National Accounts* (SNA) 2008 except for Japan and Turkey, where figures are available on the basis of SNA 1993.

Patents in ICT-related technologies and major players, 2010-13

Data refer to IP5 patent families with members filed at the EPO or at the USPTO, by first filing date, the applicant's residence using fractional counts. Patents in ICT are identified following a new experimental classification based on their International Patent Classification (IPC) codes. Data from 2012 are estimates.

Innovative enterprises in ICT manufacturing and IT services, 2010-12

International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns.

Data refer to product, process, marketing or organisational-innovating firms (including ongoing or abandoned innovation activities) with ten or more persons employed.

ICT manufacturing refers to ISIC Rev. 4 Division 26 (Manufacture of computer, electronic and optical products). 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, J, K, M71-72-73.

4.4. Mixed modes of innovation

General notes for all figures:

Section 1:

International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey. Please see *www.oecd.org/sti/inno-stats.htm* for more details.

For countries following the Eurostat CIS 2012 the Industry core coverage includes ISIC Rev. 4 Sections and Divisions B, C, D, E, G46, H, J, K, M71-72 and 73. Only enterprises with 10 or more employees are covered.

For Australia, data come from the Business Characteristics Survey (BCS) and refer to financial year 2012/13. The sectoral and size coverage of enterprises matches the CIS scope.

For Brazil, data come from the Brazil Innovation Survey 2011 (PINTEC) and refer to 2009-11. The industries surveyed differ from the CIS core coverage. ISIC Rev. 4 Section E, is not included and only selected services are covered (Divisions and Groups: 592, 61, 62, 631, 71 and 72).

For Canada, data come from the Survey of Innovation and Business Strategy (SIBS) 2012 and refer to 2010-12. The survey covered firms with 20 or more employees and with at least CAD 250 000 annual revenue in 2009. The industries covered are NAICS (2007) 31-33, 41, 48, 49, 51, 52 and 54.

For Chile, data come from the Chilean Innovation Survey 2013 and refer to 2011-12. The survey covers firms with more than UF 2 400 in annual revenue, no cut-off by size is applied. Sectoral coverage is larger for the industrial sector and besides CIS core activities includes: ISIC Rev. 3 Sections A, Agriculture, hunting and forestry; B, Fishing and F, Construction. The services covered are ISIC Rev. 3 (G, I, J and K).

For Colombia, data come from the Survey of Development and Technological Innovation in the Manufacturing Sector 2011-12 and from the Survey of Development and Technological Innovation in the Service Sector 2012-13. Data refer to 2011-12 for manufacturing and to 2012-13 for services. The size of the enterprise surveyed varies according to the sector. For ISIC Rev. 4: Sections D and E, data are collected for firms with 20 employees or more. For Division 46, data are collected for firms with 20 employees or more. For Section H, Division 49 is not available, Division 51 and 53 are collected respectively for firms with 20 and 40 employees or more. For Section J, Division 63 is not entirely available (only 631 is surveyed) and data for Divisions 59, 60 and 61 are collected for firms with 40 employees or more, while data for Divisions 62 and 631 are for firms with 75 employees or more. For Section K, only Groups 6411 and 6412 are available on a census basis. Divisions 71 and 73 are not surveyed. Division 72 is collected on a census basis.

For India, data come from the Indian National Innovation Survey and refer to 2010-11. The sample is drawn from the Indian Annual Survey of Industries 2009-10 database. Sectoral coverage is broader than that of CIS and also includes: ISIC Rev. 4 Sections A, F and all service activities except for Sections T and U.

For Israel, data come from the Israel Innovation Survey, 2010-12. The sectoral and size coverage of enterprises matches the CIS scope.

For Japan, data come from the Japanese National Innovation Survey (J-NIS 2012). Data refer to the financial years 2009/10, 2010/11 and 2011/12. The sectoral and size coverage of enterprises matches the CIS scope.

For Korea, data come from the Korean Innovation Survey. The survey is carried out separately for manufacturing and services, but both sets of data refer to 2011-13. The phrasing of the question on product innovation is slightly different from the guidelines given in the *Oslo Manual*. As a result the introduction of new services by manufacturing firms or of new goods by service firms might be under reported. Sectoral coverage is smaller than CIS for the industrial sector and includes ISIC Rev. 4 Section C, Manufacturing only. All services are covered except for Section (O) Public administration and defence; compulsory social security.

For the Russian Federation, data refer to 2011-13 and firms with 15 or more employees. The industries surveyed differ from the CIS core coverage. ISIC Rev. 3.1 Sections C, Mining and quarrying; D, Manufacturing; E, Electricity, gas and water supply and Divisions 64, 72, 73 and 74 for services, are covered.

For Switzerland, data come from the Survey of Innovation Activities in the Swiss Economy, 2013 and refer to 2010-12. The sectoral and size coverage of enterprises matches the CIS scope.

Section 2:

For countries following the Eurostat CIS 2012, Australia, Japan and Korea the data include ongoing or abandoned innovative activities. For the remaining countries ongoing or abandoned innovative activities are not included.

4.5. New-to-market innovation

General notes for all figures:

See under 4.4 (Section 1).

4.6. The IP bundle

IP bundle of top 12 applicants on the European, Japanese and US markets, 2011-13

Data are presented by filing date and residence of the applicant. Data for the European market (the Japanese market) refer to the 12 economies with the highest number of patent applications at the EPO (the JPO) and trademark and design applications at OHIM (the JPO). Data for the US market refer to the 12 economies with the highest number of patent and trademark applications at USPTO.

Economies are ordered according to the percentage of patents in the market considered.

Trademark specialisation in European, Japanese and US markets, 2012-14

Data refer to trademark applications at USPTO, OHIM and JPO by filing date and applicant's residence using fractional counts.

The following aggregated fields based on the Nice Classification are used: Chemicals: Classes 1, 2 and 4; Construction: Classes 6, 17, 19, 27 and 37; Tools and machines: Classes 7 and 8; Agricultural products: Classes 29, 30, 31, 32, 33 and 34; Furniture and household goods: Classes 11, 20 and 21; Leisure and education: Classes 13, 15, 16, 28 and 41; Health, pharma and cosmetics: Classes 3, 5, 10 and 44; Transport: Classes 12 and 39; R&D: Class 42; Clothes, textiles and accessories: Classes 14, 18, 22, 23, 24, 25 and 26; Advertising and business services: Classes 35, 36 and 45; ICT and audio-visual: Classes 9 and 38 and Hotels, restaurants and other services: Classes 40 and 43.

Data for OHIM refer to economies with at least 2 000 trademark applications over the period, at least 1 000 applications for USPTO and at least 200 applications for JPO. Fields are ordered by the median share at USPTO.

Design specialisation in European and Japanese markets, 2011-13

Data refer to design applications at OHIM and JPO by filing date and applicant's residence using fractional counts.

The following aggregated fields based on the Locarno Classification are used: Furniture and household goods: Classes 6, 7 and 30; Clothes, textiles and accessories: Classes 2, 3, 5 and 11; Tools and machines: Classes 4, 8, 10 and 15; Health, pharma and cosmetics: Classes 24 and 28; Leisure and education: Classes 17, 19, 21 and 22; Agricultural and food products: Classes 1, 27 and 31; Construction: Classes 23, 25 and 29; ICT and audio-visual: Classes 14, 16 and 18; Electricity and lighting: Classes 13 and 26; Advertising: Classes 20 and 32; Transport: Class 12 and Packaging: Class 9.

Data for OHIM refer to economies with at least 300 design applications over the period, data for JPO refer to economies with at least 100 design applications over the period. Fields are ordered by the median share at OHIM.

4.7. Registered designs

Design applications by application field, 2006-08 and 2011-13

Figures are calculated using the application date and fractional counts of the Locarno classes mentioned in the design registrations.

The following aggregated fields based on the Locarno Classification are used: Furniture and household goods: Classes 6, 7 and 30; Clothes, textiles and accessories: Classes 2, 3, 5 and 11; Tools and machines: Classes 4, 8, 10 and 15; Health, pharma and cosmetics: Classes 24 and 28; Leisure and education: Classes 17, 19, 21 and 22; Agricultural products and food preparation: Classes 1, 27 and 31; Construction: Classes 23, 25 and 29; ICT and audio-visual: Classes 14, 16 and 18; Electricity and lightning: Classes 13 and 26; Advertising: Classes 20 and 32; Transport: Class 12 and Packaging: Class 9.

Class 32 (Graphic symbols and logos, surface patterns, ornamentation) has been included in the Locarno Classification since the ninth edition, which entered into force in January 2009.

Acceleration in the development of registered design fields, 2005-13

Data relate to design applications filed at each of the three offices. Design counts are based on the application date and fractional counts of the Locarno subclasses (4-digit level). Design "bursts" correspond to periods characterised by a sudden and persistent increase in the number of designs registered in a specific subclass. Top design bursts are identified by comparing the filing patterns of all Locarno subclasses, excluding Class 32 (which was introduced in the Locarno classification in 2009). Only Locarno subclasses corresponding to at least 20 applications in 2005-13 and featuring a positive burst intensity in the 2000s are included in the analysis.

The labels included in the graphs summarise the content of the following Locarno subclasses: Screen displays: 14-04; Printers: 18-02; Photocopiers: 16-03; Measurement accessories: 10-07; Lighting: 26-02; Prostheses: 24-03; Vending machines: 20-01; Office machinery n.e.c.: 18-99; Transport n.e.c.: 12-99; Aircraft and space vehicles: 12-07; Generators and motors: 13-01; Medical equipment n.e.c.: 24-99; Entertainment articles: 21-03; Recording: 14-01; Communication: 14-03; Machines n.e.c.: 15-99; Construction machinery: 15-04; Pharma: 28-01 and Games and toys: 21-01. Full descriptions of the Locarno subclasses are available at: *www.wipo.int/classifications/nivilo/locarno/index.htm*.

Top applicants' share in ICT and audio-visual-related design applications, 2006-08 and 2011-13

Figures are calculated using the application date and fractional counts of the applicants and the Locarno classes mentioned in the design registrations.

Computers correspond to designs in Locarno Subclasses 14-02, 14-04, 16-03, 18-01 and 18-02; Communication equipment correspond to designs in Subclass 14-03; Audio-visual devices correspond to designs in Subclasses 14-01, 16-01 and 16-02 and Miscellaneous ICT components and goods correspond to designs in Subclasses 14-99 and 16-06.

4.8. R&D tax incentives

General note for all figures:

Country specific notes are available at *www.oecd.org/sti/rd-tax-stats.htm*.

Direct government funding of business R&D and tax incentives for R&D, 2013

For Canada, Chile, France, Norway, Portugal, South Africa, Spain and the United Kingdom, preliminary R&D tax incentive estimates are reported for 2013 (or closest year). Figures are rounded to the second decimal unless rounding would result in a value of zero.

For Belgium, Brazil, Ireland, Israel, South Africa, Spain, Switzerland and the United States, figures refer to 2012. For Australia, Iceland, Mexico and the Russian Federation, figures refer to 2011.

Estimates of direct funding for Belgium, Brazil, France, Italy and Portugal are based on imputing the share of direct government-funded BERD in the previous year to the current ratio of BERD to GDP. For Austria, the 2011 share is used for 2013.

In Austria and South Africa, R&D tax incentive support is included in official estimates of direct government funding of business R&D. It is removed from direct funding estimates to avoid double counting. In the case of South Africa, where the overlap of estimates cannot be identified based on available budget data, this transformation was not undertaken.

Estonia, Germany, Luxembourg, Mexico, New Zealand, Sweden and Switzerland did not provide information on expenditure-based R&D tax incentives for 2013. For Israel the R&D component of incentives cannot be identified separately at present. No data on the cost of expenditure-based R&D tax incentive support are available for Poland.

Estimates do not cover sub-national and income-based R&D tax incentives and are limited to the business sector (excluding tax incentive support to individuals). Data refer to estimated initial revenue loss (foregone revenues) unless otherwise specified.

Estimates refer to the cost of incentives for business expenditures on R&D, both intramural and extramural unless otherwise specified. Direct support figures refer only to intramural R&D expenditures, except for Brazil.

Change in government funding of business R&D through direct funding and tax incentives, 2006-13

For Canada, Chile, France, Norway, Portugal, South Africa, Spain and the United Kingdom, preliminary R&D tax incentive estimates are reported for 2013 (or closest year).

For Belgium, Brazil, Ireland, South Africa, Spain and the United States, figures refer to 2012 instead of 2013. For Australia and Mexico, figures refer to 2011. For Belgium, Brazil, France, Italy and Portugal, estimates of direct funding in 2013 (or closest year) are based on imputing the share of direct government-funded BERD in the previous year to the current ratio of BERD to GDP. For Austria, the 2011 share is used for 2013.

For Belgium, Denmark, Italy, Korea, Mexico and Slovenia, figures refer to 2007 instead of 2006. For Chile, New Zealand, and Turkey, figures refer to 2008 instead of 2006. For New Zealand, the figure for direct government support for BERD is estimated as an average of 2007 and 2009 values. For Brazil, Greece and the Netherlands, estimates of direct funding in 2006 (or closest year) are based on imputing the share of direct government-funded BERD in the previous year to the current ratio of BERD to GDP.

Mexico and New Zealand repealed tax incentive schemes in 2009. In 2008, the cost of R&D tax support amounted to MXN 4 500 million in Mexico and to NZD 103 million in New Zealand.

In Austria and South Africa, R&D tax incentive support is included in official estimates of direct government funding of business R&D. It is removed from direct funding estimates to avoid double counting. In the case of South Africa, where the overlap of estimates cannot be identified based on available budget data, this transformation was not undertaken.

Estonia, Germany, Luxembourg, Mexico, New Zealand, Sweden and Switzerland did not provide expenditure-based R&D tax incentives for 2013. For Israel the R&D component of incentives cannot be identified separately at present. No data on the cost of expenditure-based R&D tax incentive support are available for Poland.

Estimates do not cover sub-national and income-based R&D tax incentives and are limited to the business sector (excluding tax incentive support to individuals). Data refer to estimated initial revenue loss (foregone revenues) unless otherwise specified.

Estimates refer to the cost of incentives for business R&D expenditures, both intramural and extramural, unless otherwise specified. Direct support figures refer only to intramural R&D expenditures, except for Brazil.

Tax subsidy rates on R&D expenditures, 2015

This is an experimental indicator based on quantitative and qualitative information representing a notional level of tax subsidy rate under different scenarios. It requires a number of assumptions and calculations specific to each country. International comparability may be limited.

The tax subsidy rate is calculated as 1 minus the B-index, a measure of the before-tax income needed to break even on USD 1 of R&D outlays (Warda, 2001). It is based on responses from national finance/tax/innovation authorities and R&D statistical agencies to the OECD questionnaire on R&D tax incentives and also draws on other publicly available information. As a measure of the marginal cost of R&D to users, the B-index is estimated based on marginal tax credit (allowance) rates. Whenever caps and thresholds applied to eligible R&D expenditure or the amount of R&D tax relief, an attempt was made to compute weighted marginal tax credit (allowance) rates for SMEs and large firms, using available data or proxy measures for the distribution of eligible R&D spending. Weighted marginal tax credit rates reflect the magnitude of marginal tax credit rates applicable to an extra unit of R&D spend across the firm population (e.g. SMEs or large enterprises). They are likely to differ from average tax subsidy rates as companies may surpass established R&D expenditure or R&D tax relief thresholds (cap).

Estimates allow for differences in the treatment of the various components of R&D expenditures: current (labour, other current) and capital (machinery and equipment, facilities/buildings) expenditures. A common 60:30:5:5 percentage distribution of labour, other current, machinery and equipment, and building expenditures is applied based on average estimates for OECD countries (*www.oecd.org/sti/rds*).

Benchmark tax data information, including statutory corporate income tax rates (non-targeted and small business corporate income tax rates), is obtained from the *OECD Tax Database*, May 2015, and public sources for non-OECD countries. The model accounts for targeted, SME-specific corporate income tax rates in Australia, Brazil, Canada, Hungary, Japan, Korea and the Netherlands.

Expenditures on capital assets used for R&D are depreciated over their useful life, using a straight-line or declining balance depreciation method, as applicable. Estimates of the net present value of provisions relating to R&D capital expenditures draw on information about the benchmark tax treatment of capital expenditures, as collected through the OECD-NESTI questionnaire on R&D tax incentives, and the OECD Centre for Tax Policy and Administration questionnaire on the tax treatment of the creation, acquisition and use of knowledge capital. Estimates of tax subsidy rates are fairly robust to different choices of sources and methodologies because of the small weight of this component in eligible R&D expenditures.

R&D tax allowances are deducted from taxable income while R&D tax credits are applied against corporate income tax payable (as is the case for payroll withholding tax incentives and wage taxes). R&D tax benefits are taxable in Australia, Canada, Chile, the United Kingdom (Above-the-line tax credit for large enterprises) and the United States. Exemptions of payroll withholding tax and social security contributions are effectively taxable as they reduce the amount of expenditure deductible from taxable income.

The model excludes incentives related to personal income, value added, property taxes, as well as taxes on wealth and capital and other forms of direct government support (grants and subsidies). Some countries remove in part or in full R&D expenditures funded through grants. These differences have not been modelled in the calculations.

Unless otherwise specified, figures refer to "representative" firms in their class for which caps or ceilings that limit the amount of eligible expenditures or tax support are not applicable. Ceilings on the amount of eligible R&D expenditure or R&D tax relief exist in Australia, Canada, Chile, Denmark, France, Hungary, Iceland, Italy, Japan, Korea, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States. A minimum R&D expenditure threshold determines eligibility for R&D tax relief in Australia, Spain and Italy. The rate of R&D tax relief varies below and above a certain level of qualified R&D expenditure (two level incentives) in Canada, France, the Netherlands (WBSO), and Hungary and the Russian Federation (exemption of social security contributions).

The B-index for the profit scenario assumes that the "representative firm" generates a sufficiently large profit to achieve the incentive's full potential benefit. An adjusted B-index is reported for a loss-making firm that is unable to claim tax benefits in the reporting period, using an adjusted effective tax rate that takes into account refundability and carry-forward provisions.

Refunds are generally modelled as immediate and full payment of tax incentive claims unless excess claims are payable over time and require discounting.

Carry-forwards are modelled as discounted options to claim the incentive in the future, assuming a constant annual probability of returning to profit of 50% and a nominal discount rate of 10%.

For simplicity, loss-making firms are assumed to enjoy an infinite carry-forward of standard deductions of current R&D expenditures and depreciation expenses arising from the use of machinery, equipment and buildings in R&D, unless expenditures are refundable.

The definitions of SMEs and large firms vary across countries and may also vary over time. In France, Italy, the Netherlands, Portugal and Spain, special tax incentive provisions are available for young innovative firms, start-ups and innovative SMEs as a subgroup of the SME population. The figure displays tax subsidy rates for large firms and SMEs. SME subgroup-specific B-indices are reported in the country-specific notes.

Estimates are not included for some countries that provide expenditure-based R&D tax incentives as these lack sufficient detail to carry out calculations for representative firms in the relevant categories.

Figures for Finland, Germany, Luxembourg, Mexico and Switzerland, which apply no special treatment to R&D, reflect the value (or lack thereof) of available allowances for current and capital expenditures.

4.9. Demand and support for innovation

General notes for all figures:

See under 4.4 (Section 1).

Additional notes:

Firms receiving public support for innovation, by firm size, 2008-10 and 2010-12

For countries following the Eurostat CIS 2012, Australia, Brazil, Japan and the Russian Federation, the data on public support for innovation include product or process innovative firms (including ongoing or abandoned innovation activities).

For Israel the data on public support for innovation include product or process innovative firms, while ongoing or abandoned innovation activities are not identified.

For Canada and Chile data on public support for innovation include organisational and marketing innovative firms in addition to firms with product or process innovation, while ongoing or abandoned innovative activities are not identified. Korea includes the four types of innovative firms and also their ongoing or abandoned innovation activities.

4.10. Policy environment for innovation

Venture capital investment, 2014

Data for Japan and South Africa refer to 2013.

The early stage includes: for Australia, pre-seed, seed and start-up stage; for Canada and the United States, seed and early stage; for European countries, seed and start-up stage; for Israel, seed/start-up stage and early/expansion stage; for Japan, seed, early stage and expansion stage.

The later stage includes: for Australia, early expansion stage; for the United States, expansion and later stage.

Korea, New Zealand, the Russian Federation and South Africa do not provide breakdowns of venture capital by stage that would allow for meaningful international comparisons.

Data providers are: EVCA (European countries), ABS (Australia), CVCA (Canada), KVCA (Korea), NVCA (the United States), NZVCA (New Zealand), PwCMoneyTree (Israel), RVCA (the Russian Federation), SAVCA (South Africa) and VEC (Japan).

Barriers to entrepreneurship, 2013

For China, data are based on preliminary estimates, as some of the underlying data has not been validated with national authorities. Subsequent data validation may lead to revisions to the indicators for this country.

For Indonesia, data refer to 2009.

For the United States, data refer to 2007.

Taxation on corporate income and personal income, 2014

General notes for the figure:

The marginal tax rate covers employees' and employers' social security contributions and personal income tax, with respect to a change in gross labour costs. It is given for a single person without dependent, at 167% of the average wage earner/ average production worker. It assumes a rise in gross earnings of the principal earner in the household. The outcome may differ if the wage of the spouse goes up, especially if partners are taxed individually.

The marginal rates are expressed as a percentage of gross labour costs.

Corporate income tax shows the basic combined central and sub-central (statutory) corporate income tax rate given by the adjusted central government rate plus the sub-central rate.

Additional notes for the statutory corporate income tax (CIT) rates:

For Australia, New Zealand and the United Kingdom, which have a non-calendar tax year, the rates shown are those in effect as of 1 July, 1 April and 5 April, respectively.

In Belgium, the effective CIT rate can be substantially reduced by a notional allowance for corporate equity (ACE).

In Chile, the Tax Reform Law enacted in September 2014 modified the Business Profits Tax from 20% to 21% in 2014.

In Estonia, since 1 January 2000, the corporate income tax is levied on distributed profits.

For France, the standard corporate income tax rate is 33.33%. It is increased by a 3.3% surcharge (Contribution Sociale sur les Bénéfices) for companies with a turnover of at least EUR 7 630 000 on the part of their liable tax payments in excess of EUR 763 000 – resulting in an effective tax rate of 34.43% for companies that have profits above EUR 2 289 000. It does not include the local business tax (Contribution économique territoriale, which replaced the former Taxe professionnelle from 1 January 2010) or the 10.7% temporary surtax, which applies to the standard corporate income tax liability for large companies with a turnover exceeding EUR 250 million. The CIT rate does not include the 3% additional contribution on distributed profits.

For Germany, the rates include the regional trade tax (Gewerbesteuer) and the surcharge.

For Greece, the 26% tax rate applies to Corporations and to Legal entities which maintain double entry books. For those entities that maintain single entry accounting books, a tax rate of 26% is applicable for income up to EUR 50 000 and 33% for any exceeding amount.

For Hungary, the rates do not include the turnover-based local business tax, the innovation tax, bank levy and surtax on the energy sector.

In Iceland, in late 2011, the Icelandic Parliament passed Act No. 165/2011 on a new financial activities tax (FAT) as part of a general set of measures aimed at increasing tax revenues. The FAT, collected from financial institutions and insurance companies (excluding pension funds), has two components: i) a levy on total remuneration paid to employees at a rate of 6.75% and ii) a special income tax of 6% on institutions' corporate income tax base in excess of ISK 1 billion.

In Israel, under the VAT law, financial institutions pay taxes on the combination of their wages and salaries and their profits. These amounts are deductible from profits in the assessment of corporate income tax.

In Japan, the combined corporate income tax rate was reduced to 34.6% in 1 April 2014.

For Italy, these rates do not include the regional business tax: Imposta Regionale sulle Attività Produttive (IRAP). The effective CIT rate can be substantially reduced by a notional allowance for corporate equity (ACE).

In Luxembourg, the contribution to the unemployment fund is 7%.

In the Netherlands, the CIT applies to taxable income over EUR 200 000.

In Poland, there is no sub-central government tax; however local authorities (at each level) participate in a given percentage of tax revenue.

Portugal implemented a state surtax in 2011. In 2012, the surtax was set at 3% for taxable profits above EUR 1.5 million, 5% for taxable profits above EUR 7.5 million and 7% for taxable profits above EUR 35 million.

In the Slovak Republic, as of 2014, there is a minimum tax license at three levels: EUR 480 for small corporations, not registered to VAT; EUR 960 for small corporations, registered to VAT and EUR 1 280 for large companies (turnover over EUR 500 000). These minimum amounts have to be paid if the tax calculated on the actual taxable income is lower. The minimum tax is paid as the ordinary CIT (i.e. when the tax return is filed). The difference between the minimum tax and the tax calculated based on taxable income may be carried forward and deducted from tax liability for up to three years. Companies in the first year of existence and non-profit organisations are exempt.

For Switzerland, church taxes, which enterprises cannot avoid, are included.

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EURO 5
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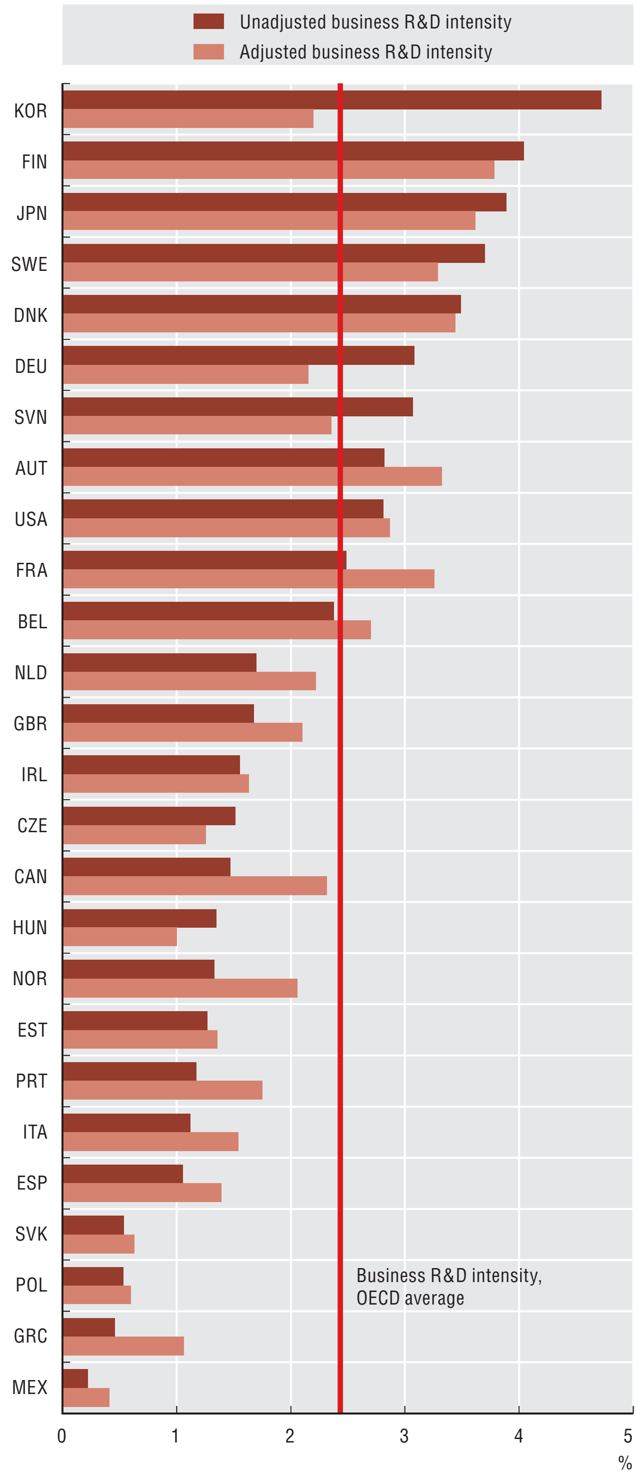
5. COMPETING IN THE GLOBAL ECONOMY

Today's knowledge economies are increasingly service-oriented. The degree of R&D specialisation of economies matters and the sophisticated use of ICT technologies in firms' business processes is of increasing importance. Strong start-up dynamics are essential for an economy to compete successfully in the global landscape. At the heart of innovation and competitiveness is creativity, a concept hard to measure. Novel use of design data features shows how indicators can capture certain aspects of design creativity. Indexes of technological advantage are used to compare countries' technological strengths. Competing in the global economy entails participating in global value chains, and the extent to which economies are successful in integrating and specialising along these chains depends on a number of structural factors. Employment patterns in key industries, the size and characteristics of firms such as foreign ownership, the linkages between manufacturing and services, the dynamism of start-ups and patterns of final demand, all help to explain countries' participation in global value chains. Novel indicators building on the OECD Trade in Value Added (TiVA) Database shed new light on economies' participation in global trade and value chains and the implications of this participation for jobs and consumers everywhere. The greater sectoral detail of the new TiVA data enables the analysis of economies' relative strengths in specific industrial global value chains.

1. R&D specialisation

Business R&D intensity adjusted for industrial structure, 2013

As a percentage of value added in industry



Source: OECD calculations based on the *ANBERD Database*, *www.oecd.org/sti/anberd*, *Annual National Accounts Database*, *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, and *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

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Efforts to compare countries' business R&D intensity (business R&D expenditure relative to value added) need to consider the impact of differences in industrial structure, as R&D intensity varies considerably across sectors. It is possible to ascertain the extent to which structural differences account for observed differences in business R&D intensity by calculating the value of a country's business R&D intensity by assuming its industrial structure equals the OECD average.

If countries have an average OECD industrial structure and all other things are equal (i.e. the same R&D intensities within sectors) adjusted business R&D intensity for Germany and Korea would be below the OECD average of 2.5%. These economies are relatively specialised in R&D intensive industries. In Belgium and France, business R&D intensity would shift above the OECD average, while in Canada, the Netherlands and Norway there would be significant convergence. In most countries in Southern and Eastern Europe, industry structures closer to the OECD average would not significantly change their overall R&D intensity. In the case of the United States there is no major difference as its own industrial structure closely resembles that of the OECD, given its large weight.

For most countries, R&D-intensive industries account for the largest share of business enterprise expenditure on R&D (BERD) in manufacturing. China, Germany, Japan and Korea have the highest shares of BERD in manufacturing.

In most OECD countries, services account for one third or more of BERD. This share has increased over the last decade, boosted in part by the role of information and communication service industries. Cross-country comparisons of the sectoral distribution of BERD should nonetheless be made with care, owing to differences in how countries allocate R&D to various industries and whether they classify a sizable share of BERD under R&D services. Firms in this group may account for up to half of all R&D in services.

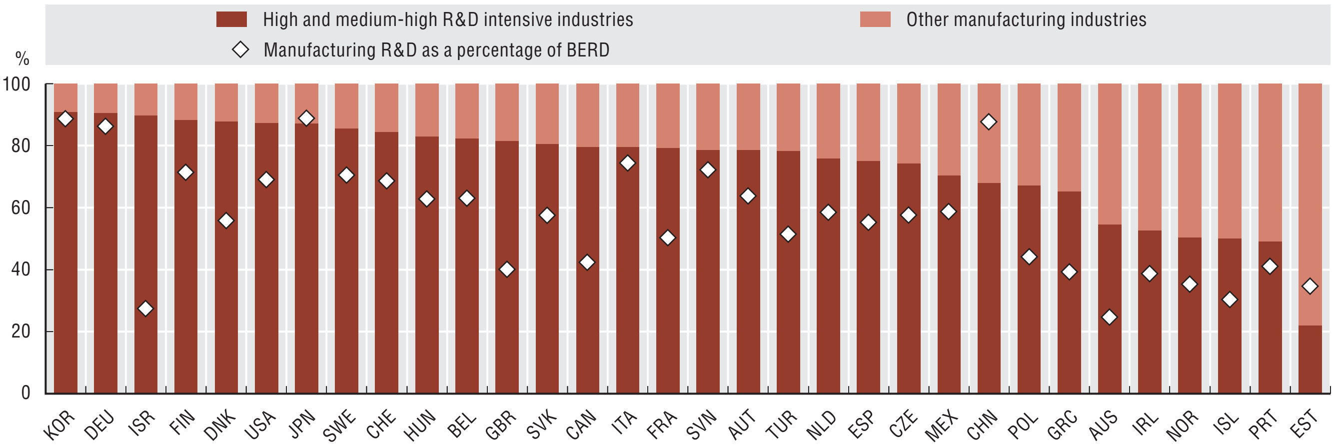
Definitions

R&D intensity adjusted for industry structure is a weighted average of the R&D intensities of a country's industrial sectors, using the OECD industrial structure's sector value added shares as weights instead of the actual shares used in the unadjusted measure of R&D intensity. Calculations are based on the ISIC Rev. 4 classification.

The *R&D intensity groups* are defined in OECD (2015, forthcoming). High and medium-high R&D intensive manufacturing includes "chemicals and pharmaceutical products" (ISIC Rev. 4 20 and 21) and "computer, electronic and optical products, electrical equipment, machinery, motor vehicles and other transport equipment" (ISIC Rev. 4 26 to 30). R&D services correspond to ISIC Rev. 4 Division 72.

Business R&D in manufacturing, by R&D intensity group, 2013

As a percentage of manufacturing R&D



Source: OECD, *ANBERD Database*, *www.oecd.org/sti/anberd*, and *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

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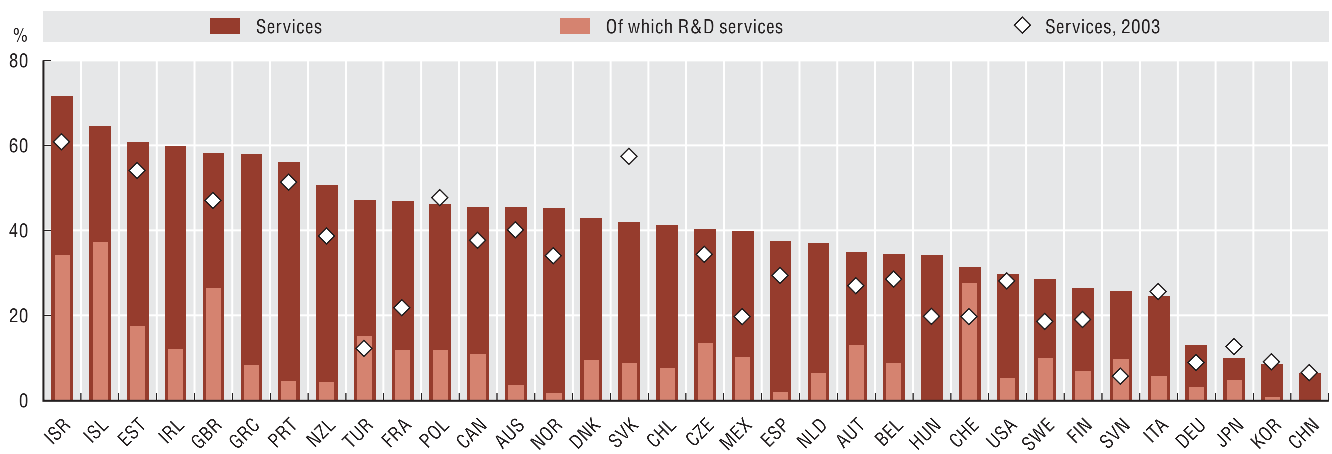
R&D in services, 2013

As a percentage of business enterprise R&D



Source: OECD, *ANBERD Database*, *www.oecd.org/sti/anberd*, and *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274426

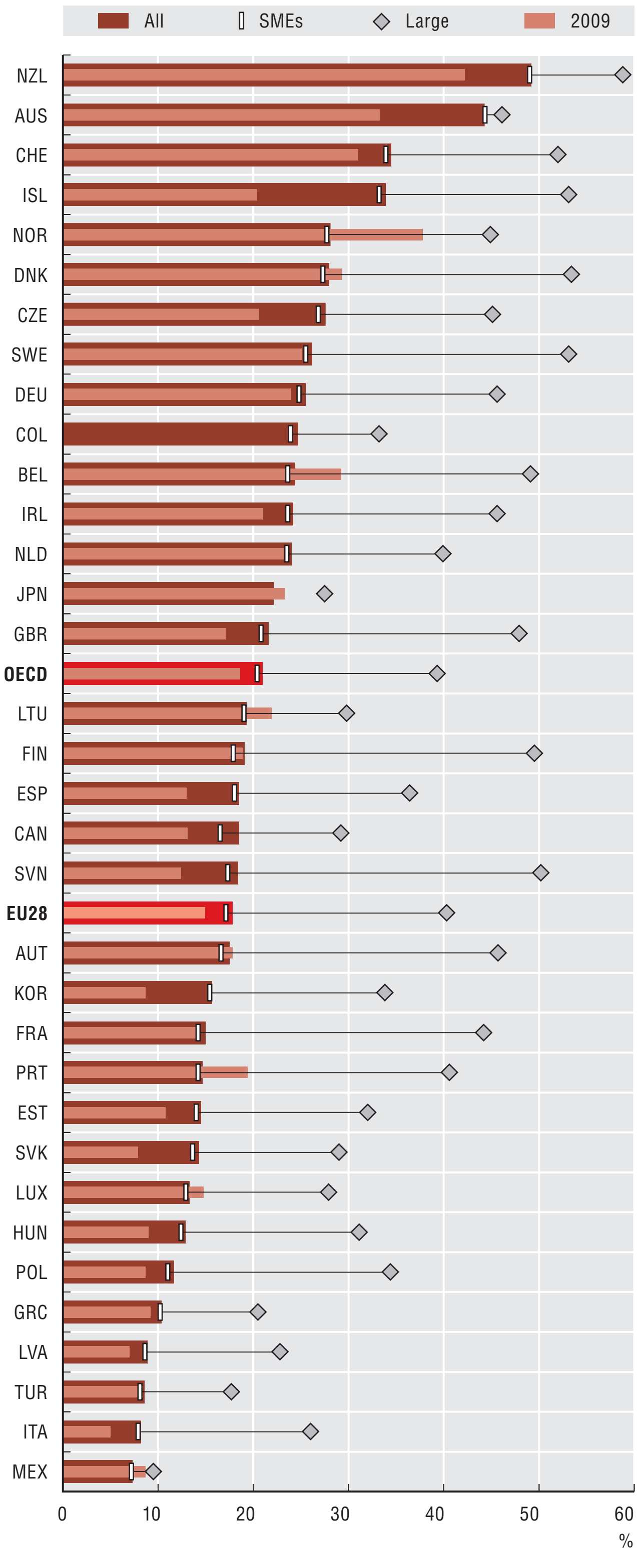
Measurability

Allocating R&D by industry presents various challenges. In most countries, a firm's R&D expenditure is assigned to its principal industrial activity based on value-added (the "main activity" approach). In some countries, it is based on the main R&D activity of the firm or the content of the R&D itself (the "product field" approach). The *Frascati Manual* recommends following a main activity approach when classifying statistical units, but for firms carrying out significant R&D relating to several activities, it recommends subdividing by units or product fields. The methodology used to adjust R&D intensity for industrial structure is sensitive to a number of factors, notably the industrial classification used. Other factors that have an impact are the level of aggregation at which the sectoral weights are calculated and the countries included in the benchmark. Countries where the disaggregation level for R&D is too low and where there is no comparable SNA data on gross value added (GVA) by industry have been excluded. For France and the United Kingdom, 2003 data on main activity basis for services have been backcasted by OECD using historical series reported on a product field basis.

2. E-business uptake

Enterprises engaged in sales via e-commerce by size, 2013

As a percentage of enterprises in each employment size class



Source: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database* and national sources, July 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274434

Electronic business (e-business) can help drive business growth by enlarging enterprises' market reach and saving on costs. On average, 21% of firms in reporting OECD countries made sales via e-commerce in 2014, over 2 percentage points more than in 2009. Differences among countries are considerable. In New Zealand, almost half of enterprises reported making sales via e-commerce as opposed to less than one in ten firms in Italy, Latvia, Mexico and Turkey. While non-harmonised definitions of e-sales might explain some of these differences, the results are dominated by the weight of smaller firms in economies. On average, 39% of larger firms engage in e-sales, with shares over 30% even in certain countries with lower e-sales uptake.

In 2014, 95% of enterprises had a broadband connection and over 76% had a website, but only 42% purchased via e-commerce. Meanwhile social media has made considerable inroads with 35% of businesses reporting its use. The use of more sophisticated ICT technologies is less widespread. Examples include ICT applications used to manage information flows, which require changes in business organisation, and Radio Frequency Identification (RFID), where uptake is limited to certain types of businesses.

Cloud computing merits special attention here, as it allows firms to scale up, use and pay for on demand computing services. Usage of cloud computing is increasing rapidly – over 22% of firms reported using such services in 2014, with shares ranging from over 50% in Finland to 6% in Poland. On average, uptake is higher among large businesses (close to 40%) than among small or medium-sized enterprises (20% and 27%, respectively).

Definitions

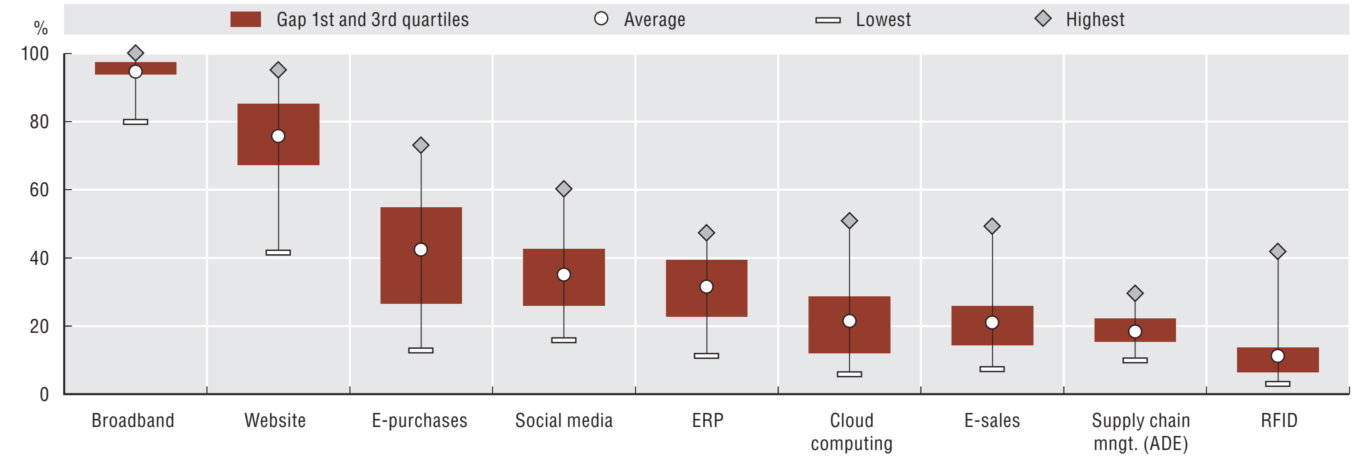
E-commerce transactions refer to the sale or purchase of goods or services conducted over computer networks by methods specifically designed for the purpose of receiving or placing of orders (i.e. webpages, extranet or EDI), but not orders by telephone, fax or manually typed e-mail. Transactions can occur between enterprises, households, individuals, governments and other organisations.

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. Only sharing of information within firms is considered here. *Cloud computing* refers to ICT services used over the Internet as a set of resources to access server, storage and network components, as well software applications.

Size classes are defined as: *small* (from 10 to 49 persons employed), *medium* (50 to 249), *SMEs* (10 to 249) and *large* (250 and more).

Diffusion of selected ICT tools and activities in enterprises, 2014

As a percentage of enterprises with ten or more persons employed



Source: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database* and national sources, July 2015. StatLink contains more data. See chapter notes.

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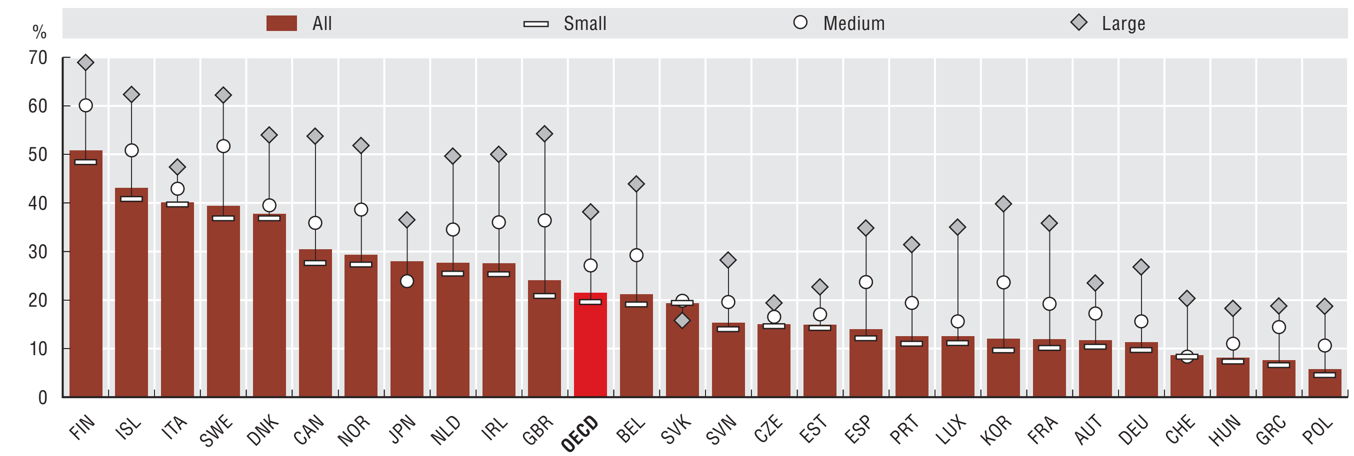
Enterprises using cloud computing services by size, 2014

As a percentage of enterprises in each employment size class



Source: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database*, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274459

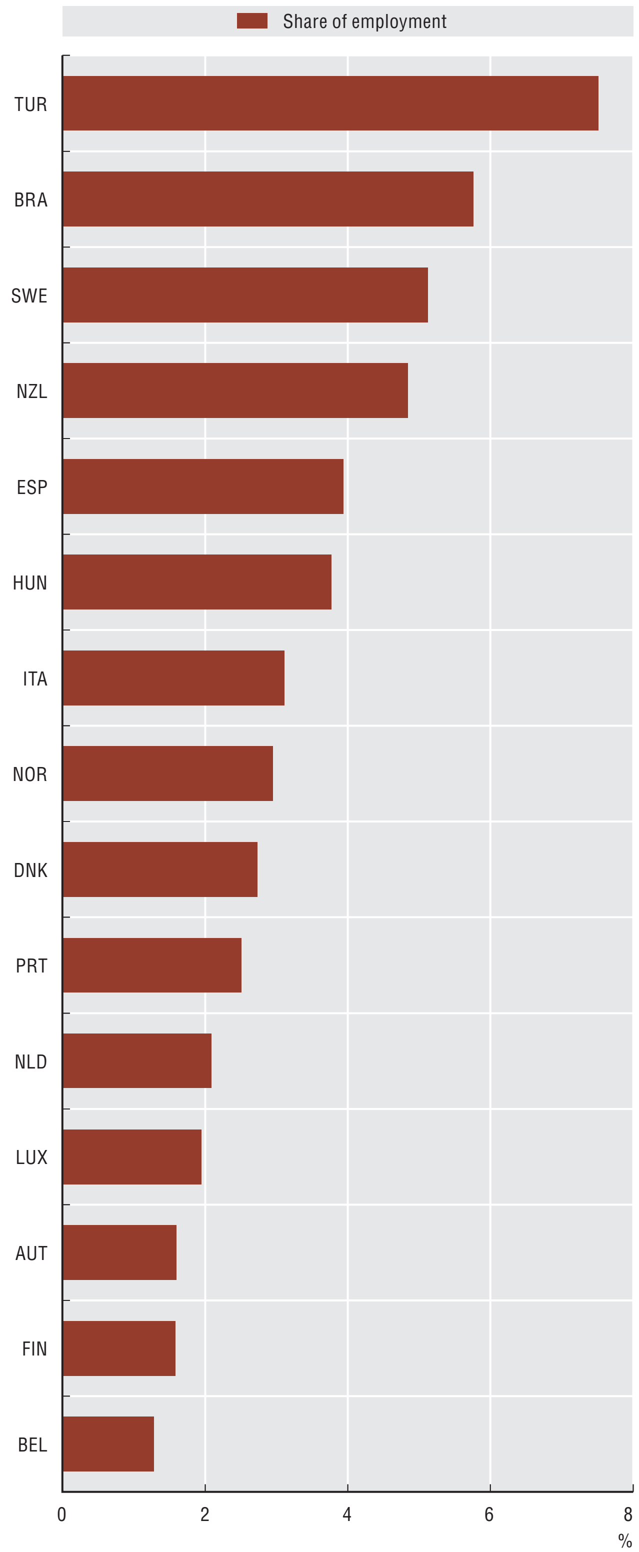
Measurability

Measurement of e-commerce presents several methodological challenges that can affect international comparability, such as the adoption of different practices for data collection and estimations, as well as the treatment of outliers and e-commerce by multinationals. Other issues include differences in sectoral coverage of surveys and lack of measures concerning the actors involved (B2B, 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. Not all OECD countries undertake specific surveys on ICT usage by businesses. Aside from differences in the survey vehicle, the majority of indicators correspond to generic definitions, which can only proxy ICT tools' functionalities and potential uses. For example, various software tools with different functionalities fall under the same ERP heading, and there are substantial differences in the sophistication of ERP systems and their degree of implementation. Cloud computing services raise similar issues.

3. Start-up dynamics

The start-up contribution to employment, 2001-10

Net job creation by surviving entrants over total employment, non-financial business sector



Source: OECD calculations based on the *DynEmp v.2 Database*, preliminary data, *www.oecd.org/sti/dynemp.htm*, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274460

On average around 40% of start-ups exit within the first three years of activity, but those that survive contribute disproportionally to job creation. The OECD DynEmp project points to substantial cross-country differences in start-up dynamics.

Indicators from the OECD DynEmp project show net job creation of surviving start-ups normalised on total employment in the entry year, as an average of three cohorts and three time periods in the 15 economies considered. Turkey, Brazil, Sweden, and New Zealand are characterised by relatively higher net job creation by start-ups. In these economies, in any given year, for every existing 100 jobs, start-ups will add between five and seven new jobs within the following three years.

Net job creation by surviving entrants can be decomposed in: 1) *Start-up ratio*; 2) *Survival share*; 3) *Average size at entry*; and 4) *Average post-entry growth*. Significant cross-country differences emerge in the four measures, even across economies presenting similar net job creation by entrants. Start-up ratios are higher in Turkey, Sweden, Spain and New Zealand (more than 20 start-ups per 1 000 employees) and substantially lower in Belgium, Finland and Norway. Three-year survival rates range between about 55% in Denmark and the Netherlands to more than 70% in Sweden. Average size at entry is quite similar across countries, at around two or three employees, with the notable exception of Norway and, to some extent, Brazil and Austria. Final-over-initial employment ratios range between about 110% in Norway to about 240% in Belgium.

Definitions

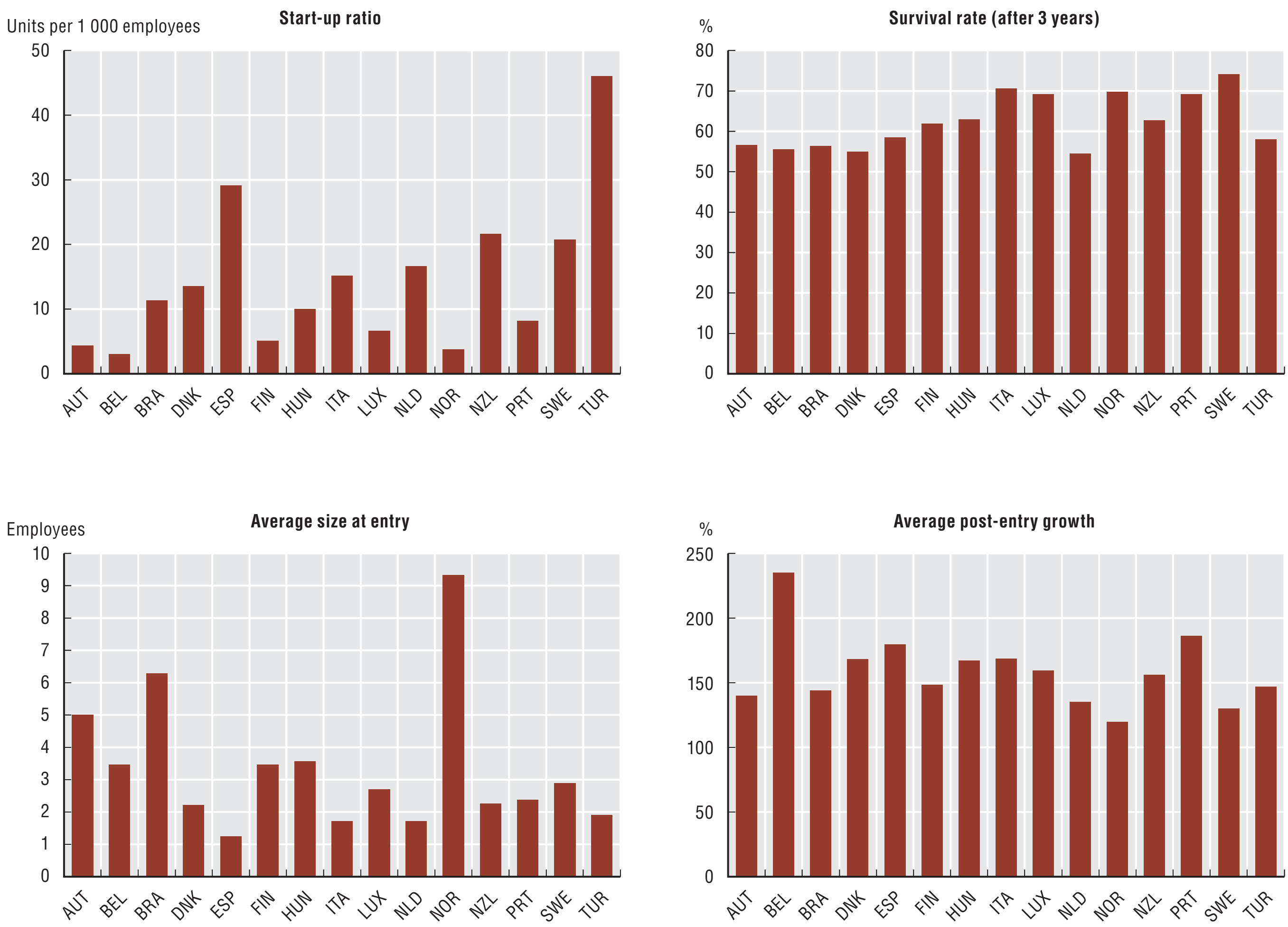
A firm is defined as a *start-up* in the year that corresponds to its creation. *Net job variation* is calculated as the difference between gross job creation and gross job destruction. *Gross job creation* is defined as the sum of all positive unit-level job variations relative to the previous year. *Gross job destruction* is defined as the sum of all negative unit-level job variations relative to the previous year. Normalised net job creation by surviving entrants (NJCSE) is decomposed as follows:

$NJCSE_{t,\,t+k}$ = (Start-up ratio)$_t$ * (Survival share)$_{t+k}$ * (Average size at entry)$_{surv}$ * (Average post-entry growth)$_{surv}$

where the *start-up ratio*$_t$ in the economy $\frac{NrUnit_{act}(t)}{EMP_{ct}(t)}$ is defined as the total number of entering units over total employment at time t; the *survival share* is calculated as the number of entrants in any country surviving between time t and $t + k$ over the total number of entrants in that country at time t; the *average size at entry* is defined as the ratio between total employment at time t for entrants surviving until time $t + k$, *defined as "surv"*, over their total number; the *average post-entry growth* is defined as the ratio of total employment at time $t + k$ of surviving entrants over their total employment at time t, where $k = 3$.

Employment growth decomposition, 2001-10

Non-financial business sector



Source: OECD calculations based on the *DynEmp v.2 Database*, preliminary data, *www.oecd.org/sti/dynemp.htm*, July 2015. See chapter notes.

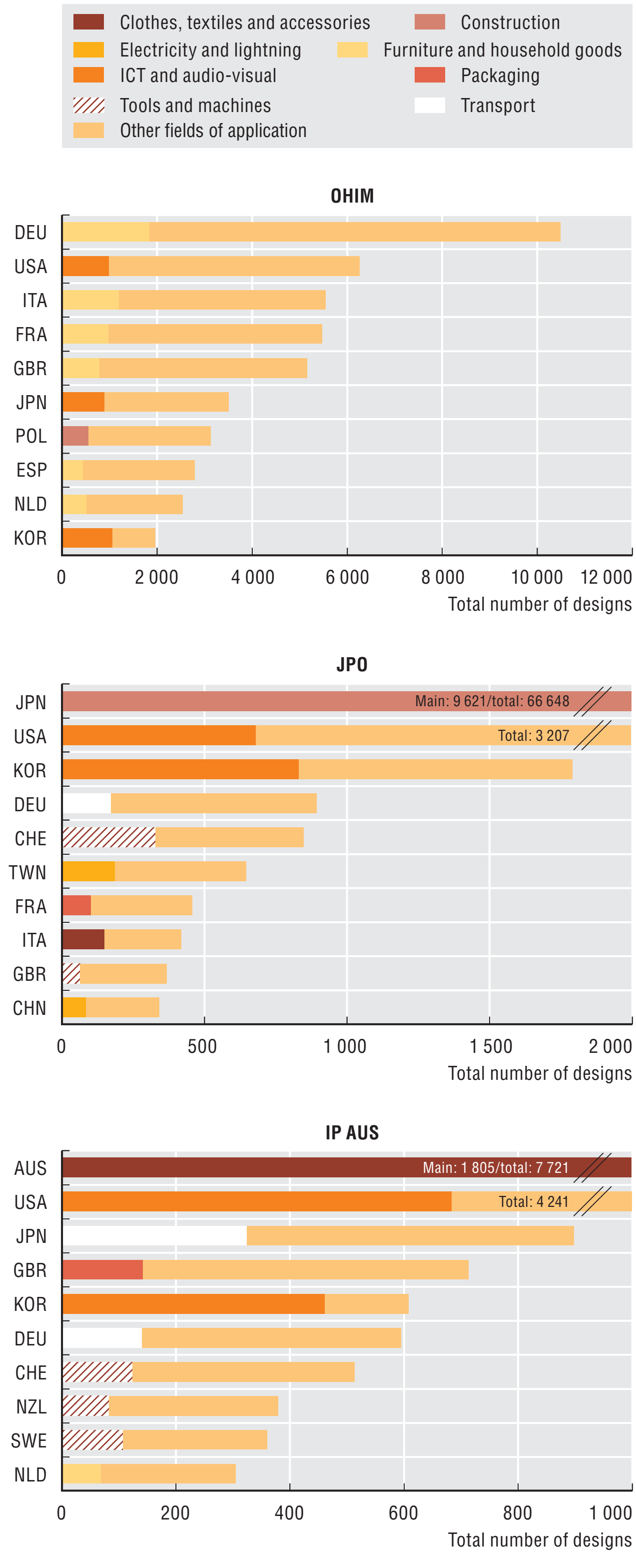
StatLink http://dx.doi.org/10.1787/888933274476

Measurability

The OECD DynEmp project is based on a distributed data collection to create a harmonised cross-country micro-aggregated database on employment dynamics from confidential micro-level data, where the primary sources of firm and establishment data are national business registers. The project is supported by a network of national experts who run common statistical routines developed by the OECD DynEmp team on confidential micro-data to which they have access (see Criscuolo, Gal and Menon, 2015). The experts also implement country-specific disclosure procedures to ensure that confidentiality is respected. A number of significant extensions are implemented in the new phase of the project entitled DynEmp v.2. First, the DynEmp network has been expanded to include several additional economies. Second, DynEmp v.2 includes a more disaggregated analysis of transition dynamics allowing for a deeper investigation of start-up dynamics. Third, the dataset allows for a more granular analysis at industry level. Owing to methodological differences, figures may deviate from officially published national statistics. Mergers and acquisitions are not accounted for in determining firm age, entry and exit.

Top ten design applicants by main field of application, 2011-13

Number of designs registered at OHIM, JPO and IP Australia



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274485

In terms of design, Germany has a strong reputation for cars, Italy for furniture and clothes, and the United States and Korea for mobile phones and computers. But in which design fields are economies most specialised? Does specialisation differ across markets? And where do firms in different fields find the creative talents they need? Registered industrial design data help to address these and other questions related to the sources and uses of creativity.

Germany, Japan, Korea, the United Kingdom and the United States place consistently among the top ten countries in terms of design activities in Europe, Japan and Australia, as reflected by registrations at the Office for Harmonization in the Internal Market (OHIM), the Japan Patent Office (JPO) and IP Australia (IP AUS). Korea and the United States are especially active in information and communication technologies (ICT) and audio-visual design in all markets considered, while Germany, Japan and the United Kingdom exhibit different specialisations in different markets. The case of construction-related design activities by Japanese firms in Japan is of particular note, with most applications relating to building materials and prefabricated or pre-assembled building parts, and activities increasing substantially after the 2011 earthquake.

An analysis of the design areas in which creators residing in different countries specialise, provides evidence in support of general beliefs: US and Korean creators focus on ICTs; French and Italians are especially active in the design of clothes, textile and accessories; Germans specialise mostly in transport equipment designs; and Swiss designers focus on tools and machines.

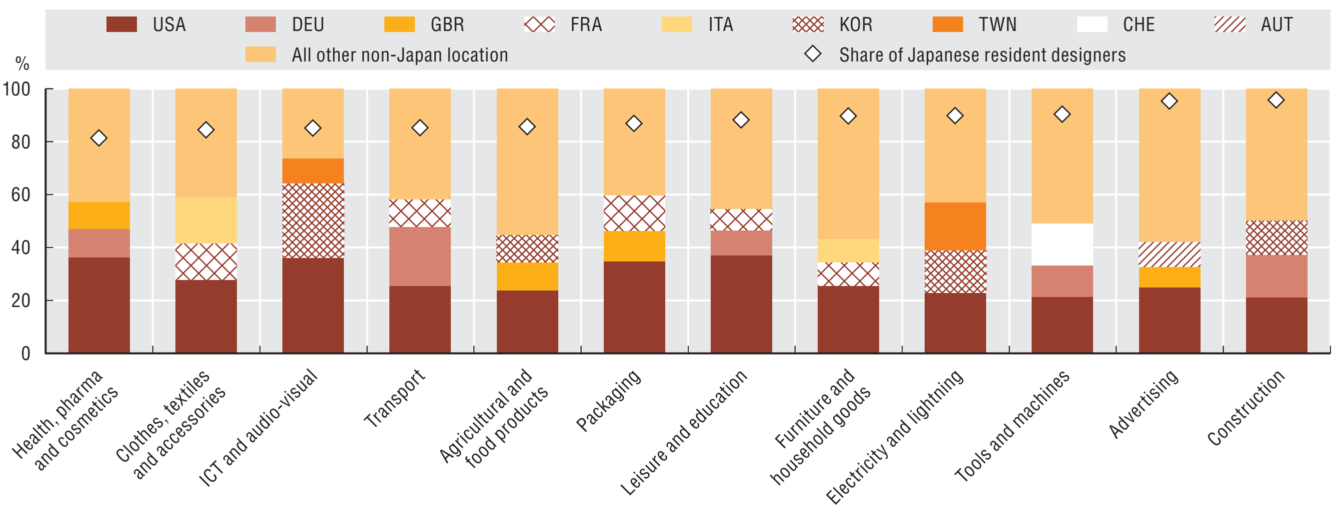
Finally, the extent to which design applicants rely upon creative talents residing abroad is revealed due to the unique characteristics of JPO. Small open economies such as the Netherlands and Finland rely on foreign designers for more than half of their designs registered at JPO, whereas most big economies (e.g. the United States, Germany, France and the United Kingdom) rely on foreign talents for about 15-20% of their designs. Japanese companies rely almost exclusively on local designers. When seeking talents abroad (1% of cases) they mostly do so in the United States.

Definitions

Industrial designs are intellectual property (IP) rights protecting the ornamental or aesthetic aspects of an article or its parts. For designs registered at JPO, applications must state the name and domicile of the applicant and the name and domicile of the creator of the design (the "designer"). This feature of JPO's design system makes it possible to analyse international collaboration on design and identify the designs created in one country that are owned by residents in another country (referred to here as "designs created abroad").

Residence of designers active on the Japanese market, by field of design, 2004-14

Top three residence economies



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

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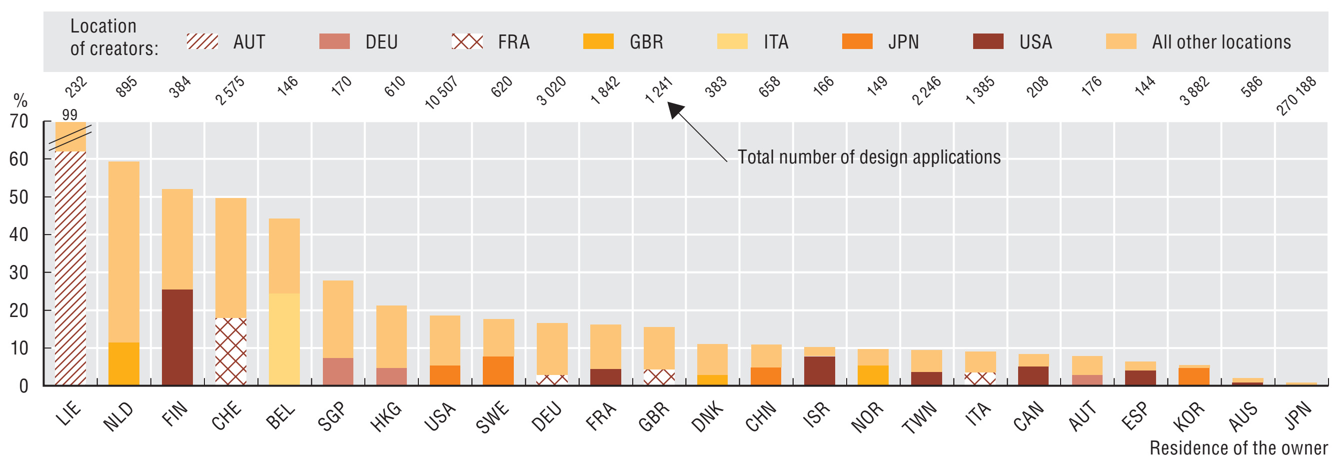
Designs on the Japanese market created abroad, 2004-14

By residence of design owner and most frequent location of design creators



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274509

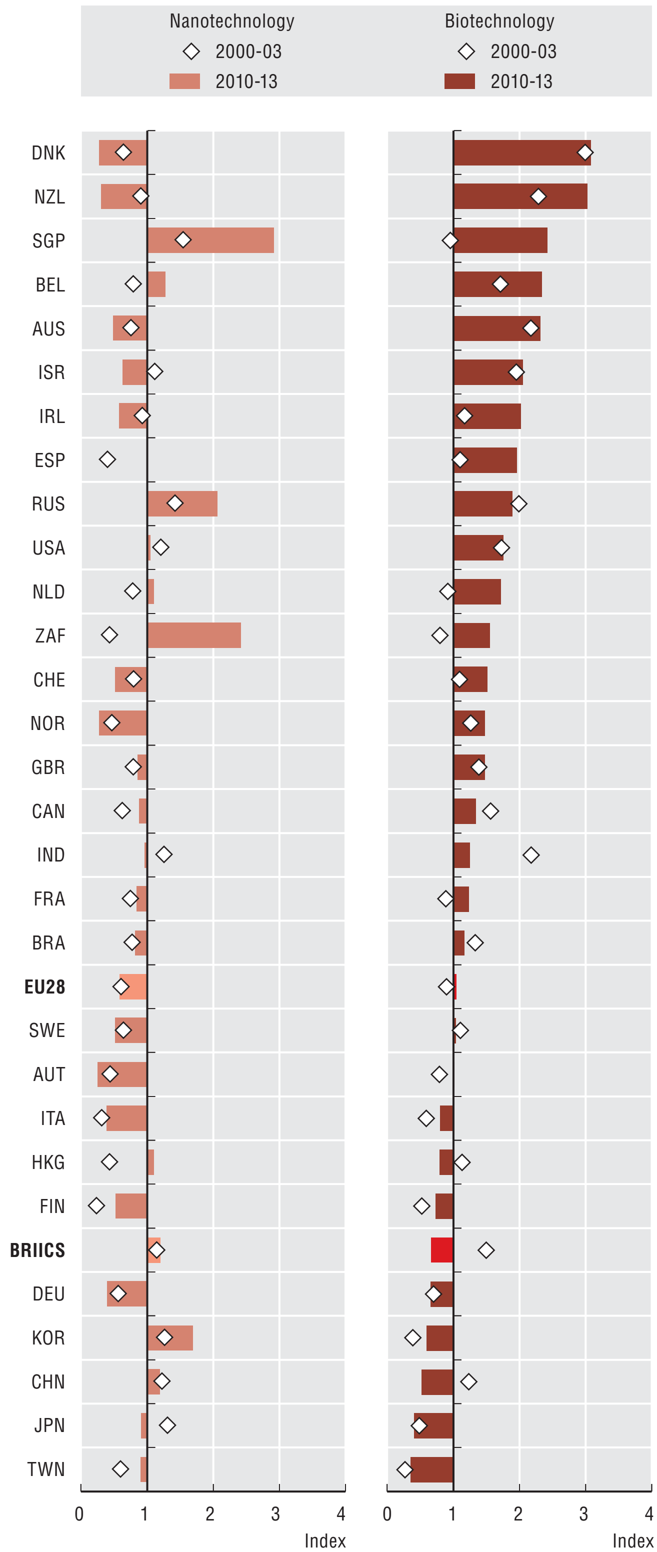
Measurability

Registered industrial design data are used here to proxy creative activities regarding the visual features of products. For example, the third figure shows that about half (49.6%) of the 2 575 designs registered by Swiss companies at JPO are designed by creators located elsewhere. The most frequent origin of these "foreign" designers is France, with 18% of Swiss designs sourced from this country. Industrial designs cannot be registered as such in all countries, notably in the United States, where design is protected through a combination of patents (especially design patents), trademarks and copyrights. The high number of design registrations at JPO is due partially to a feature of this system, whereby only one distinct design may be included in an application. For 99% of designs registered at JPO between 2004 and 2014, JPO provides information on the country of residence of applicants (i.e. owners) and creators (i.e. professionals including designers and architects responsible for the design). Design application fields are defined using an experimental taxonomy based on Locarno classes (see chapter notes). Differences in design systems may affect comparability across offices.

5. Technological advantage

Revealed technological advantage in biotechnology and nanotechnology, 2000-03 and 2010-13

Index based on IP5 patent families



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274511

Some of information contained in patent documents, such as the technology class to which an invention belongs and the location of inventors, can be used to assign patented inventions to technology fields, and thus identify areas in which economies are relatively specialised and those in which they lag behind. The revealed technological advantage (RTA) index applied to data from the International Patent Classification (IPC) is used here to provide an indication of the relative specialisation of economies in nanotechnology, biotechnology, and information and communication technologies (ICT). An index value greater than 1 denotes relative specialisation in a particular field.

Overall, nanotechnology patenting grew by 43% during the last decade. Singapore remained the most specialised economy, while economies such as Japan and South Africa reversed their trends becoming less specialised and more specialised, respectively. Patenting in biotechnology decreased by almost 10% over the same period, with Denmark remaining the most specialised economy and Singapore, Ireland and Spain showing the highest increases in specialisation. Patenting in ICT technologies grew by 40% overall. Although ICT-related specialisation did not increase in most economies, patenting increased six fold in India and by more than 16 times in China, the latter becoming the second most specialised ICT economy after Korea.

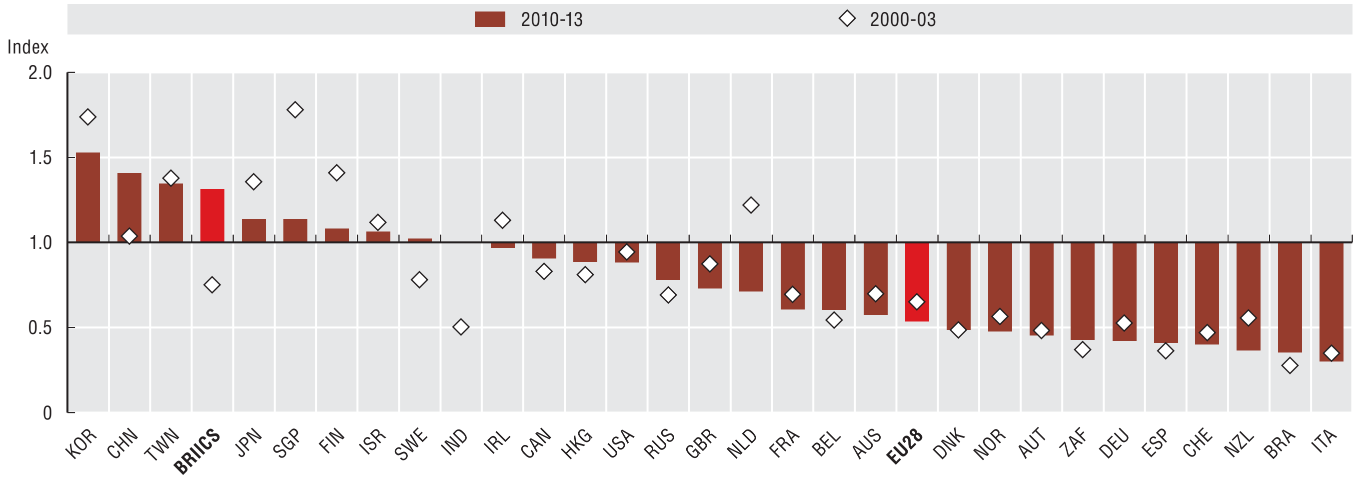
RTA values for 2010-13 suggest that while most economies do not seem specialised in specific technology fields (i.e. the median RTA is equal to or less than 1), differences in technological specialisation do emerge across economies and fields. RTA values range between 0.03 and 12.3 across technology fields and top-scoring economies exhibit values up to 60 times higher than bottom-scoring ones in the same field. Examples of high specialisation include Norway in civil engineering (7.4), Turkey in thermal devices and other consumer goods (5.8 and 12.3, respectively), and the Netherlands in food chemistry (5.3).

Definitions

The *revealed technological advantage* (RTA) index measures the share of an economy's patents in a specific technology relative to the share of total patents owned. The index is equal to zero when the economy has no patents in a given field, equals 1 when the economy's share in the technology field is equivalent to its share in all fields (no specialisation), and rises above 1 when specialisation is observed. The index is calculated on the basis of patents filed at the European Patent Office (EPO) or the US Patent and Trademark Office (USPTO), which belong to patent families within the *Five IP offices (IP5)*, by earliest filing date and inventor's location (see Dernis et al., 2015, about IP5 patent families).

Revealed technological advantage in ICT, 2000-03 and 2010-13

Index based on IP5 patent families

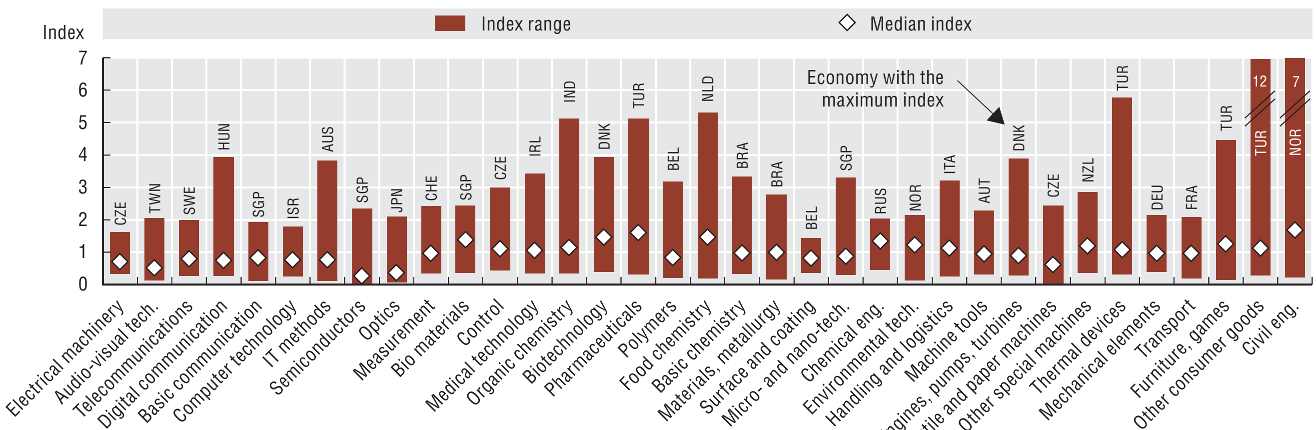


Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274529

Range of revealed technological advantage in economies by field, 2010-13

Index by technology field based on IP5 patent families



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274534

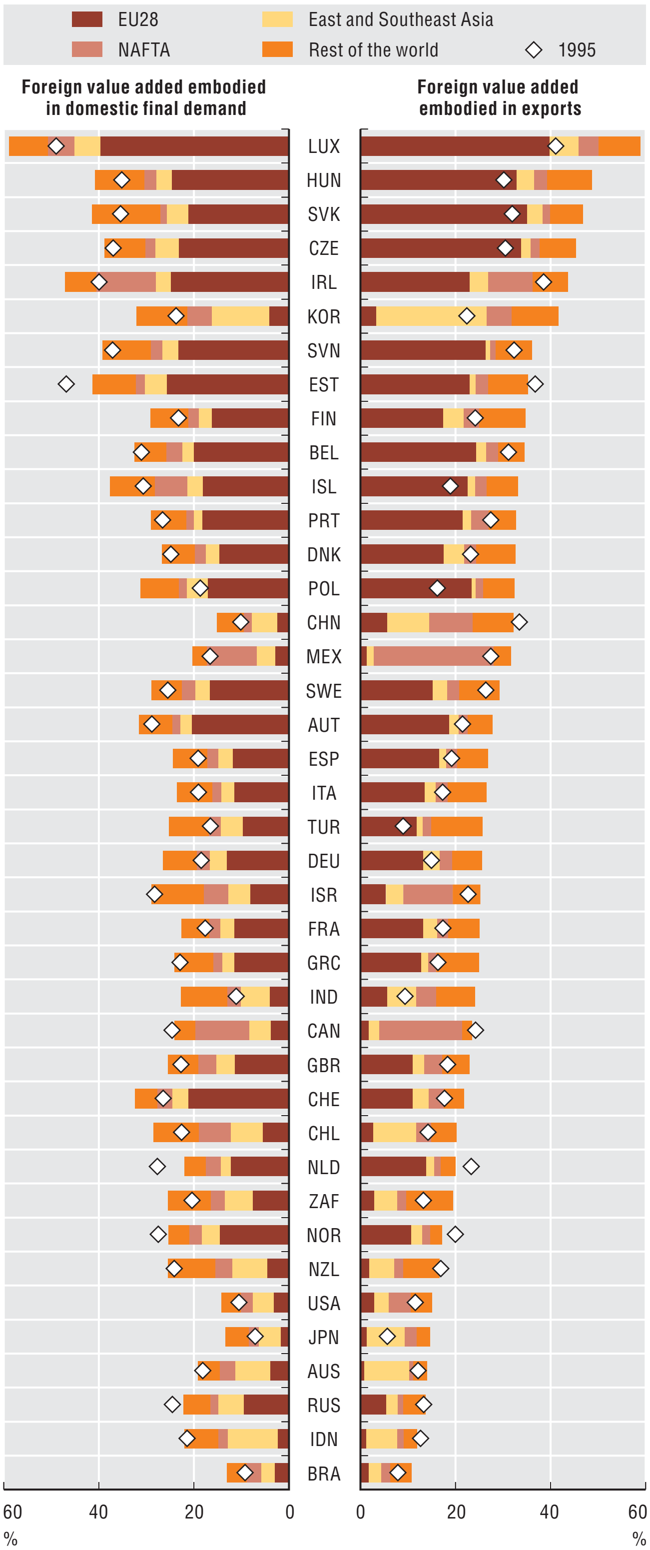
Measurability

International Patent Classification (IPC) codes attributed by patent examiners during the examination process identify the technological domains to which inventions belong. IPC classifications are revised periodically to account for the emergence of new technologies and the evolution of existing ones. This may lead to the reclassification of patents into different classes. Biotechnology and nanotechnology patents are defined according to lists of IPC classes compiled by experts in the respective fields while ICT patents are identified from a new experimental classification (see also Chapter 6, Section 9). The last figure is based on a classification proposed by WIPO (2013) which groups all IPC classes into 35 technology fields, identified on the basis of their content. The use of data from other patent offices may change the patterns observed, as companies within and across technology fields may behave differently and pursue different innovative strategies in different markets. Given the way the RTA is compiled, economies with relatively low levels of patenting may appear highly specialised in certain technologies as their activities are more likely to be concentrated in only a few fields.

6. Participation in global value chains

Foreign value added embodied in exports and in domestic demand, by source region, 2011

As a percentage of total exports/total domestic demand



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274544

Integration of countries into global value chains (GVCs) can be measured by indicators that track the origins of value added embodied in exports and final demand. Estimates of foreign value added in exports highlight the importance of imports for export performance, while domestic value added embodied in the exports of partner countries show how industries within a country reach consumers abroad even when no direct trading relationship exists.

For most countries, the majority of foreign value added originates from the same region. Exceptions include larger economies such as Brazil, China, India and the United States where the origin of foreign value added is distributed broadly across regions. Smaller, relatively isolated economies such as Chile and New Zealand also exhibit less reliance on a particular region. In countries such as China and Mexico, an asymmetry between foreign value added in exports and that in final demand persists, suggesting that their production for exports have stronger links to GVCs than their final consumption. Since 1995, most countries have experienced significant increases in the share of foreign value added in both exports and final consumption, reflecting the increasing interdependency of the global economy.

In all OECD and BRIICS countries, the share of exported domestic value added embodied in partners' exports increased significantly between 1995 and 2011 (from about 20% to 32%), reflecting growing participation in global value chains.

The share of foreign value added in exports of manufactured goods is significantly higher than that in exports of services. The production processes of many manufactured goods can be distributed across countries more easily than services. Consequently, value chains for manufactured goods are far more dispersed than those for services. Countries with very low foreign value added content of service exports compared to manufacturing exports are Mexico and China, both of which have highly developed processing or global manufacturing zones.

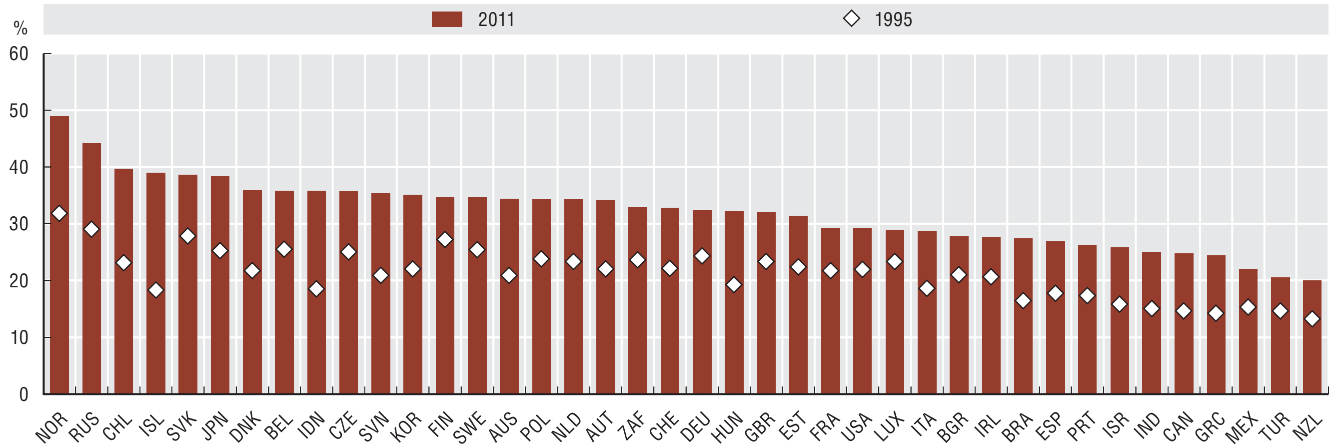
Definitions

The *Trade in Value Added (TiVA) Database* developed under the OECD-WTO TiVA initiative provides indicators on the origin, both domestic and foreign, of value added embodied in exports and in final demand. The indicators are derived from OECD's *Inter-Country Input-Output (ICIO) Database* (*http://oe.cd/icio*) which provides estimates of the flows of goods and services between 61 countries and 34 industries from 1995 to 2011. Tracing the flows of value added that arise from global production provides new insights for analysing GVCs that are not always evident from conventional trade statistics.

Final demand refers to final consumption expenditures by households, government and NPISH and, gross fixed capital formation as defined in the 1993 *System of National Accounts*.

Domestic value added embodied in partner countries' exports, 1995 and 2011

As a percentage of total domestic value added in gross exports

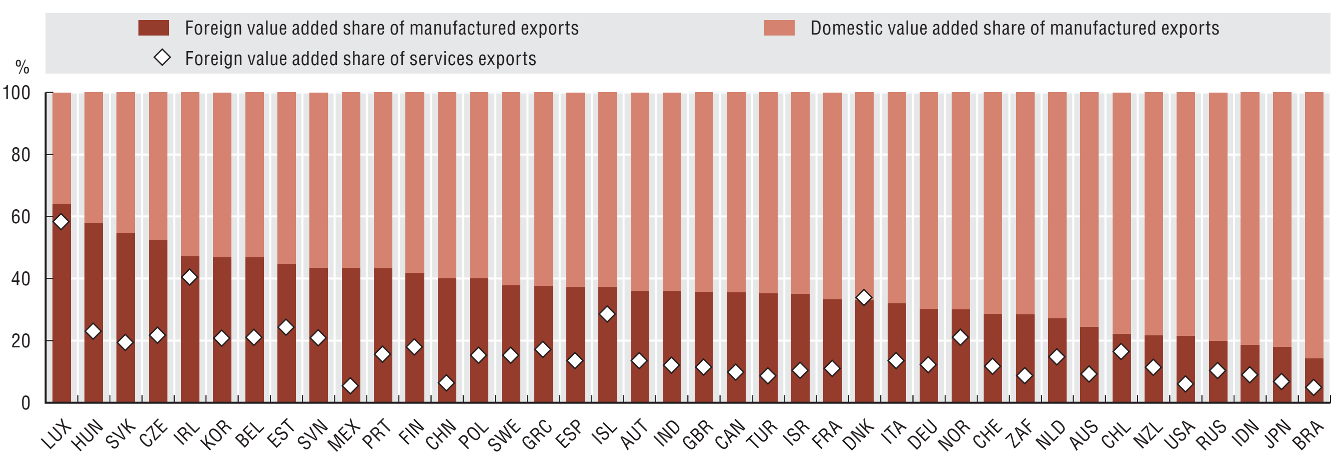


Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274554

Foreign value added embodied in exports of manufactured goods and in exports of services, 2011

As a percentage of total exports of manufactured goods/services



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274565

Measurability

Estimates of foreign value added (or import) content of exports are sometimes referred to as backward linkages in global value chains while estimates of domestic value added content in partner countries' exports (calculated as the sum of domestic value added in exports of intermediates that are then embodied in other countries' exports) are referred to as forward linkages. Both are used to provide an indication of GVC participation and, given the different perspectives (foreign versus domestic value added), are best analysed separately for this purpose.

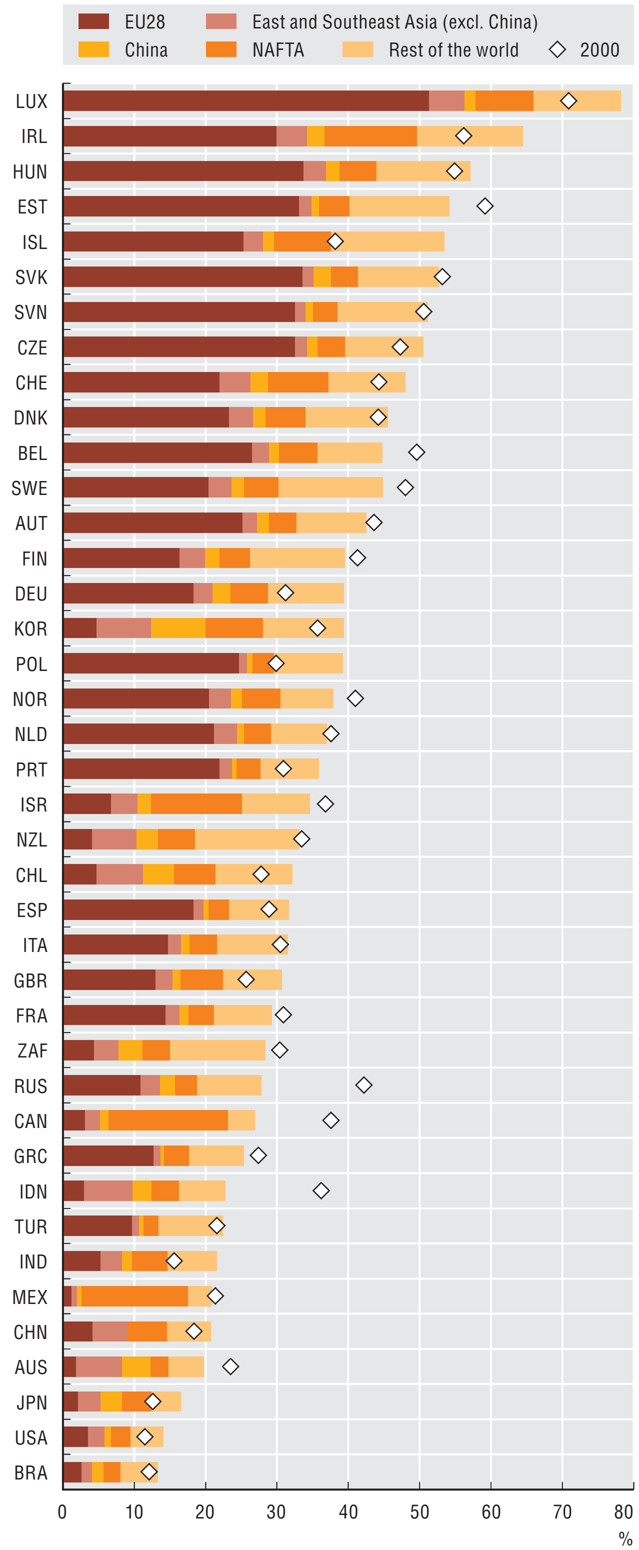
Not only can changes in participation in GVCs reflect changes in specialisation towards activities at the beginning or end of value chains but also, changes in commodity prices so that, for example, a surge in oil prices could result in an increase in import content of exports for many countries. Thus, care should be taken when interpreting measures of GVC participation over time.

Non-resident final expenditures (e.g. by tourists) are allocated to the consumer's country of residence i.e. treated as exports of the country in which the goods and services are purchased.

7. Trade and jobs

Jobs in the business sector sustained by foreign final demand, by region of demand, 2011

As a percentage of total business sector employment



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*, June 2015; *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274578

Estimates of jobs embodied in foreign final demand can reveal the extent of a country's integration into the global economy. The increase in the number of firms specialising in particular stages of global production has led to deepening dependencies between economies. The ability of countries to meet foreign final demand increasingly determines the evolution of job markets. Traditional statistics are unable to reveal the full nature of these interdependencies – notably, how consumers in one country may drive production and thus sustain jobs in economies further up the value chain. Experimental indicators based on the OECD's *Inter-Country Input-Output (ICIO) Database* can shed light on these relationships.

In 2011, for example, between 30% and 40% of jobs in the business sector in most European countries were sustained by consumers in foreign markets. For some smaller European countries this share reached over 50%. In Japan and the United States shares are lower, reflecting their relatively large size and lower dependency on exports/imports. In spite of this, initial estimates suggest that in 2011 the number of jobs sustained by foreign demand reached over 11 million in the United States and over 7 million in Japan. For many countries, foreign demand stems from neighbouring economies, particularly within Europe. The EU excluding intra-EU dependencies has a foreign demand structure closer to that of the larger OECD countries.

Employment in primary goods sectors engaged in meeting foreign final demand is relatively high both for emerging economies and OECD countries with significant mining activities, such as Chile and Mexico. For most other countries, service sector jobs predominate, notably those related to trade and transportation. For many countries, over 20% of business sector service jobs are driven by foreign demand for manufactured goods.

Definitions

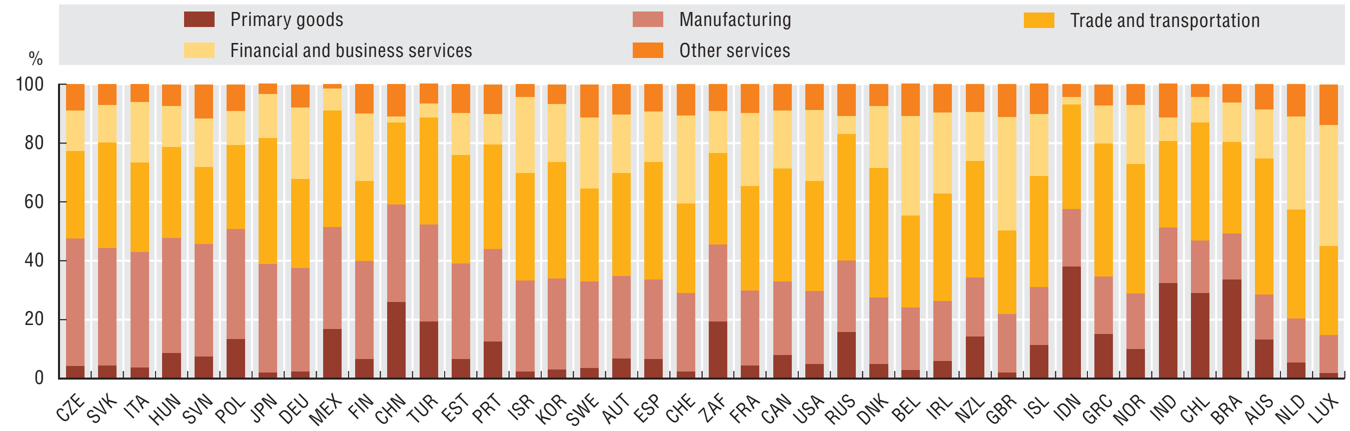
Jobs refer to the total number of persons engaged in production.

Jobs embodied in (or sustained by) foreign final demand can be estimated using a similar methodology to that of domestic value added embodied in foreign final demand on the basis of OECD's ICIO system for the *Trade in Value Added (TiVA) Database*. Similar calculation techniques are applied (see chapter notes).

Estimates of jobs sustained by foreign final demand capture the fluctuating origins of demand, both domestic and foreign, for goods and services produced by domestic economic activities. Thus, for example, an increase in the number of jobs engaged in production to meet foreign final demand does not necessarily translate to an explicit increase in total employment due to foreign demand if the number of jobs sustained by domestic demand has decreased.

Jobs sustained by foreign final demand, by sector, 2011

As a percentage of total jobs embodied in foreign final demand

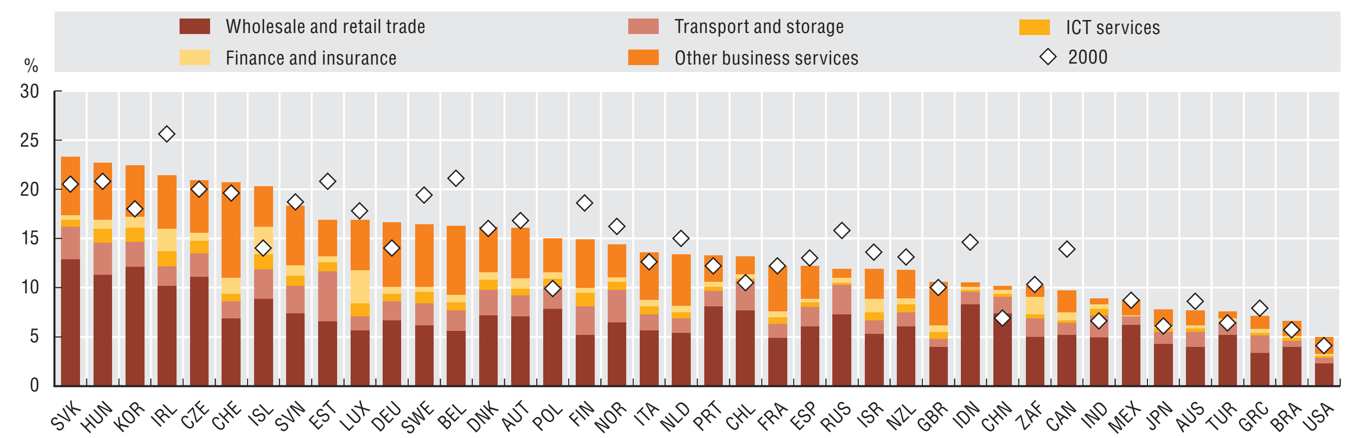


Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*, June 2015; *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274587

Business sector service jobs sustained by final demand of manufactured goods, 2011

As a percentage of total business sector service jobs



Source: OECD, *Inter-Country Input-Output (ICIO) Database*, *http://oe.cd/icio*, June 2015; *World Input-Output Database (WIOD)*, *www.wiod.org*, July 2014. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274594

Measurability

Estimates derived through an input-output accounting framework, such as OECD's ICIO, are sensitive to certain assumptions. Those that are particularly relevant for jobs related indicators include the assumptions: i) that exporting firms have the same labour productivity as firms producing goods and services for their domestic market; and ii) that exporters have the same share of imports in relation to output as domestic firms. However, evidence suggests that exporting firms have higher labour productivity and a higher share of imports for a given output, suggesting that the results may be biased upwards. Better accounting for firm heterogeneity within industry groups could reduce such biases.

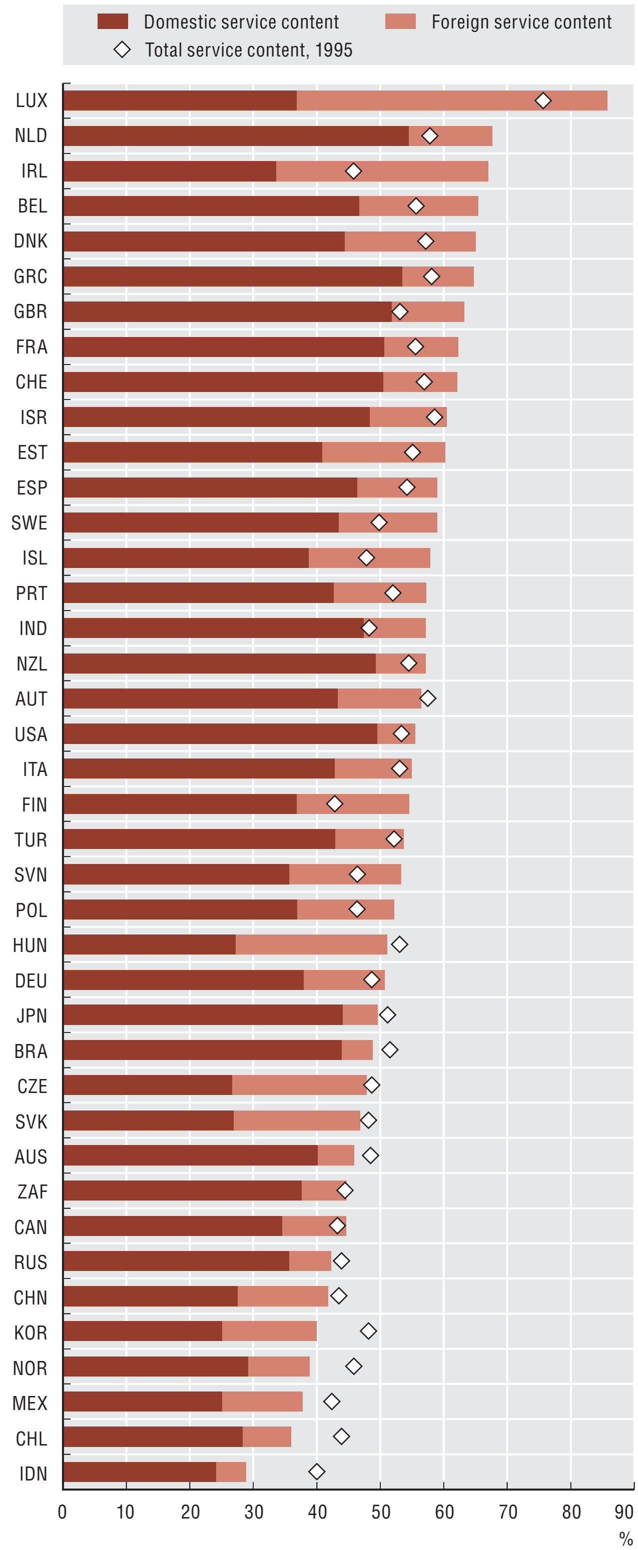
Jobs embodied in final demand may unduly capture employment in non-market activities. In particular, for non-OECD economies there is no differentiation between employment engaged in non-market agricultural activities and that used to produce intermediate agricultural goods.

Finally, jobs estimates are not full-time equivalent measures. The results relate to jobs *sustained* rather than *created*, as jobs may have existed previously to serve domestic consumers.

8. Service-manufacturing linkages

Services value added content of gross exports, domestic and foreign, 2011

As a percentage of total gross exports



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274600

Service activities are a dominant feature of OECD economies, on average accounting for over 70% of GDP and employment. Manufacturing activities have declined generally, however their scope and nature has evolved in many OECD countries to become more reliant on service inputs. This reflects increasing use of technology in production, international sourcing of manufactured goods and a range of social factors including the changing skill composition of populations. Ultimately, many service activities are tied to the production of goods, whether manufactured domestically or along global value chains. The indicators presented here provide an insight into the interdependency of services and manufacturing industries in the context of world trade.

Results from the latest *Trade in Value Added (TiVA) Database* reveal that the share of value added from service activities embodied in total gross exports varies generally between 40% and 70% across OECD countries. This figure is significantly higher than the share of services in total exports apparent in traditional (Balance of Payments) trade statistics – typically between 10% and 30%. For some OECD countries, foreign services content accounted for over one third of gross exports in 2011, reflecting their high level of integration in global or regional value chains. Examples include Luxembourg (57%), Ireland (50%), Hungary (47%), the Czech Republic (44%), the Slovak Republic (43%) and Korea (37%).

Wholesale and retail trade and transportation make up the bulk of services embodied in manufactured exports, and while their share remained relatively stable between 1995 and 2011, the value added content from finance, ICT and other business service activities increased for most countries.

In 2011, the service content of manufactured exports varied between 30% and 45% across OECD with increases since 1995 apparent in many countries, often driven by increases in embodied foreign services. However, for China domestic service content of exported goods increased significantly hinting at upward moves in certain value-chains as domestic services providers integrate upstream.

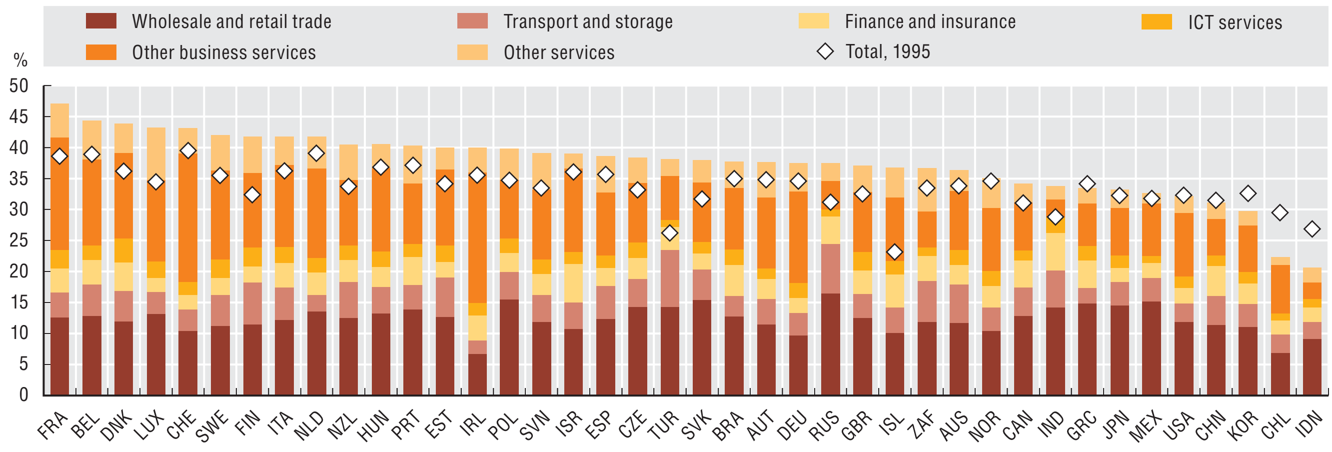
Definitions

Indicators of *(domestic and foreign) services embodied in industry gross exports*, are provided in the *TiVA Database*. Other available indicators also provide insights into the role of services in GVCs such as the service value added content of final demand for manufactured goods.

The database covers 14 service sectors defined according to ISIC Rev. 3: Wholesale and retail trade (Divisions 50 to 52), Transport and storage (60 to 63), Finance and insurance (65 to 67), Other business services (70, 71, 73 and 74), Other services (45, 55 and 75 to 93) and ICT services which consists of Telecommunications (64) and Computer and related service activities (72).

Services value added embodied in manufacturing exports, by type of service, 2011

As a percentage of total manufacturing exports

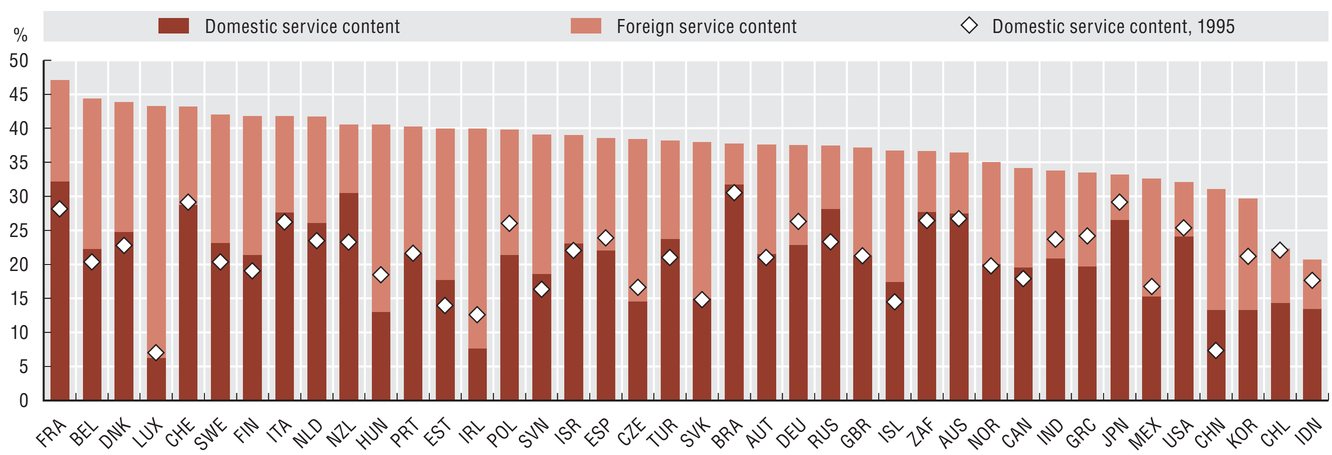


Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274615

Services value added embodied in manufacturing exports, by domestic and foreign origin, 2011

As a percentage of total manufacturing exports



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274627

Measurability

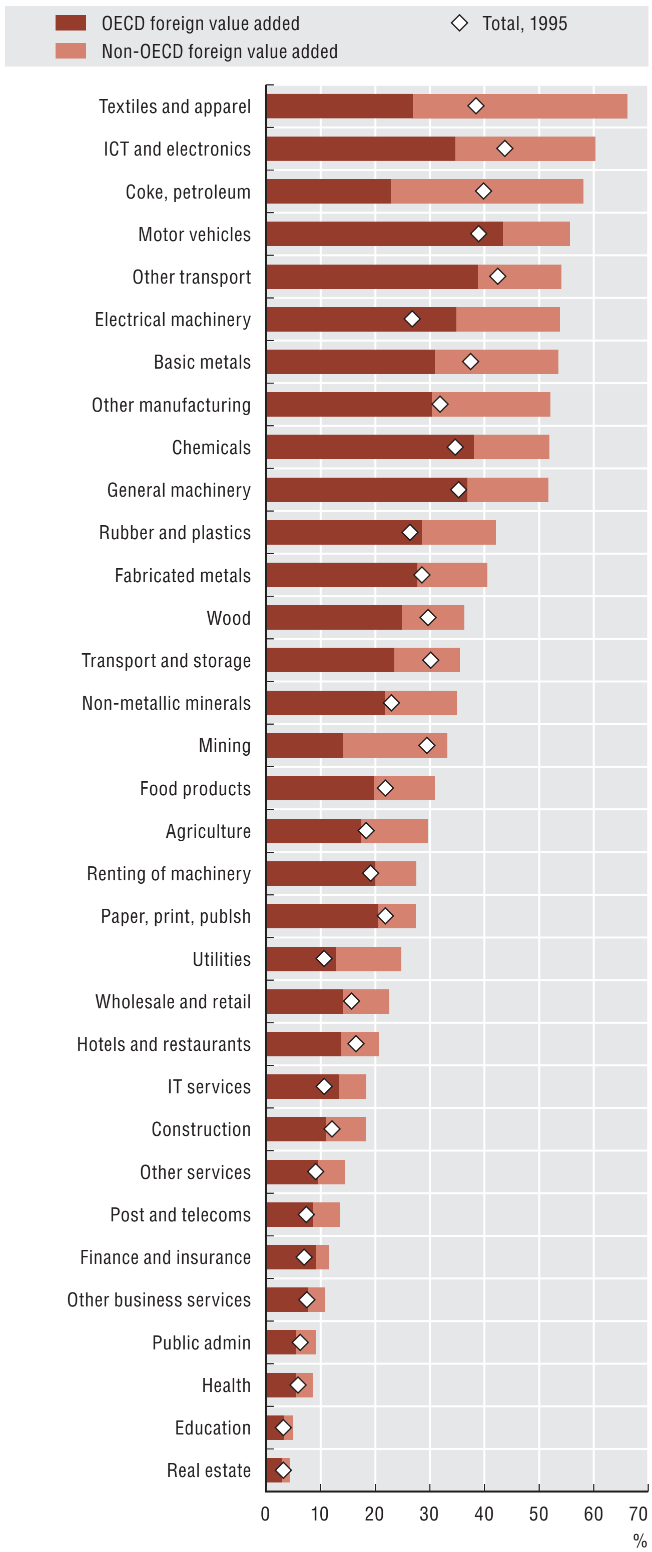
The distinction between services and manufactures originates from industry classifications and the allocation of firms thereof. Many manufacturing firms produce in-house services that are not captured in the ISIC Rev. 3 service categories used for TiVA indicators. In fact, the ISIC Rev. 3 classification explicitly includes some services activities within goods-producing sectors. For example, agricultural and mining support services are included in the Agricultural and Mining sectors, respectively. Therefore, the underlying value added of service-based tasks embodied in gross output and exports of goods may be underestimated.

A requirement when developing TiVA indicators is balanced bilateral trade in services matrices. However, this can be very challenging: few countries publish detailed data by partner country and type of service and, when such data exist they are prone to significant asymmetries e.g. exports of financial services reported by Country A to B may be very different to the imports reported by B from A. Mathematical modelling techniques are used to reconcile the differences and produce balanced estimates. Improvements will come as countries improve reporting of trade in services.

9. Industry global value chains

Foreign value added embodied in domestic final demand, by sector, OECD average, 2011

As a percentage of total domestic demand



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274637

The share of foreign value added embodied in an economy's final demand (or "imports of value added") varies considerably across sectors. This variation is linked to a country's industrial composition and access to basic factors of production (e.g. mineral resources, raw materials and skilled labour force), as well as to the technical characteristics of the final products themselves. Foreign value added is far more prevalent in final manufactured goods than in services. Production of goods can be fragmented across many economies, whereas services often require proximity between the provider and consumer.

In certain economies, some final products contain very little domestic value added if domestic production is virtually absent (e.g. textiles or motor vehicles). Foreign value added can dominate the output of domestic industries that make heavy use of imported primary goods, such as petroleum, basic metals and chemicals. International fragmentation of production is a major determinant of foreign value added in modular products from high-technology industries, such as ICT and electronics.

Between 1995 and 2011, there were notable increases in foreign value added content across all sectors of OECD demand. By 2011, on average, over 50% of value added in many product groups originated from abroad, driven mainly by large increases in value added originating from non-OECD economies. The origin of value added can reflect regional value chains, such as linkages within Europe, within NAFTA, and within East and Southeast Asia ("Factory Asia"). However, demand for *ICT and electronics* in many OECD countries contains a large and increasing share of value added from East and Southeast Asia. In OECD, on average, foreign value added accounts for about 60% of the content of final *ICT and electronics* goods. Japan and the Netherlands are the only OECD countries with domestic value added content greater than 50%.

Many OECD countries rely heavily on foreign value added for *Textiles and apparel*. However, in emerging economies, domestic demand is still mostly satisfied by domestic production.

Definitions

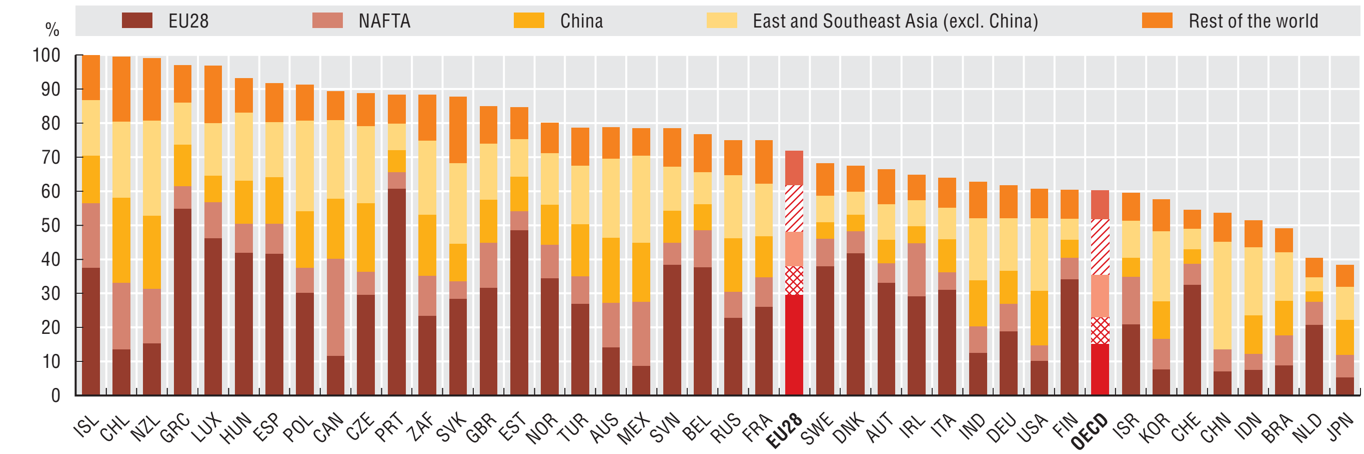
Sectors are defined according to ISIC Rev. 3, notably, *Textiles and apparel* (Divisions 17 to 19) and *Computer, electronic and optical equipment* (30, 32 and 33).

The OECD average share is based on the sum of foreign value added in final demand within each OECD country and includes intra-OECD flows of value added.

The sectors are defined here as the *sectors of demand* such that the value added content may come from any economic activity, domestic or foreign. An alternative perspective, possible with the *Trade in Value Added (TiVA) Database*, comes from analysing the total demand for value added originating from particular sectors within certain countries.

Foreign value added embodied in domestic demand for computer, electronic and optical equipment, by source region, 2011

As a percentage of total final demand for computer, electronic and optical equipment

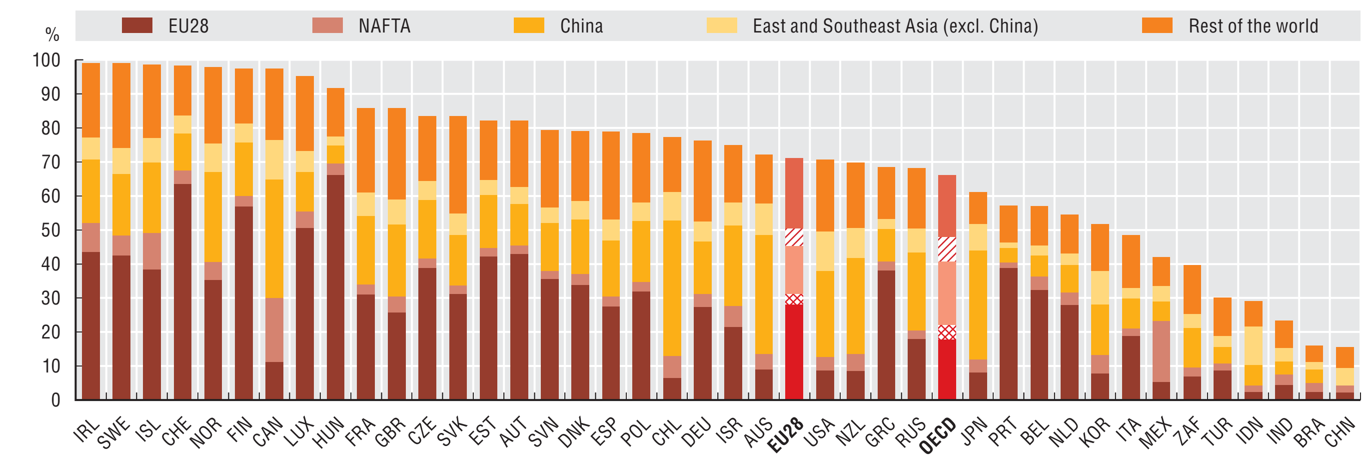


Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274640

Foreign value added embodied in domestic demand for textiles and apparel, by source region, 2011

As a percentage of total final demand for textiles and apparel



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274651

Measurability

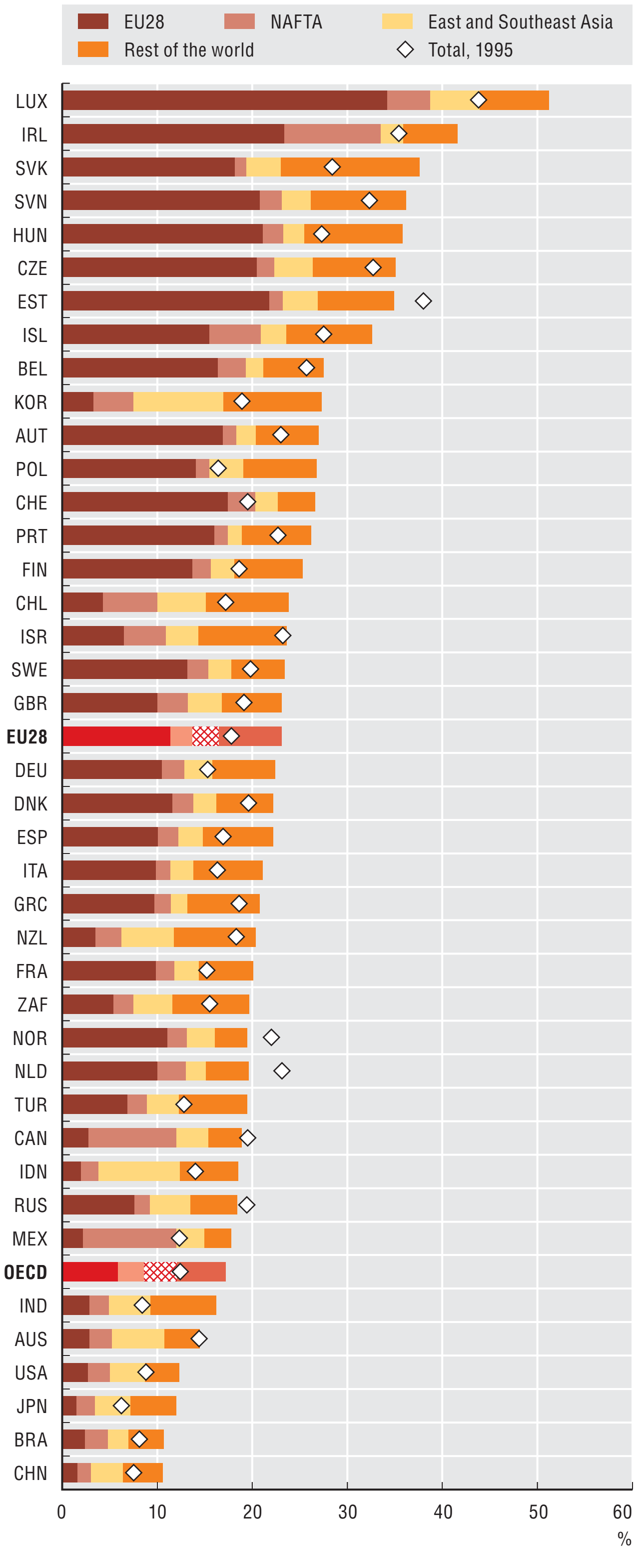
Since trade and transport margins included in purchasers' prices are recorded in the wholesale/retail sector, value added from domestic distribution services for final goods are not included in calculations for individual goods sectors. As a result, the foreign value added content for certain product groups is close to 100% in some smaller economies.

Adjustments for changes in inventories are not included in the estimates for final demand. Not all goods that are produced domestically or imported are used (as intermediates) or consumed in the same accounting year, whether by design (stockpiling) or through circumstance (e.g. a collapse in demand). Instead, these goods are added to inventories. Similarly, domestic or export demand may be met by drawing on inventories – goods produced or purchased in previous years – especially in the case of a collapse in production (e.g. due to unforeseen shortages of raw materials). However, countries only report *changes* in inventories within a National Accounts framework. Efforts are ongoing to determine best practices for dealing with inventory adjustments, as well as discrepancies, when constructing TiVA indicators.

10. Global consumption patterns

Foreign value added embodied in domestic consumption, by source region, 2011

As a percentage of total domestic consumption



Source: OECD, *Trade in Value Added (TiVA) Database*, http://oe.cd/tiva, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274669

On average, about one sixth of OECD-area domestic consumption consists of foreign value added, ranging from about 12% in the largest OECD countries (Japan and the United States) to over one third in the smaller OECD countries. For most economies, a significant share of foreign value added comes from neighbouring economies within the same region.

In general, domestic consumption in large economies or those with significant mineral or agricultural resources tends to rely less on foreign value added, a trend that is also apparent in certain sectors. The 2015 edition of OECD's *Trade in Value Added (TiVA) Database* provides estimates of the country and industry origins of value added in a country's demand for certain products. Estimates of value added origins in final demand for food and beverages, for example, can reveal which countries are more self-sufficient in feeding their population through basic agriculture and food production. Foreign value added plays a relatively large role in food and beverages consumption. Particularly in Europe where for most countries it ranges between 30% and 60% of final demand, due to strong interdependencies and a common agricultural policy.

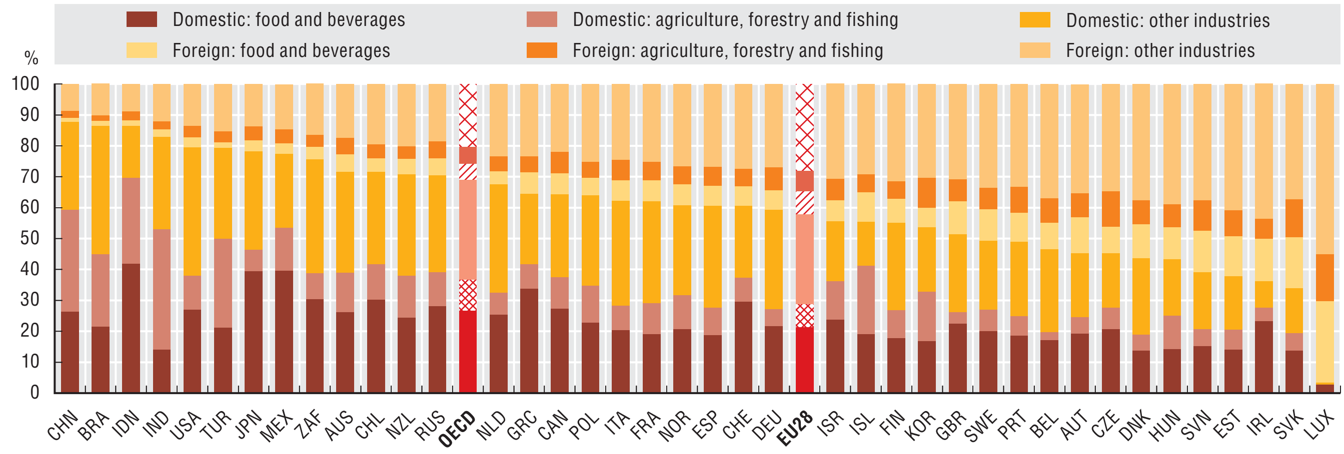
The foreign content of capital investment by businesses, or gross fixed capital formation (GFCF), is significantly higher than that of consumption. Services typically account for over three-quarters of household consumption, many of which are characterised by low foreign content. On the other hand, manufactured goods (such as ICT equipment, machinery and transport equipment) with high foreign content, still account for a large share of capital investment among businesses seeking to facilitate production and improve productivity. In 2011, foreign content of GFCF ranged between 40% and 70% in countries with a strong presence of multinational enterprises. In larger economies such as Brazil, China, Japan and the United States foreign value added content of GFCF was about 20% in 2011, up markedly from 1995.

Definitions

In OECD's Inter-Country Input-Output (ICIO) tables, final demand is split into components of domestic final consumption i.e. expenditures by households, general government and non-profit institutions serving households (NPISH), and GFCF, defined according to the 1993 *System of National Accounts* (SNA93). This allows the development of indicators that reveal, for example, the origins of value added in the purchases made to meet the everyday needs of resident households either via direct expenditure (food, clothing, energy, etc.) or via government provision (education and health care). The *TiVA Database* is therefore able to provide indicators showing the value added content of both final consumption and GFCF by country and industry of origin.

Origin of value added embodied in final demand for food and beverages, 2011

As a percentage of total final demand for food and beverages

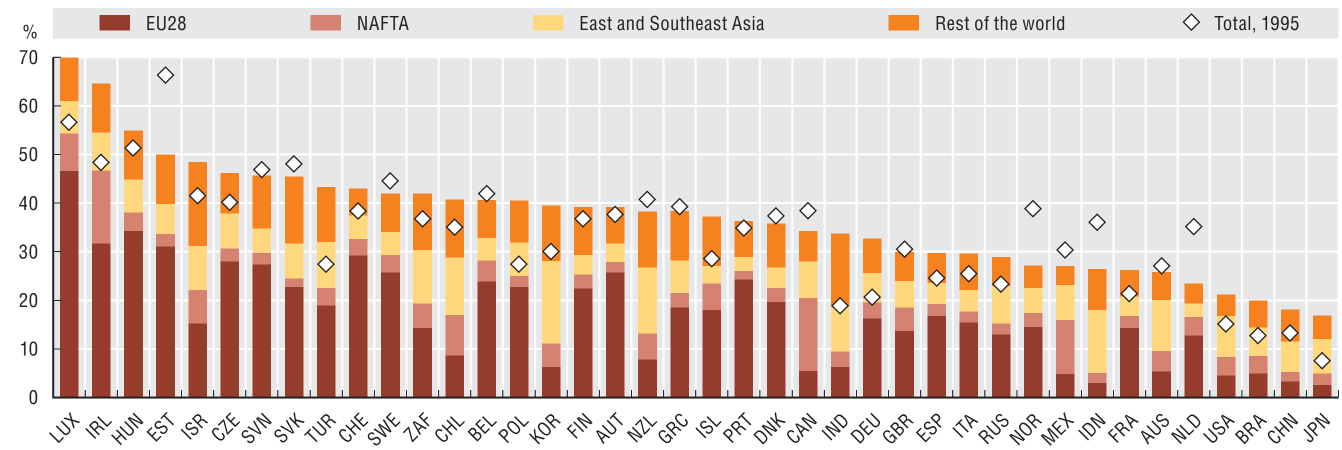


Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274676

Foreign value added content of gross fixed capital formation, 2011

As a percentage of total gross fixed capital formation



Source: OECD, *Trade in Value Added (TiVA) Database*, *http://oe.cd/tiva*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274685

Measurability

Time series of final demand, and its components, by expenditure category are not available in published National Accounts and need to be estimated when constructing ICIO tables.

In the case of household consumption, data provided in benchmark Input-Output tables (IOTs) or Supply and Use tables (SUTs) are used as a starting point. For missing years, interpolation or extrapolation is carried out based on SNA93 statistics on final consumption expenditure of households broken down by the Classification of Individual Consumption According to Purpose (COICOP) – which has been allocated approximately to the ISIC Rev. 3 based product categories used in ICIO. While 3-digit COICOP data is available for most OECD countries, for non-OECD economies estimates are derived from 2-digit COICOP data. Similarly, while many OECD countries publish time series of GFCF by purchasing industries and public sectors, or by type of asset, under SNA93, time series of GFCF by industry of origin remain elusive. Broad assumptions are applied to available data found in IOTs or SUTs to provide estimates for the target years identified in the *TiVA Database*.

Notes and references

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 recognises 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 of the European Union Member States of the OECD and the European Union:

"The Republic of Cyprus is recognised 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."

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

5.1. R&D specialisation

Business R&D intensity adjusted for industrial structure, 2013

A country's industrial structure-adjusted indicator of R&D intensity is a weighted average of its sectoral R&D intensities (ratio of R&D to value added), using the OECD industrial structure – sectoral share in OECD value added for 2013 – as adjusted, common weights across all countries. The unadjusted measure of BERD intensity is by definition an average based on each country's actual sector shares.

R&D series are presented as a percentage of value added in industry estimated as the value added in all activities except: Real estate activities (ISIC Rev. 4 68); Public administration and defence; compulsory social security and education (ISIC Rev. 4 84-85); Human health and social work activities (ISIC Rev. 4 86-88); and Activities of households as employers (ISIC Rev. 4 97-98). R&D performed in these sectors across the OECD is reported to be negligible.

Figures are based on estimates of business R&D by sector reported on a main activity basis, in ISIC Rev. 4.

For Austria, Belgium, Canada, Greece, Ireland, Mexico and Portugal, data refer to 2011.

For Denmark, France, Germany, Hungary, Italy, the United Kingdom and the United States, data refer to 2012.

Value added is measured at basic prices except for Japan and the United States (factor cost and purchasers' prices respectively).

Data on value added come from the OECD, Annual National Accounts database except for Canada and Japan (national sources).

Business R&D in manufacturing, by R&D intensity group, 2013

The R&D intensity groups are defined in OECD (2015, forthcoming), "The R&D Intensity of Economic Activities in OECD Countries: Proposal for a new classification for industry and services".

High and medium-high R&D intensive manufacturing includes "chemicals and pharmaceutical products" (ISIC Rev. 4 Divisions 20 and 21) and "computer, electronic and optical products, electrical equipment, machinery, motor vehicles and other transport equipment" (ISIC Rev. 4 Divisions 26 to 30).

Figures are based on estimates of business R&D by sector reported on a main activity basis, in ISIC Rev. 4.

For Australia, Austria, Belgium, Greece, Ireland and Mexico, data refer to 2011.

For Denmark, France, Germany, Hungary, Israel, Italy, Portugal, Switzerland, the United Kingdom and the United States, data refer to 2012.

For Israel, Norway, Sweden and Switzerland, "chemicals and chemical products" (ISIC Rev. 4 Division 20) are included in the "other manufacturing industries".

R&D in services, 2013

Figures are based on estimates of business R&D by sector reported on a main activity basis, in ISIC Rev. 4.

For Australia, Austria, Belgium, Greece, Ireland and Mexico, data refer to 2011.

For China, data refer to 2000 and 2012.

For Denmark, France, Germany, Hungary, Israel, Italy, Portugal and the United Kingdom, data refer to 2012.

For Estonia, data refer to 2005 and 2013.

For France and the United Kingdom, 2003 data on main activity basis have been backcasted by the OECD using historical series reported on a product field basis.

For Switzerland and the United States, data refer to 2004 and 2012.

5.2. E-business uptake

Enterprises engaged in sales via e-commerce by size, 2013

Unless otherwise stated, only enterprises with ten or more persons employed are considered. Size classes are defined as: SMEs (10 to 249) and large (250 and more).

For countries in the European Statistical System, sector coverage consists of all activities in manufacturing and non-financial market services.

For Australia, data refer to any transaction where the commitment to purchase was made via the Internet, including via email, for the fiscal years 2008/09 and 2013/14, ending 30 June. Data for the fiscal year 2013/14 include agriculture, forestry and fishing activities.

For Canada, data refer to 2007 and 2013 and to small businesses (from 10 to 49 employees) instead of SMEs. In 2013, data refer to sales online over the Internet. Large enterprises have 300 or more employees.

For Colombia, data refer to enterprises with ten or more persons employed in the manufacturing sector (excluding ISIC Rev. 4 Divisions 12-14, 17, 21 and 33) and enterprises with 75 or more persons employed in the non-financial market services (excluding Divisions 49-51, 58, 75 and 77). For industry G – Wholesale and retail trade, data refer to enterprises with 20 or more persons employed; for industries H – Transportation and storage (Divisions 52 and 53), I – Accommodation and food service activities and J – Information and communication (Divisions 59-61), data refer to enterprises with 40 or more persons employed.

For Japan, data refer to businesses with 100 or more employees. Large enterprises have 300 or more employees.

For Mexico, data refer to 2008 and 2012 and to orders received via the Internet. For 2008, data refer to businesses with 20 or more persons employed. For 2012, data refer to establishments with ten or more persons employed. Size categories refer to establishments with 10 to 250, and 251 and more persons employed.

For New Zealand, data refer to orders received via the Internet for the fiscal years 2007/08 and 2013/14, ending 31 March.

For Switzerland, data refer to 2008 and 2011. For 2008, data refer to businesses with five or more persons employed.

For Turkey, data refer to small businesses instead of SMEs.

Diffusion of selected ICT tools and activities in enterprises, 2014

Broadband includes both fixed and mobile connections with an advertised download rate of at least 256 Mbps.

E-purchases and e-sales refer to the purchase and sales of goods or services conducted over computer networks by methods specifically designed for the purpose of receiving or placing of orders (i.e. webpages, extranet or EDI but not orders by telephone calls, fax or manually typed e-mail). Payment and delivery are not considered.

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 customer relations. Here, only sharing of information within the firm is considered.

Cloud computing refers to ICT services used over the Internet as a set of computing resources to access software, computing power, storage capacity and so on.

Supply chain management refers to the use of automated data exchange (ADE) applications.

Social media refers to applications based on Internet technology or communication platforms for connecting, creating and exchanging content online with customers, suppliers or partners, or within the enterprise. Social media might include social networks (other than paid advertisement), blogs, file sharing and wiki-type knowledge sharing tools.

Radio Frequency Identification (RFID) is a technology that enables contactless transmission of information via radio waves. RFID can be used for a wide range of purposes, including personal identification or access control, logistics, retail trade and process monitoring in manufacturing.

Unless otherwise stated, only enterprises with ten or more persons employed are considered.

For countries in the European Statistical System, sector coverage consists of all activities in manufacturing and non-financial market services.

For countries in the European Statistical System, data on e-purchases and e-sales refer to 2013.

For Australia, data refer to the fiscal year 2013/14, ending 30 June and include agriculture, forestry and fishing activities.

For Canada and Japan, data refer to 2013 except cloud computing (2012).

For Korea, data refer to 2013.

For Mexico, data refer to 2012 and to establishments with ten or more persons employed.

For New Zealand, data refer to the fiscal year 2013/14, ending 31 March.

For Switzerland, data refer to 2011.

Enterprises using cloud computing services by size, 2014

Cloud computing refers to ICT services used over the Internet as a set of computing resources to access software, computing power, storage capacity and so on.

Data refer to manufacturing and non-financial market services enterprises with ten or more persons employed, unless otherwise stated.

Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249) and large (250 and more).

For Canada, data refer to 2012 and to enterprises that have made expenditures on software as a service (e.g. cloud computing). Medium-sized enterprises have 50-299 employees. Large enterprises have 300 or more employees.

For Japan, data refer to 2012 and to businesses with 100 or more employees. Medium-sized enterprises have 100-299 employees. Large enterprises have 300 or more employees.

For Korea, data refer to 2013.

For Switzerland, data refer to 2011.

5.3. Start-up dynamics

General notes for all figures:

The figures for the period are constructed as averages of observations gathered over three-year reference periods (2001-04, 2004-07, 2007-10). The period covered is 2001-10 for all countries except Portugal and Turkey, for which the period covered is 2007-10, and Spain, for which the period covered is 2004-10.

Sectors covered are: manufacturing, construction, and non-financial business services.

Figures report the unweighted average of each country-period value, conditional on their availability.

Owing to methodological differences, figures may differ from those officially published by national statistical offices.

Mergers and acquisitions are not taken into account in determining firm age, firm entry and firm exit.

5.4. Creative by design

Top ten design applicants by main field of application, 2011-13

Data refer to designs registered, by filing date, applicant's residence and Locarno classes using fractional counts.

The following aggregated fields based on the Locarno Classification are used: Furniture and household goods: Classes 6, 7 and 30; Clothes, textiles and accessories: Classes 2, 3, 5 and 11; Tools and machines: Classes 4, 8, 10 and 15; Health, pharma and cosmetics: Classes 24 and 28; Leisure and education: Classes 17, 19, 21 and 22; Agricultural and food products: Classes 1, 27 and 31; Construction: Classes 23, 25 and 29; ICT and audio-visual: Classes 14, 16 and 18; Electricity and lightning: Classes 13 and 26; Advertising: Classes 20 and 32; Transport: Class 12 and Packaging: Class 9.

Residence of designers active on the Japanese market, by field of design, 2004-14

Data refer to designs registered at the JPO, by filing date, creator's residence and Locarno classes using fractional counts.

The following aggregated fields based on the Locarno Classification are used: Furniture and household goods: Classes 6, 7 and 30; Clothes, textiles and accessories: Classes 2, 3, 5 and 11; Tools and machines: Classes 4, 8, 10 and 15; Health, pharma and cosmetics: Classes 24 and 28; Leisure and education: Classes 17, 19, 21 and 22; Agricultural and food products: Classes 1, 27 and 31; Construction: Classes 23, 25 and 29; ICT and audio-visual: Classes 14, 16 and 18; Electricity and lightning: Classes 13 and 26; Advertising: Classes 20 and 32; Transport: Class 12 and Packaging: Class 9.

JPO registered design data cover the period up to June 2014.

Designs on the Japanese market created abroad, 2004-14

Data refer to designs registered at the JPO, by filing date, applicant's and creator's residence using fractional counts. The share of registered designs created abroad corresponds to the share of applications where the residence of the "creator" (designer) is different from the applicant's residence.

Only economies with more than 100 designs registered at JPO in 2004-14 are included. JPO registered design data cover the period up to June 2014.

5.5. Technological advantages

General notes for all figures:

The revealed technological advantage index is calculated as the share of patents of an economy in a particular technology area relative to the share of total patents belonging to the economy. Data refer to IP5 patent families with members filed at the EPO or the USPTO, by first filing date and the inventor's residence using fractional counts. Only economies with more than 500 patents in 2010-13 are included.

Additional notes:

Revealed technological advantage in biotechnology and nanotechnology, 2000-03 and 2010-13

Biotechnology and nanotechnology patents are defined on the basis of their International Patent Classification (IPC) codes.

Data from 2012 are estimates.

Revealed technological advantage in ICT, 2000-03 and 2010-13

Patents in ICT are identified following a new experimental classification based on their International Patent Classification (IPC) codes.

Data from 2012 are estimates.

Range of revealed technological advantage in economies by field, 2010-13

Patents are allocated to technology fields on the basis of their International Patent Classification (IPC) codes, following the concordance provided by WIPO (2013).

5.6. Participation in global value chains

General notes for all figures:

For a given year, foreign value added embodied in final demand or exports of country c can be calculated as:

$$\text{diag}(\mathbf{V}_f)\ (\mathbf{I}\text{-}\mathbf{A})^{-1}\ \mathbf{FD}_c$$

$$\text{diag}(\mathbf{V}_f)\ (\mathbf{I}\text{-}\mathbf{A})^{-1}\ \mathbf{EXGR}_c$$

where diag($\mathbf{V}_f$) is the diagonalised matrix form of vector $\mathbf{V}_f$ with value added to production (gross output) ratios for all industries in countries $f \neq c$, zero for the entries corresponding to c; $\mathbf{A}$ is the global input coefficient matrix derived from the OECD Inter-Country Input-Output (ICIO) table for the target year, and $\mathbf{FD}_c$ and $\mathbf{EXGR}_c$ are vectors of length (number of countries × number of industries) which contain final demand and exports, respectively, by country c and are zero for the elements corresponding to countries $f \neq c$.

Sectors are defined according to ISIC Rev. 3: Manufactures (Divisions 15 to 37); Services: Wholesale, retail trade, hotels and restaurants (50 to 55); Transport, storage and communications (60 to 64); Finance and insurance (65 to 67); Business services (70 to 74) and Other services (75 to 93).

Additional notes:

Foreign value added embodied in exports and in domestic demand, by source region, 2011

East and Southeast Asia comprises Brunei Darussalam, Cambodia, China, Chinese Taipei, Hong Kong (China), Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand and Viet Nam.

Domestic value added embodied in partner countries' exports, 1995 and 2011

Domestic value added in partner countries' exports is the sum of the domestic value added in exports to all other countries that is then included in other countries' exports.

5.7. Trade and jobs

General notes for all figures:

For a given year, jobs in country *c* embodied in (or sustained by) foreign final demand is calculated as:

$$\text{diag}(\mathbf{E}_c)\ (\mathbf{I\text{-}A})^{-1}\ \mathbf{FFD}$$

where diag($\mathbf{E}_c$) is a matrix with sectoral employment to production (gross output) ratios in country *c* as diagonal elements, zero otherwise; **A** is the global input coefficient matrix derived from the ICIO table for the target year, and **FFD** is a vector of foreign final demand and includes final expenditure by non-residents in the domestic territory.

Additional notes:

Jobs in the business sector sustained by foreign final demand, by region of demand, 2011

The Business sector consists of ISIC Rev. 3 Divisions 10 to 74, i.e. total economy excluding Agriculture, forestry and fishing (Divisions 01 to 05), Public administration (75), Education (80), Health (85) and Other community, social and personal services (90 to 95).

East and Southeast Asia (excluding China) comprises Brunei Darussalam, Cambodia, Chinese Taipei, Hong Kong (China), Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand and Viet Nam.

Jobs sustained by foreign final demand, by sector, 2011

Sectors are defined according to ISIC Rev. 3: Primary goods (Divisions 01 to 05 and 10 to 14); Manufacturing (15 to 37), Trade and transportation (50 to 55 and 60 to 63); Financial and business services (64 to 74) and Other services (40 to 41, 45 and 75 to 95).

Business sector service jobs sustained by final demand of manufactured goods, 2011

Sectors are defined according to ISIC Rev. 3: Wholesale and retail trade (Divisions 50 to 52) Transport and storage (60 to 63); ICT services (64 and 72); Financial and insurance (65 to 67) and Other business services (70, 71, 73 and 74).

5.8. Service-manufacturing linkages

General notes for all figures:

For a given year, domestic services value added embodied in gross exports of country *c* is calculated as:

$$\text{diag}(\mathbf{V}_c)\ (\mathbf{I\text{-}A})^{-1}\ \mathbf{EXGR}_c$$

where diag($\mathbf{V}_c$) is a matrix with service sector value added to production (gross output) ratios of country *c* as diagonal elements, zero otherwise; **A** is the global input coefficient matrix derived from the ICIO table for the target year, and $\mathbf{EXGR}_c$ is a vector of length (number of countries × number of industries) which contains exports by country *c* and is zero for the elements corresponding to countries $f \neq c$. For foreign services content $\mathbf{V}_c$ is replaced by $\mathbf{V}_f$ containing service value added to production ratios for all countries except *c*.

5.9. Industry global value chains

General notes for all figures:

For a given year, foreign value added embodied in final demand in country *c* can be calculated as:

$$(\mathbf{V}_f)\ (\mathbf{I\text{-}A})^{-1}\ \mathbf{FD}_c$$

where $\mathbf{V}_f$ is a row vector with value added to production (gross output) ratios for all industries in countries $f \neq c$; **A** is the global input coefficient matrix derived from the ICIO table for the target year, and $\mathbf{FD}_c$ is a vector of length (number of countries × number of industries) which contains final demand in country *c* and is zero for the elements corresponding to countries $f \neq c$.

Other East and Southeast Asia comprises Brunei Darussalam, Cambodia, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand and Viet Nam.

5.10. Global consumption patterns

General notes for all figures:

For a given year, foreign value added embodied in domestic final consumption or gross fixed capital formation of country *c* can be calculated as:

$$\text{diag}(\mathbf{V}_f)\ (\mathbf{I\text{-}A})^{-1}\ \mathbf{CONS}_c$$
$$\text{diag}(\mathbf{V}_f)\ (\mathbf{I\text{-}A})^{-1}\ \mathbf{GFCF}_c$$

where diag($\mathbf{V}_f$) is the matrix form of vector $\mathbf{V}_f$ with value added to production (gross output) ratios for all industries in countries $f \neq c$, zero for the entries corresponding to *c*: **A** is the global input coefficient matrix derived from the ICIO table for the target year, and $\mathbf{CONS}_c$ and $\mathbf{GFCF}_c$ are vectors of length (number of countries × number of industries) which contain domestic consumption and gross fixed capital formation by country *c* and are zero for the elements corresponding to countries $f \neq c$.

Additional notes:

Foreign value added embodied in domestic consumption, by source region, 2011

East and Southeast Asia comprises Brunei Darussalam, Cambodia, China, Hong Kong (China), Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Chinese Taipei, Thailand and Viet Nam.

EU28 foreign origin of value added includes intra-EU flows; OECD foreign origin of value added includes intra-OECD flows.

Origin of value added embodied in final demand for food and beverages, 2011

Sectors are defined according to ISIC Revision 3: Agriculture, forestry and fishing (Divisions 01 to 05); Food and beverages (15 to 16).

EU28 foreign origin of value added includes intra-EU flows; OECD foreign origin of value added includes intra-OECD flows.

Foreign value added content of gross fixed capital formation, 2011

East and Southeast Asia comprises Brunei Darussalam, Cambodia, China, Hong Kong (China), Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Chinese Taipei, Thailand and Viet Nam.

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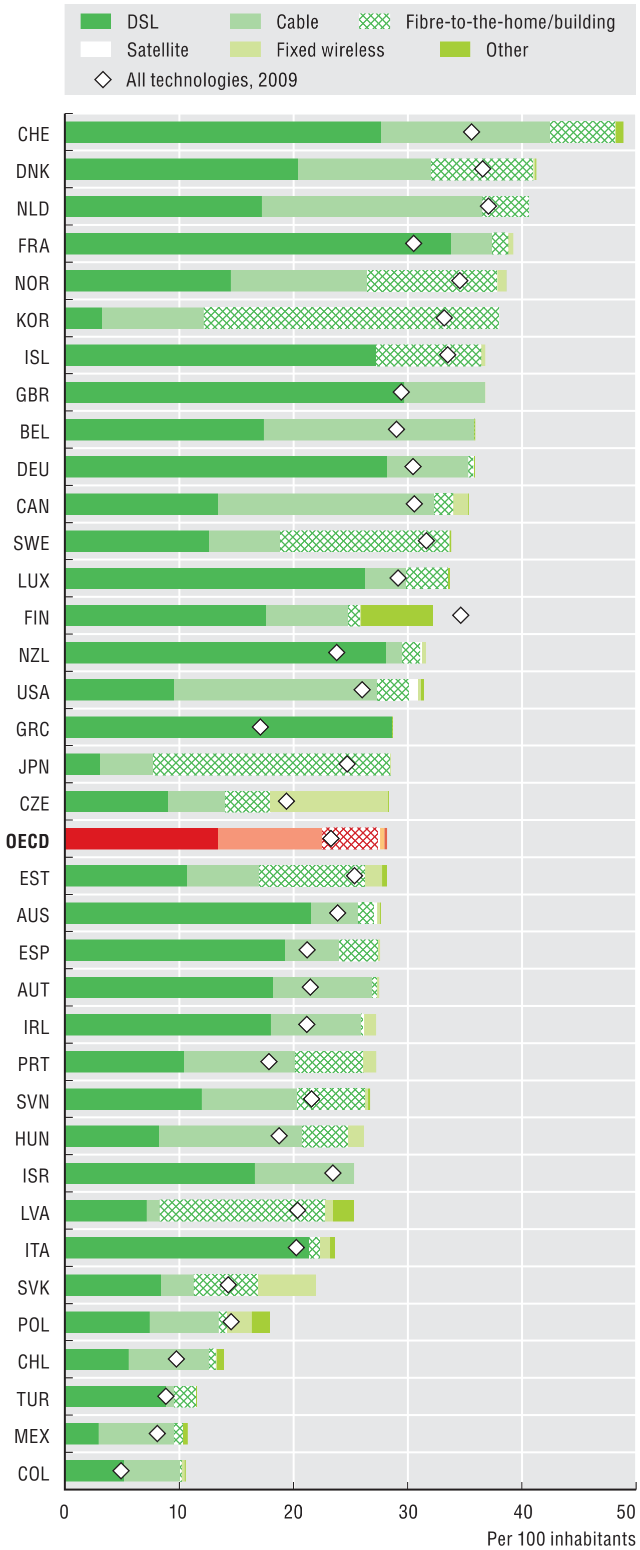
6. EMPOWERING SOCIETY WITH SCIENCE AND TECHNOLOGY

Economies' ability to innovate and grow ultimately depends on the participation of citizens in innovative processes, the degree of sophistication of demand, and the readiness to accept and recognise the potential of science and technology. Empowering society to innovate means encouraging participation in the digital economy. The pace at which digital applications are evolving poses particular challenges for tracking and monitoring the use of new technologies and their impacts. A new set of key indicators looks at individuals' access to and use of technologies from an early age. The level of sophistication of users and their role as e-consumers and e-citizens is particularly important in distinguishing the readiness of society to participate in innovative processes. Another set of indicators looks at support for innovation to tackle grand challenges, such as health and the environment, as well as countries' leadership in the development of new technologies in those areas. Finally, developments in science and technology have visible impacts on people's lives. New, experimental indicators make use of qualitative surveys to develop indicators of public perceptions of science and technology.

1. Enabling connectivity

Fixed broadband penetration by technology, December 2014

Subscriptions per 100 inhabitants



Source: OECD, Broadband Portal, *www.oecd.org/sti/broadband/oecdbroadbandportal.htm*, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274698

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. Fixed broadband subscriptions in the OECD area reached 358 million as of December 2014, with an average penetration rate of 28%, up from 23% at the end of 2009.

The majority of fixed broadband connections in OECD countries are currently provided over DSL (48%) and cable modem (32%) technologies but the share of direct fibre connections increased to 17% in December 2014, up from 11% in December 2009.

Progress has been particularly swift in mobile broadband. Mobile broadband penetration for the OECD area reached 81% in December 2014, up from 44% in 2010. Penetration rates reached over 100% in Australia, Denmark, Estonia, Finland, Japan, Korea, Sweden and the United States.

SIM cards for machine-to-machine (M2M) usage account for a growing segment of mobile data subscriptions. 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.

In December 2014, there were 104.7 million M2M SIM cards in the 29 OECD countries for which data are available. Sweden is an outlier for M2M penetration with 63 M2M SIM cards per 100 inhabitants. New Zealand and Norway follow with over 20 M2M SIM cards per 100 inhabitants.

Definitions

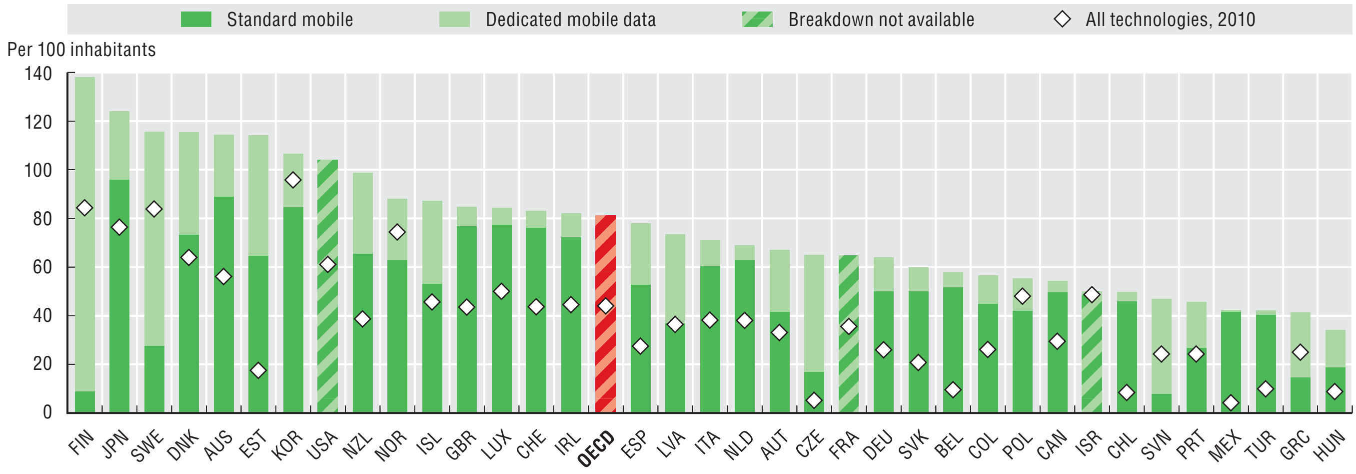
Broadband penetration indicators are defined as the number of subscriptions to fixed and mobile broadband services, divided by the number of residents in each country. *Fixed broadband* comprises DSL, cable, fibre-to-the-home (FTTH) and fibre-to-the-building (FTTB), satellite, terrestrial fixed wireless and other fixed wired technologies. *Mobile broadband* comprises 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 offer only walled gardens or email access are not counted) and when content or services were accessed via the Internet Protocol (IP) during the previous three months.

M2M communication relies on mobile wireless networks and is based on the use of SIM cards for authentication and telephone numbers for connectivity, as is the case of mobile telephony. SIM card numbers and telephone numbers are obtained from regulators who now require mobile operators to use different telephone number ranges for M2M.

Mobile broadband penetration by technology, December 2014

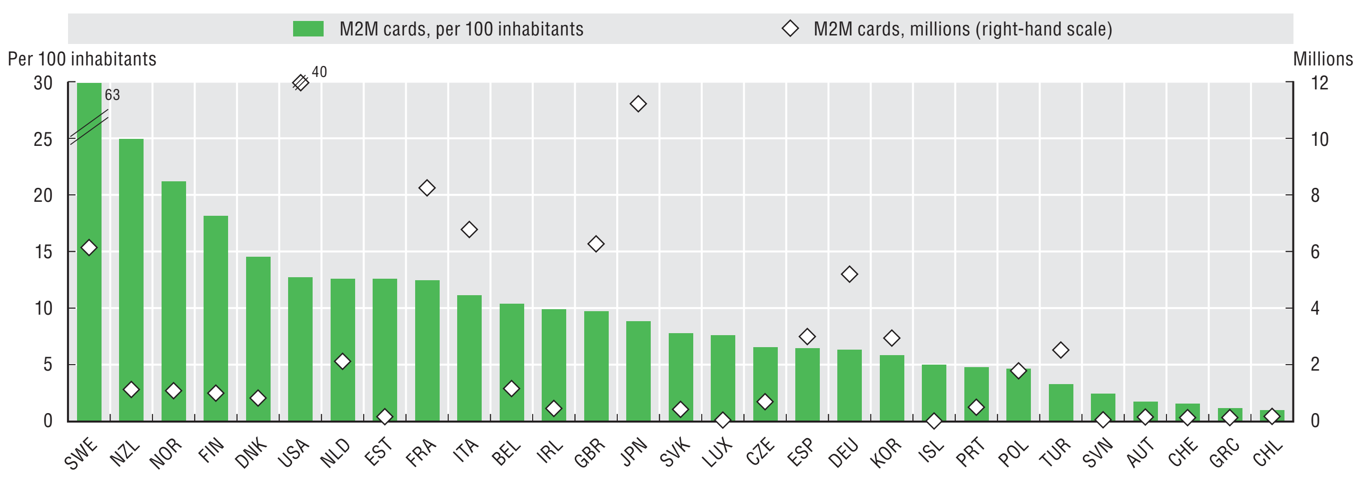
Subscriptions per 100 inhabitants



Source: OECD, Broadband Portal, *www.oecd.org/sti/broadband/oecdbroadbandportal.htm*, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274703

Penetration of machine-to-machine (M2M) SIM cards, December 2014



Source: OECD, Broadband Portal, *www.oecd.org/sti/broadband/oecdbroadbandportal.htm*, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274715

Measurability

Fixed (wired) and mobile wireless broadband subscriptions for OECD countries are collected according to common definitions and are highly comparable (OECD, 2015). Data for wireless broadband subscriptions have improved greatly in recent years, especially with regard to measurement of standard mobile and dedicated mobile data subscriptions.

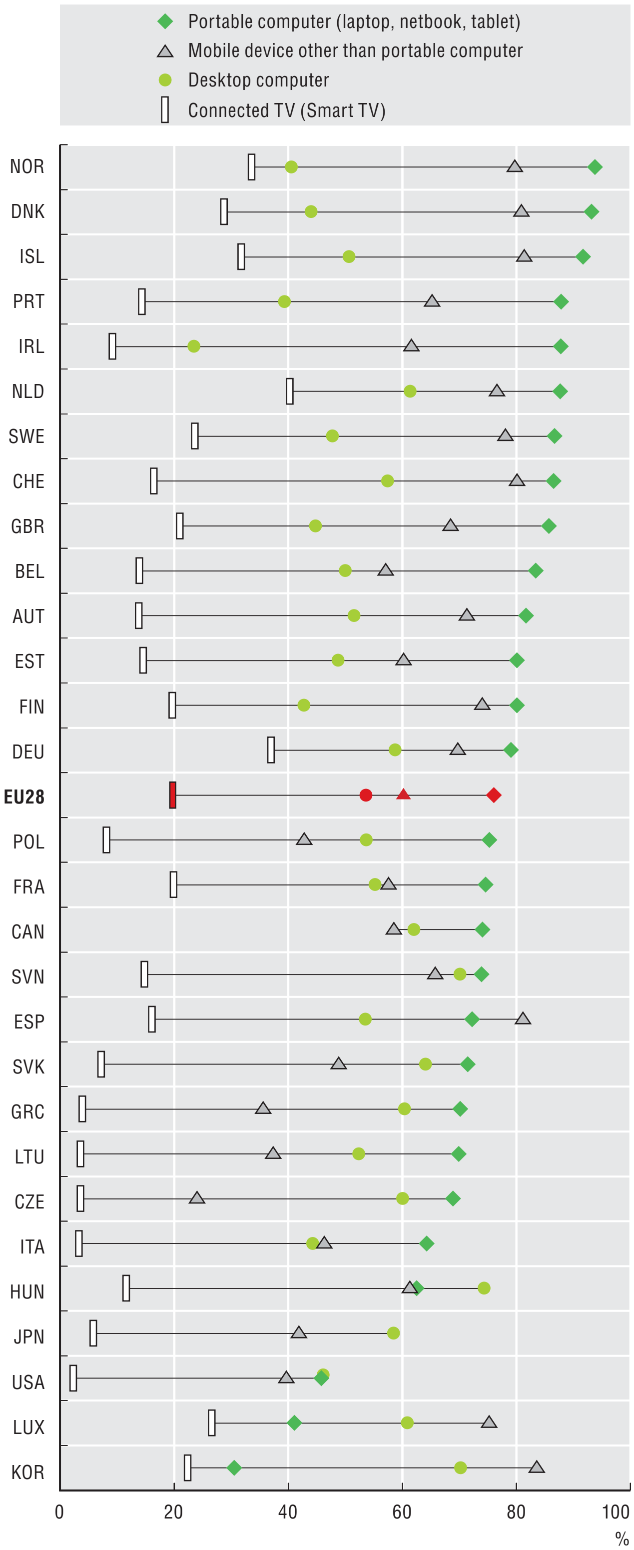
In the case of standard mobile subscriptions, these need to be active during the last three months before the date of measurement, which can pose difficulties. Data respecting these standards are now available for most OECD countries.

Coverage of dedicated data mobile statistics tends to vary across countries, which may contribute to large differences in penetration rates. A few countries do not report separate statistics for standard and data-dedicated mobile subscriptions. There is no official methodology yet 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. The indicators presented here are therefore in the initial stage of development.

2. Online devices and applications

Devices used to access the Internet at home, 2014

As a percentage of households with Internet access at home



Source: OECD, based on Eurostat, *Information Society Statistics Database* and national sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274726

Most ICT devices today are Wi-Fi enabled, allowing users to connect to the Internet anywhere and anytime. On average, 60% of households with Internet access in OECD countries connect to the Internet at home via smartphones, game players or e-book readers, 75% employ a laptop computer or tablet, and 53% use a desktop computer. Smart TVs are used to access the Internet by 17% of the households with Internet connection.

The broad 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 myriad services including many related to mobility, such as location-based services, as well as a growing array of sensors integrated with handheld devices. Apps 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 28 applications installed but uses less than 11. In general, the number of apps installed is closely correlated with the number of apps in use.

There has been a significant rise in the use of cloud computing services among Internet users. The cloud functions as a virtual storage space for documents, pictures, music or video files, which are saved or shared with other users. Cloud computing is also meeting demand for flexibility and ease of access to software and content, which can be accessed by users irrespective of location or time.

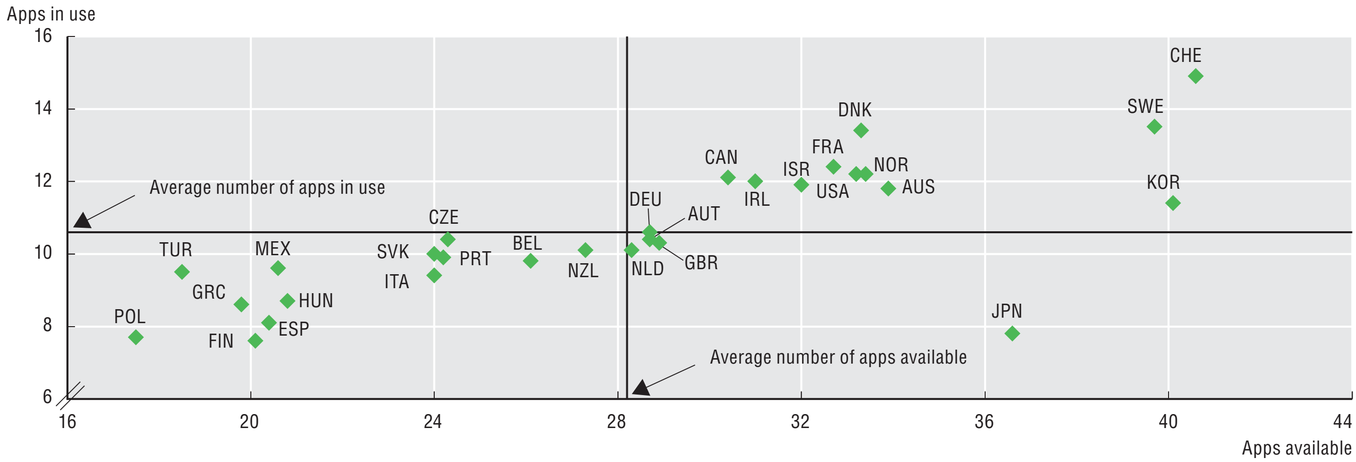
In 2014, uptake of cloud computing among Internet users in European countries ranged from 13% in Poland to 46% in Denmark. In all countries, the propensity to use cloud computing services is much higher among younger and more educated people. The share of Internet users paying for these services remains low and ranges from 10% in Norway to less than 1% in Slovenia.

Definitions

The average number of devices used is approximated based on the sum of 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 that targeted specialised enterprises in different countries. The reference period for the number of apps used was the last 30 days. Services based on cloud computing technology allow users to store large files or use software on a server run over the Internet, which can be accessed from numerous devices or locations.

Smartphone apps availability and usage, 2013

Average number per user

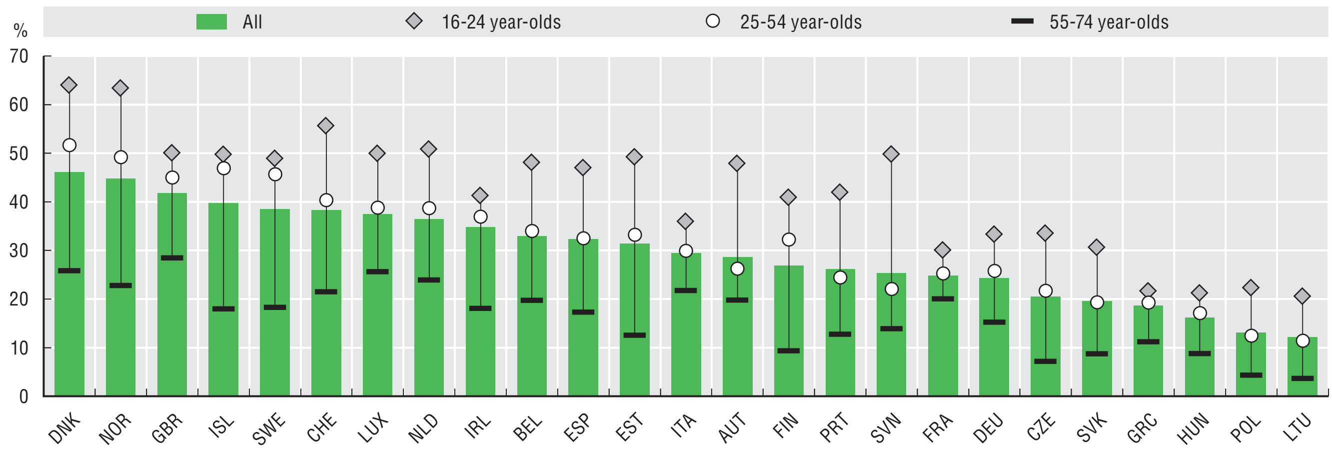


Source: Google, Our Mobile Planet, Smartphone research 2013, *http://think.withgoogle.com/mobileplanet/en/downloads*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274733

Individuals using cloud computing services, by age, 2014

As a percentage of Internet users



Source: OECD, based on Eurostat, *Information Society Statistics Database*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274742

Measurability

Devices are surveyed in different ways across countries (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.

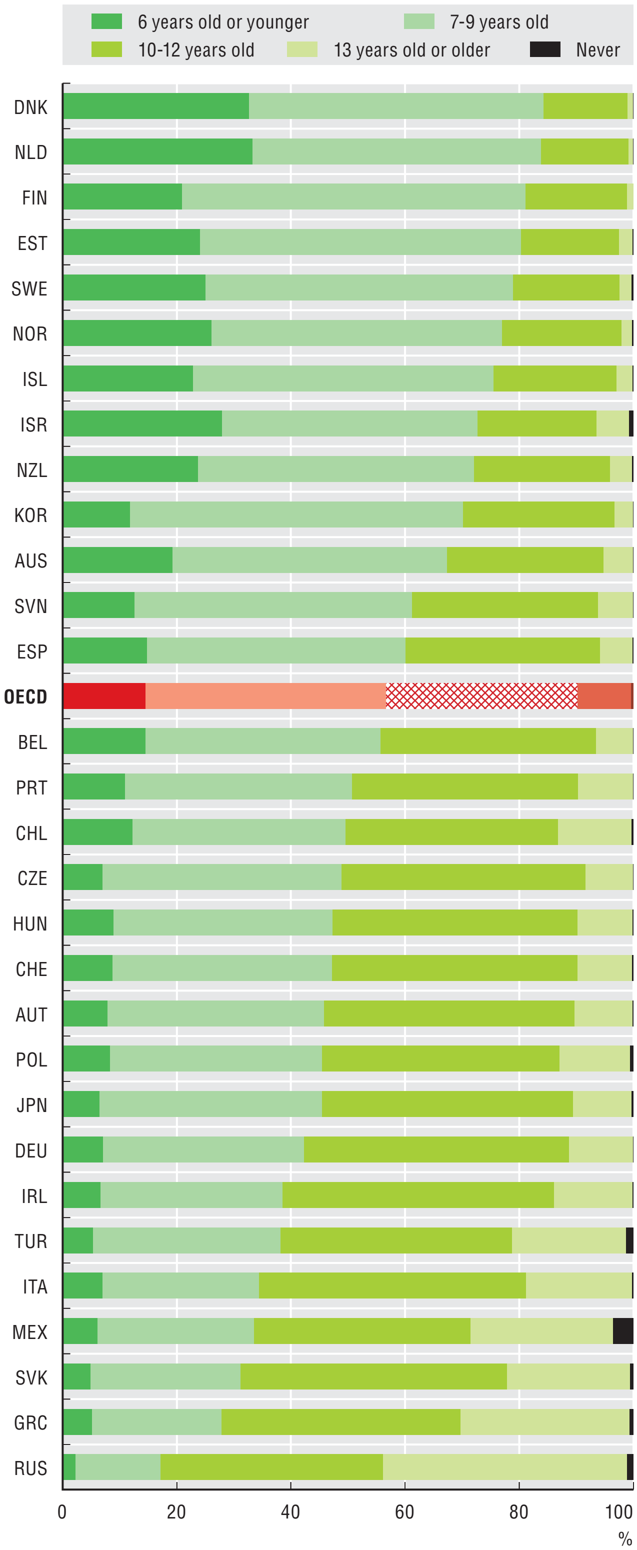
App-related information from the Google multi-country survey can be considered sufficiently reliable, but is based on relatively small country-level samples (about 1 000 individuals), which limits its use. A specific module on apps has been included in the 2014 revision of the OECD Model Survey on ICT Access and Usage by Households and Individuals (OECD, 2014b). 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.

Cloud services are a relatively new phenomenon compared to web applications for social networking, listening to music or watching films. One of the main challenges faced when measuring usage is the ability to make a clear distinction between cloud computing and other online services.

3. Digital natives

Age of first access to the Internet, 2012

As a percentage of 15 year-old students



Source: OECD, *PISA 2012 Database*, June 2015.

StatLink http://dx.doi.org/10.1787/888933274753

The Internet permeates every aspect of the economy and society and is also becoming an essential element of children's lives. On average, for countries where data are available, less than 0.5% of 15 year-olds report never having accessed the Internet.

Age of first access to the Internet varies largely across countries. About 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. According to the *PISA 2012 Database* (Programme for International Student Assessment), the average OECD student spends about 3 hours a day online, ranging from 4 hours in Australia, Denmark and Sweden to 1.5 hours in Korea.

Students are at the forefront of ICT uptake across all OECD countries, and schools play a crucial role in this respect. 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. Almost 28% of students in Japan and Mexico stated that Internet access was unavailable in school compared with the OECD average of 10%.

Over the last few years, ICTs have contributed increasingly to a wider array of learning opportunities through the development of online courses, such as massive open online courses (MOOCs). In 2013, 7.8% of Internet users in the European Union followed an online course against 6.1% in 2009. This increase was generalised across most countries. For the 26 OECD countries for which data are available, 7.6% followed an online course, varying from 16% in Finland, to less than 4% in Austria, the Czech Republic, and Poland.

Definitions

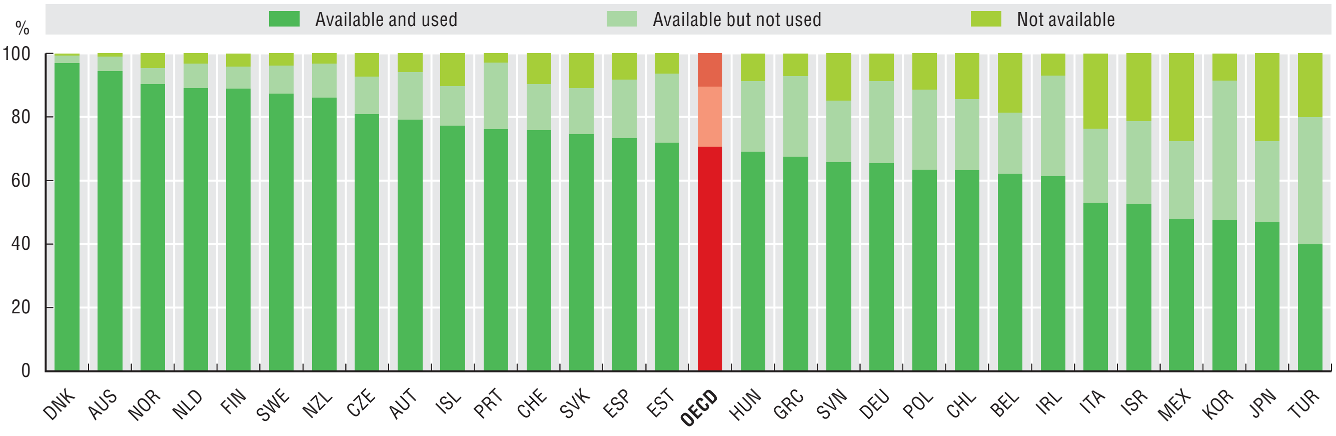
Students assessed by PISA are between the ages of 15 years 3 months and 16 years 2 months. They must be enrolled in school and have completed at least 6 years of formal schooling, regardless of the type of institution, programme followed or whether the education is full-time or part-time.

An *Internet connection at school* is considered to be available even if students' access is limited to certain times or to certain activities.

An *online course* means a course in which some content is delivered electronically using the Internet or other computer-based methods, and/or some teaching is conducted from a remote location through an online course learning management system or other online or electronic tools.

Internet connection availability at school, 2012

Percentage breakdown of 15 year-old students

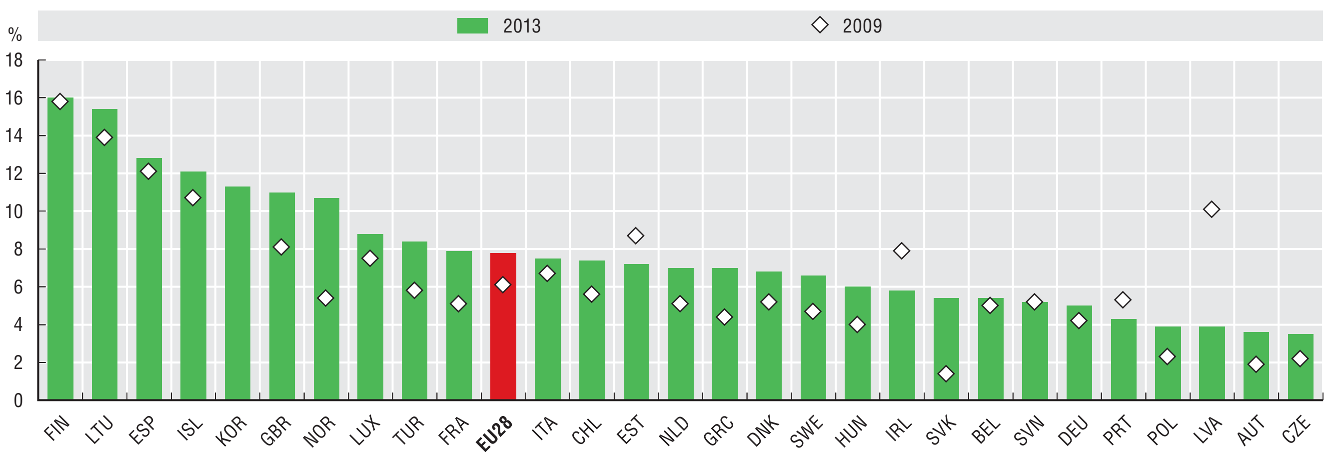


Source: OECD, *PISA 2012 Database*, June 2015.

StatLink http://dx.doi.org/10.1787/888933274765

Individuals who participated in an online course, 2009 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 Database*, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274772

Measurability

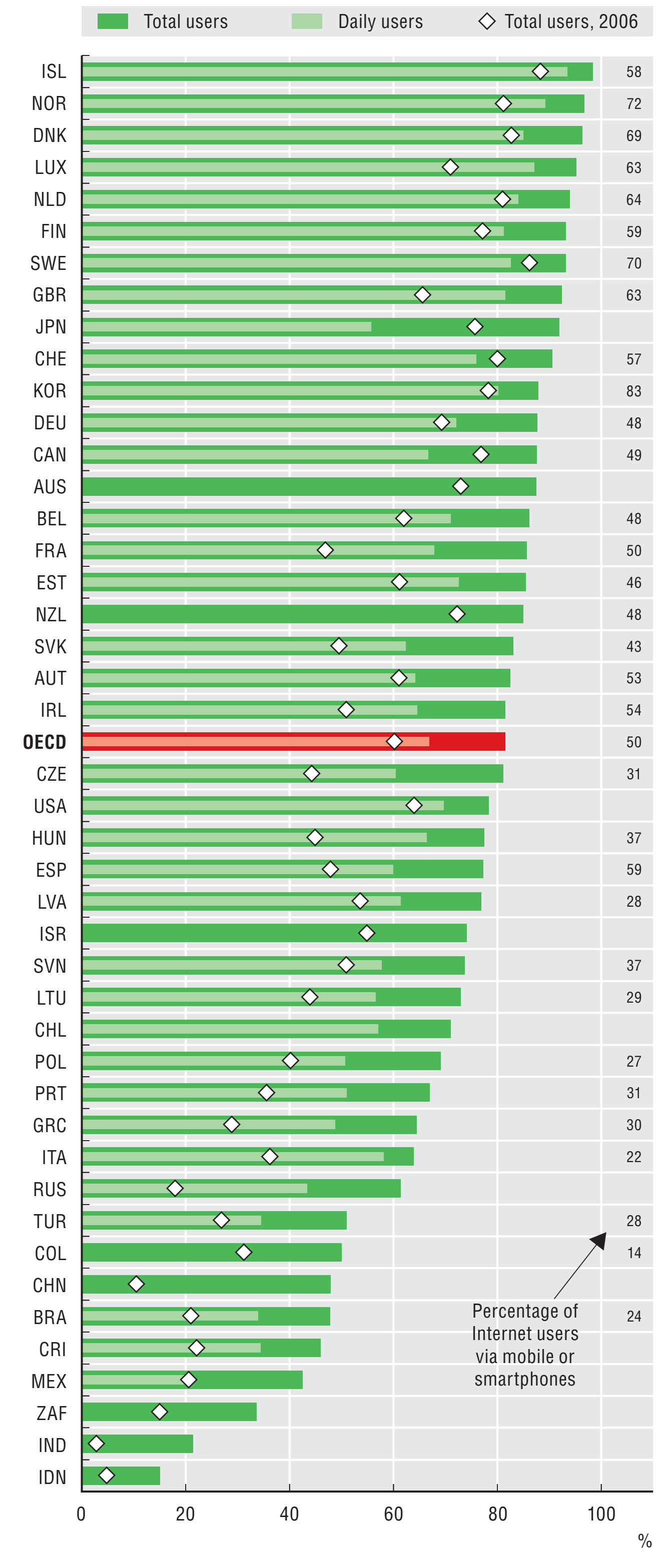
PISA 2012 assessed the skills of 15 year-olds in 65 economies. Around 510 000 students between the ages of 15 years 3 months and 16 years 2 months participated, representing 28 million 15 year-olds globally. The ICT familiarity questionnaire is an optional module administered to an overall student population of 310 000 across 43 countries and economies. It provides information on the availability of ICTs at home and in school, the frequency of use of different devices and technologies, and student's attitudes towards computers.

There is still a significant 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 subject areas, attendance frequency and participants' characteristics would allow for better understanding of ICT use in education today. In this respect, Internet-based statistics have the advantage of providing timely indicators. The use and interpretation of such statistics, however, should be undertaken with caution due to the problems of representativeness and reliability.

4. Internet users

Total, daily and mobile Internet users, 2014

As a percentage of 16-74 year-olds



Source: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database*; ITU, *World Telecommunication/ICT Indicators Database* and national sources, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274785

Internet usage varies widely across OECD countries and among social groups. In 2014, 95% and more of the adult population were accessing the Internet in Iceland, Norway, Denmark and Luxembourg, but only just over half of the population in Turkey and less in Mexico.

From 2006 to 2014, total usage rates across the OECD increased by 22 percentage points, from 60% to 82%. 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". In 2014, half of the adult OECD population used a mobile or smartphone to connect to the Internet.

For most people, the Internet is now part of everyday life. On average, 70% of individuals in OECD countries for which data are available connect to the Internet on a daily basis. In Iceland, Luxembourg and Norway over 87% of individuals access the Internet every day, while 35% and 21% of individuals are daily users in Turkey and Mexico, respectively.

Differences in Internet uptake are linked primarily to age and education, often intertwined with income levels. In most countries, uptake by young people is nearly universal, but there are wide differences for older generations, especially seniors. More than 80% of 65-74 year-olds in Denmark, Iceland, Luxembourg and Norway reported using the Internet in 2014 against less than 10% in Mexico and Turkey. Greece shows the strongest difference in uptake between the young and the old. Elderly people, in particular those with a lower education, are therefore a potential focus of strategies to foster digital inclusion.

In 2014, Internet usage among women in OECD countries (80%) was lower than the average (82%). This difference is more pronounced in Turkey, where use of the Internet among women was almost 9 percentage points below the average. In the Russian Federation, however, Internet usage among women is more than 5 percentage points above the country's average. Overall, there are large differences in the total share of Internet users between young (96%) and elderly women (57%).

Definitions

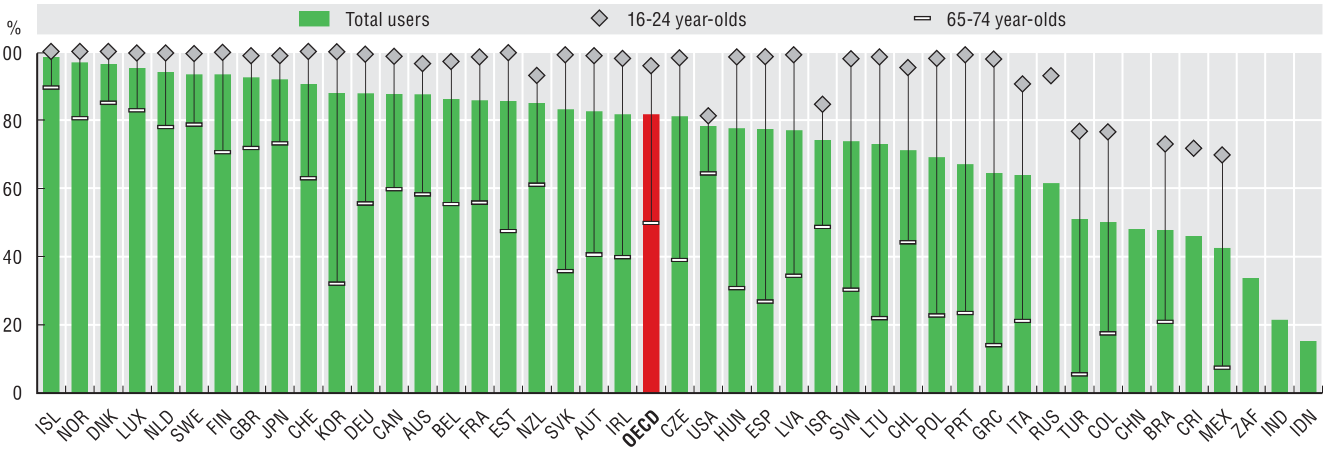
Users include individuals who accessed the Internet within the last three months prior to surveying. Different recall periods have been used for some countries (see chapter notes).

Daily users consist of individuals accessing the Internet approximately every day on a typical week (i.e. excluding holidays, etc.).

Mobile Internet usage is defined as using the Internet away from home or work on a portable computer or handheld device. Figures on individuals using the Internet via mobile or smartphones include connection via mobile or wireless networks for countries in the European Statistical System; for other countries see chapter notes.

Internet users, by age, 2014

As a percentage of the population in each age group

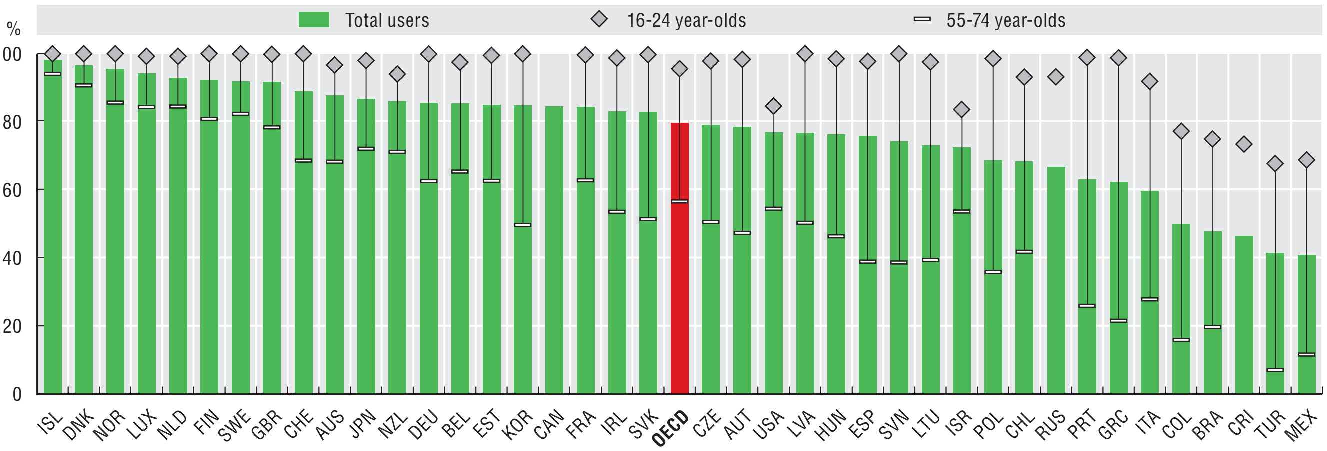


Source: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database*; ITU, *World Telecommunication/ICT Indicators Database* and national sources, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274795

Women Internet users, by age, 2014

As a percentage of the population in each age group



Source: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database*; ITU, *World Telecommunication/ICT Indicators Database* and national sources, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274801

Measurability

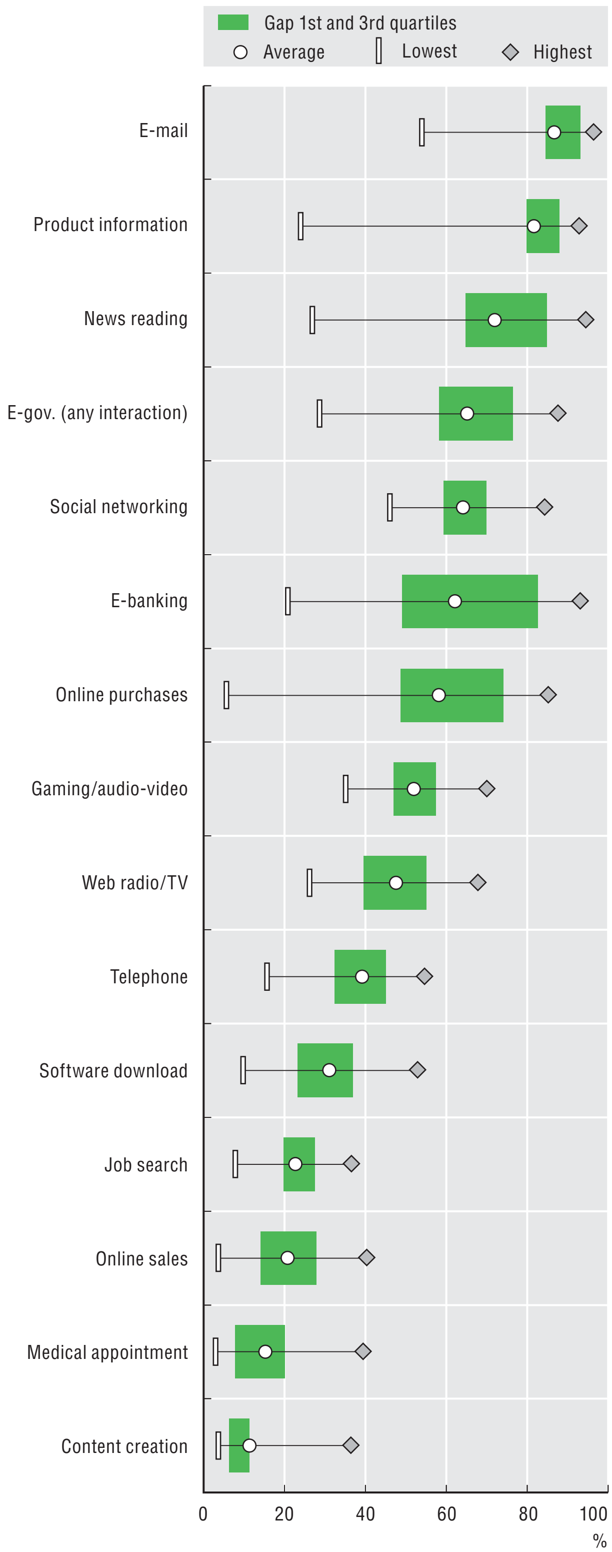
Not all OECD countries survey ICT usage by households and individuals. Data availability for specific indicators also varies (see Chapter 6, Sections 4 and 6). Surveys in Australia, Canada, Chile, Israel and New Zealand are undertaken on a multi-year or occasional basis, but take place annually in other countries. 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 about the robustness of information, especially for smaller countries, owing to sample size and survey design.

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 (OECD, 2014b), and its encouragement of co-ordinated collection of statistics on ICT usage in general (OECD, 2014c).

5. User sophistication

Diffusion of selected online activities among Internet users, 2014

Percentage of Internet users performing each activity



Source: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database*, July 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274815

The activities carried out over the Internet vary widely across countries, as a result of institutional, cultural or economic factors. By analysing the breadth of online activities it is possible to develop an indicator of user sophistication.

In 2014, the majority of Internet users (87%) sent emails and searched for product information online (82%). The least common online activities among those considered were booking medical appointments (15%) and creation of online content (11%). Uptake of e-banking and online purchasing, activities associated with a certain level of user sophistication, are the ones for which uptake across countries varies the most.

Internet users, for all countries combined, performed on average between six and seven out of the 12 activities identified. Averages range between eight activities per user in the Nordic countries to five activities or fewer in Korea, Italy and Turkey. While users with tertiary education perform on average between seven and eight activities, those with at most secondary education perform on average only five, with large variations across countries. Users with lower levels of education in the Nordic countries still perform more online activities than an average Internet user elsewhere. Senior users (individuals between 55 and 74 years old) tend to perform fewer online activities than average, especially in Korea.

In nearly all countries, the share of online purchasers in 2014 was higher than in 2009. In some countries with a lower level of uptake, such as Turkey, Lithuania and Estonia, shares more than doubled.

Even though in 2014 more than half of all OECD Internet users made a purchase online, uptake of online purchasing can be uneven across age groups. In Korea, for example, Internet users in the younger age bracket are four times more likely to purchase online, compared to Internet users in the older age group. In the Baltic States and Portugal, the younger group is more than twice as likely to make an online purchase.

Definitions

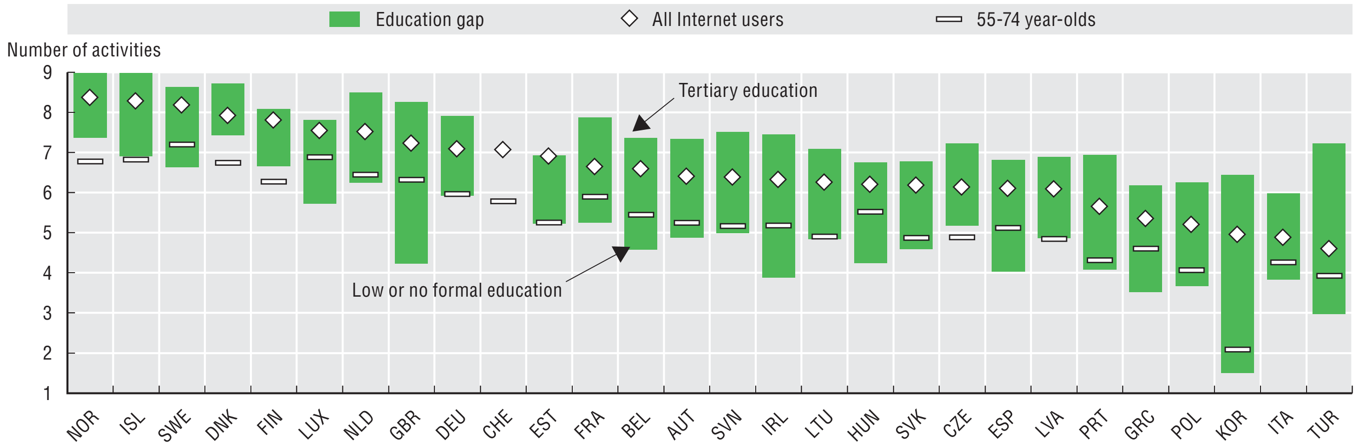
Indicators of ICT use by individuals per activity are computed as (unweighted) averages of country percentage shares. Showing the minimum, maximum and quartiles of each distribution highlights the variation in uptake of each activity among Internet users across countries. With some exceptions, a recall period of three months is used.

The *average number of online activities per user* is based on information on the share of users for each activity. These indicators are derived from individual microdata made available by Eurostat for countries in the European Statistical System (ESS). For Korea, the Korean Internet and Security Agency (KISA) has produced a special tabulation.

Online purchases by individuals are purchases that occur typically over the Internet and constitute a component of e-commerce (see Chapter 6, Section 6).

Number of activities performed online, 2014

Per Internet user by educational attainment and age

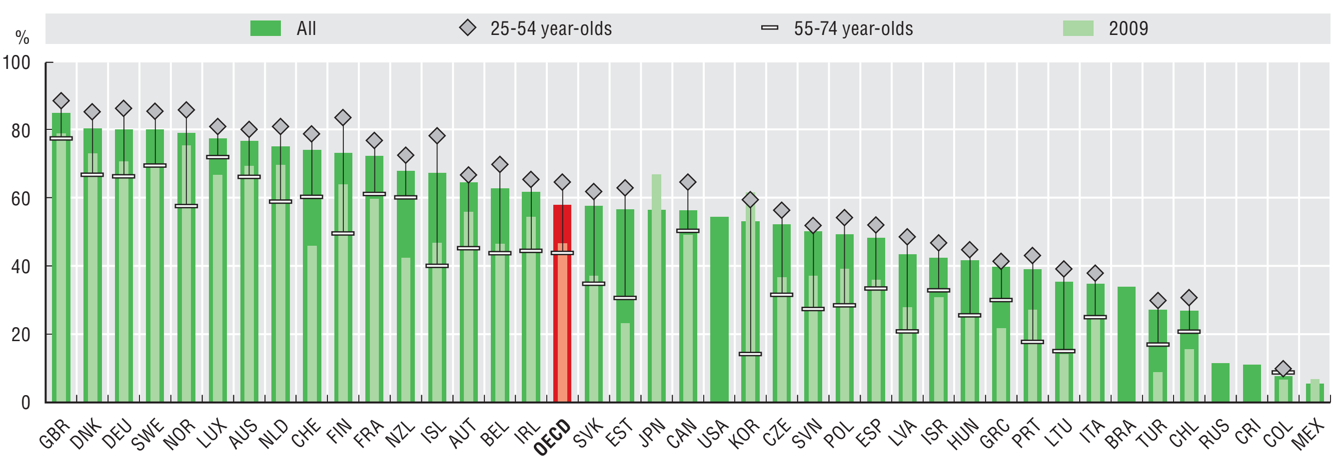


Source: OECD calculations based on Eurostat, *Information Society Statistics Database* and ad hoc data tabulation by KISA, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274829

Individuals who purchased online in the last 12 months, by age class, 2014

As a percentage of Internet users



Source: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database*; ITU, *World Telecommunication/ICT Indicators Database* and national sources, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274834

Measurability

The availability of statistics on ICT usage by individuals is uneven across OECD countries (see also Chapter 6, Sections 4 and 6). Collection of data also varies over time, as surveys shift their focus on a regular basis, for instance to spread the response burden. International comparisons may also reflect a variety of country-specific elements, including the diffusion and ease of use of alternative channels to perform certain activities, as well as institutional aspects. For example, in Korea the number of financial transactions performed over the Internet by individuals is subject to caps on security grounds.

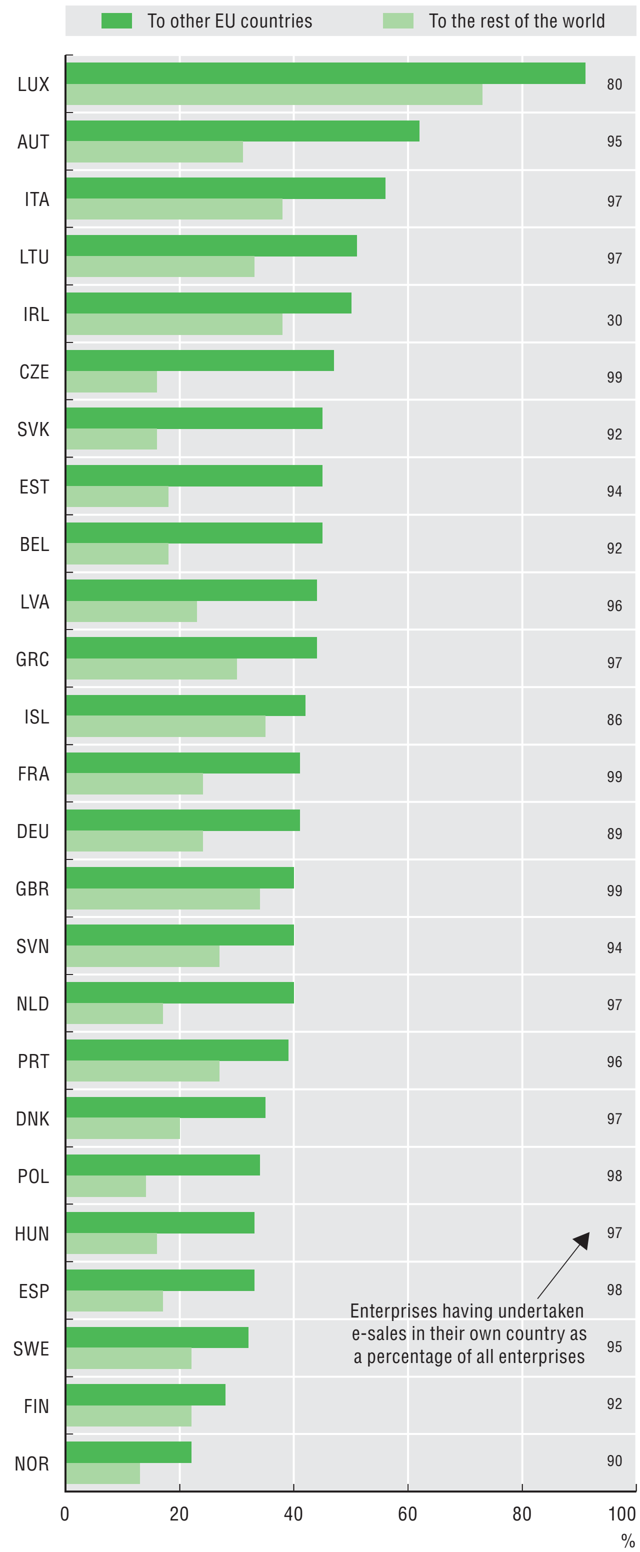
Comparability of the type of activities performed is limited to countries participating in the ESS (OECD EU member countries, Iceland, Norway and Turkey), due to differences in coverage, the year of reference and recall period. Data for Korea are also presented, although activities do not fully correspond to those listed for ESS countries, resulting in a possible underestimation of the number of activities performed.

The information on various online activities for a single country can also concern different years of reference, or be subject to different recall periods.

6. E-consumers across borders

Enterprises having undertaken cross-border e-commerce sales, 2012

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



Source: OECD, based on Eurostat, *Information Society Statistics Database*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274849

The Internet has facilitated access to global markets, creating new opportunities for consumers and businesses. Key factors that affect the uptake of cross-border e-commerce include IT infrastructure, regulatory frameworks and economic integration.

Despite policy initiatives to foster cross-border e-commerce, the bulk of activity still remains within national borders. In 2012, in most countries for which data are available, the percentage of enterprises engaging in domestic e-sales was much higher than that carrying out cross-border e-sales. The main exceptions were Ireland and Luxembourg, where multinational enterprises (MNEs) play a larger role.

The share of enterprises that conducted cross-border online sales within the European Union was highest in Luxembourg (91%) and Austria (62%) and lowest in Finland (28%). In general, European enterprises conduct cross-border online sales to customers located in the European Union.

Likewise, consumers in both Canada and Europe prefer partner countries when ordering goods or services online from a non-domestic seller despite large country differences in terms of overall uptake of cross-border e-commerce. In 2014, 88% of online purchasers in Luxembourg ordered from a seller located in a partner country as opposed to 11% in Poland.

Buying digital products is popular in Norway and Iceland, but less so in Greece and the Czech Republic. In some countries, such as Denmark, Lithuania and the Slovak Republic, more people purchase online today than in 2009, but choose to buy non-digital products more often than digitised items.

Definitions

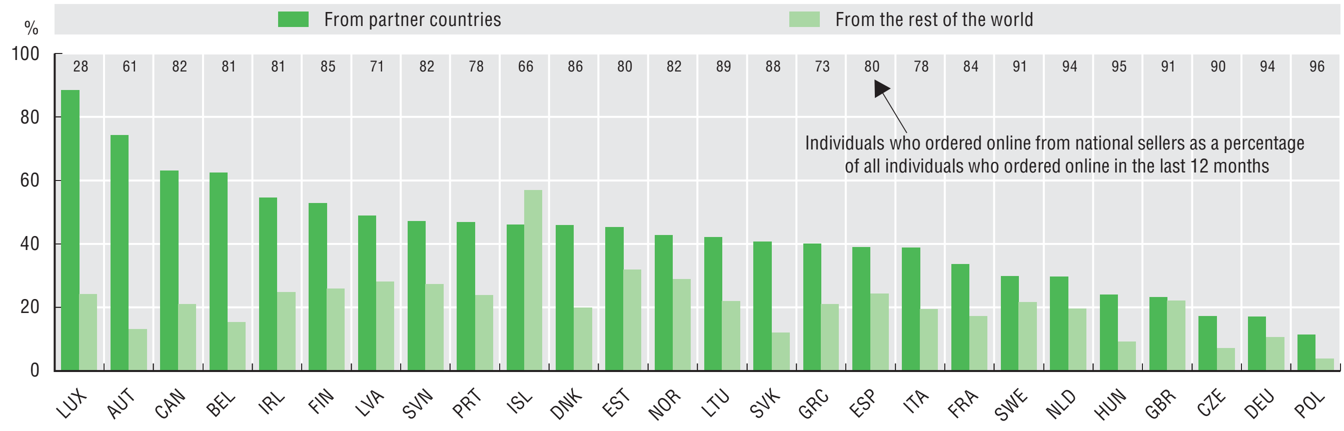
An *e-commerce transaction* is the sale or purchase of goods or services, conducted over computer networks by methods specifically designed for the purpose of receiving or placing orders (OECD, 2011). For individuals, whether sellers or purchasers, such transactions typically occur over the Internet. For enterprises, the e-commerce sales figures presented here include all transactions carried out over webpages, extranet or Electronic Data Interchange (EDI) systems. Online purchases are a component of e-commerce and, for European countries, are measured with respect to a 12-month recall period.

Digitised products refer to films/music, books/magazines/e-learning material or computer software, delivered or upgraded online.

Multinational enterprises (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 trade business or sales offices established in the country by foreign owners. Partner countries refer to EU members for countries in the European Statistical System and to the United States for Canada.

Individuals having undertaken cross-border online purchases, 2014

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

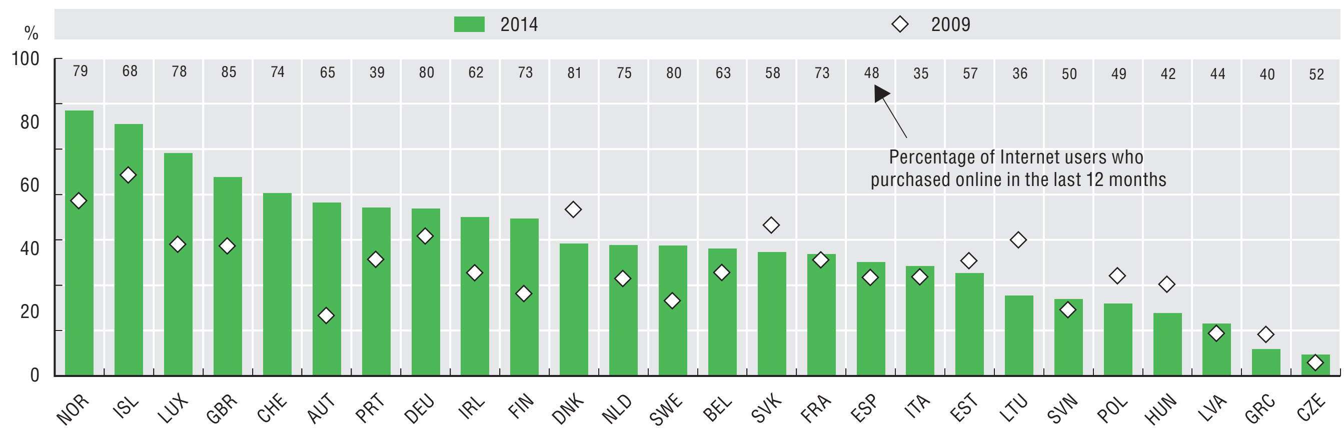


Source: OECD, based on Eurostat, *Information Society Statistics Database* and national sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274851

Individuals having purchased digitised products, 2009 and 2014

As a percentage of Internet users having purchased online



Source: OECD based on Eurostat, *Information Society Statistics Database*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274869

Measurability

Measurement of e-commerce presents methodological challenges that can affect the comparability of estimates, such as the adoption of different practices for data collection and estimations, the treatment of outliers and e-commerce by multinationals, the imputation of values from ranges recorded in surveys, and differences in sectoral coverage.

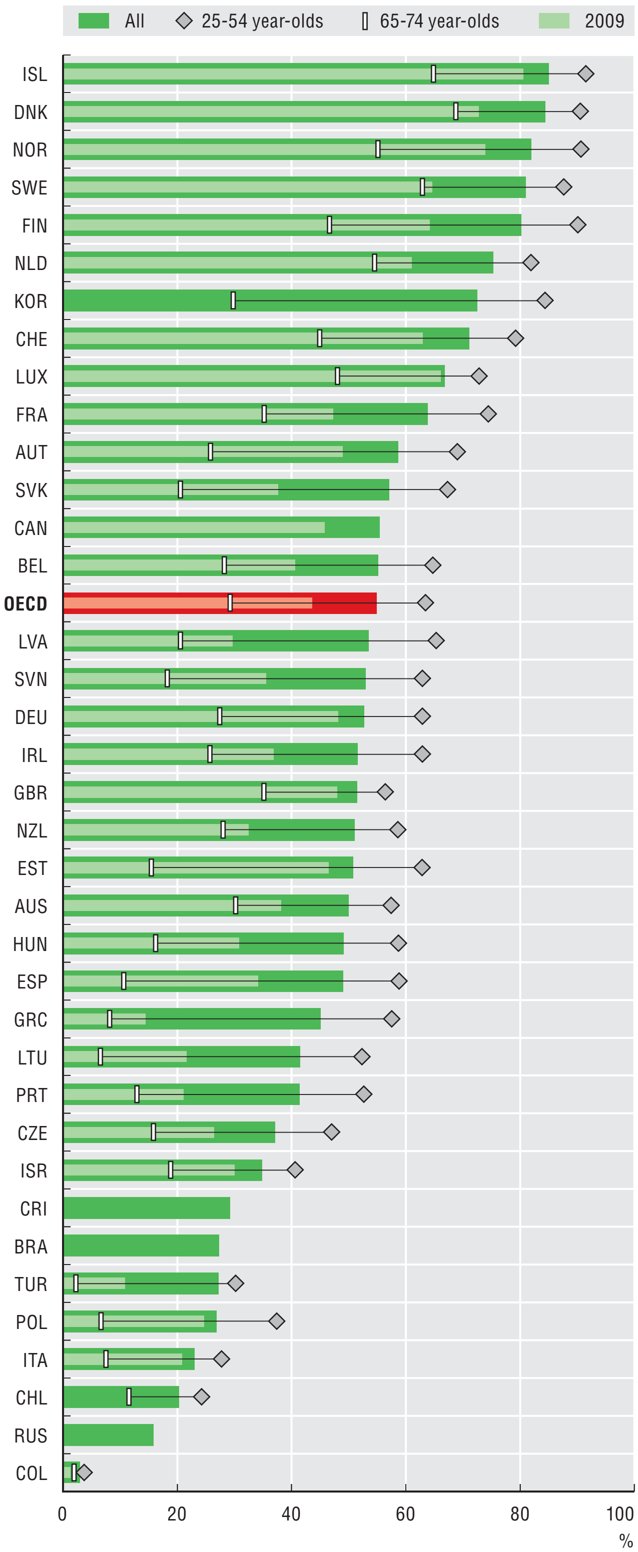
Not all OECD countries survey ICT usage by households and individuals. Data availability for specific indicators also varies. Even among European countries where indicators are fully harmonised, data collection practices differ. For example, ICT usage is not always monitored through a dedicated survey. In Austria, Belgium, the Czech Republic, Estonia and Ireland, data are collected through Labour Force Surveys and in Italy and the United Kingdom through a general survey on living conditions. Other potential sources of difference include the compulsory or voluntary nature of responses and recall periods.

Differences between surveys run by countries in the European Statistical System and those by other countries also limit the comparability of indicators.

7. E-government use

Individuals using the Internet to interact with public authorities, by age, 2014

As a percentage of population in each age group



Source: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database*; and ITU, *World Telecommunication/ICT Indicators Database*, July 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274879

ICTs can play a considerable role in simplifying interactions with public authorities while saving taxpayer resources, thanks to the digitisation and automation of many processes.

The overall share of individuals using the Internet to interact with public authorities has increased in recent years, but remains widely dispersed across OECD countries – from 85% in Iceland to less than 30% in Chile, Italy, Poland and Turkey. Use by individuals in the 65-74 years-old bracket remains significantly lower than average in all countries.

Cross-country differences may reflect differences in Internet usage rates, the supply of e-government services and the propensity of users to perform administrative procedures online, as well as limited data comparability. Citizens' perception about the utility of e-government services is also a key element. The majority of individuals reported satisfaction with e-government services in 2013, however satisfaction rates in Europe correlate negatively with user experience of problems. A relatively high incidence of problems is reported in Belgium and the Slovak Republic.

Online interactions between businesses and public authorities are more developed than for individuals, as enterprises undertake administrative procedures more frequently. In some cases use of online tools is mandatory by law. In 2012, on average 88% of OECD firms interacted online with public authorities, up from 80% in 2009. This share ranges from nearly 100% in Finland and Iceland to 65% in Canada. In most countries, differences among small and large firms are small, with a few exceptions, including Mexico, Turkey and Colombia.

Definitions

Individuals' online interactions with public authorities range from the simple collection of information on government websites to interactive procedures where completed forms are sent via the Internet – excluding interaction via e-mail (for businesses) or manually typed e-mails (for individuals). For businesses, *simple interactions* here include obtaining information and downloading forms. The indicator shows the highest value on the basis of data availability.

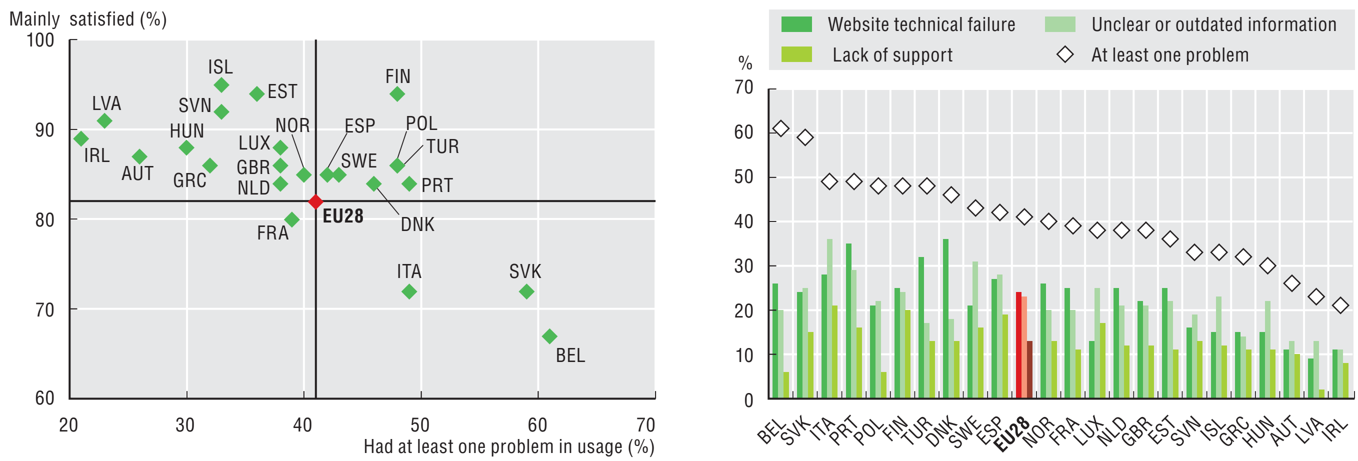
Problems encountered in using government websites are shown for countries in the European Statistical System and include technical issues, lack of clear and updated information, lack of support and other unspecified problems. The variable reporting the share of users encountering at least one of these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

Public authorities refer to both public services and administration activities. These may be authorities at local, regional or national level.

Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249), and large (250 and more).

Satisfaction with e-government services (left-hand panel) and problems linked to their use (right-hand panel), 2013

For population of individuals having used e-government services in the last 12 months

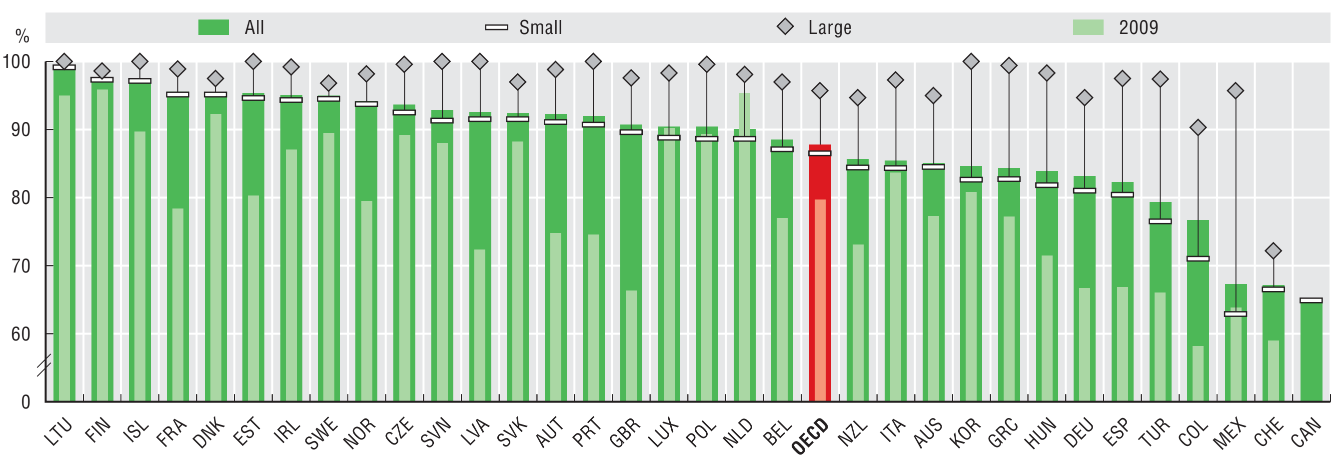


Source: OECD based on Eurostat, *Information Society Statistics Database*, July 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274882

Businesses using the Internet to interact with public authorities, by size, 2012

As a percentage of businesses in each employment size class



Source: OECD, *ICT Database*; Eurostat, *Information Society Statistics Database* and national sources, July 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274893

Measurability

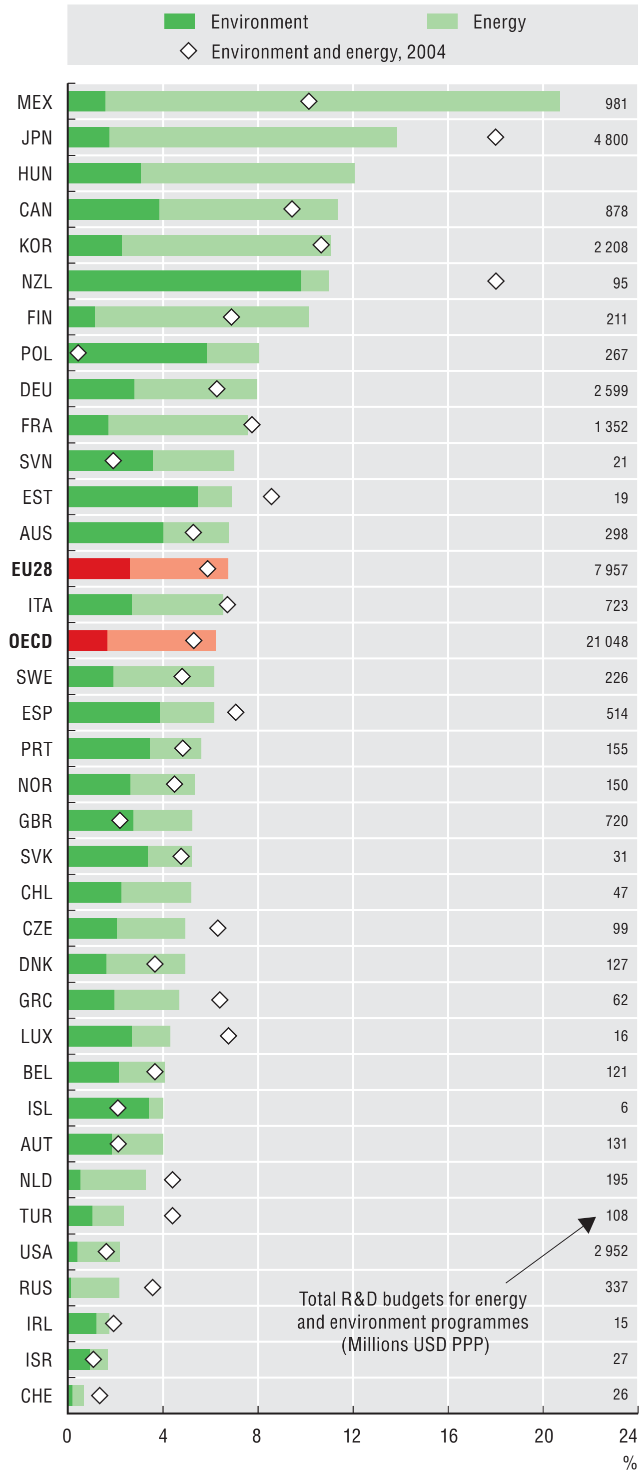
E-government can be measured by collecting information on electronic services offered by government entities (supply-side approach) or on the use of these services by businesses and individuals (demand-side approach). In recognition of the statistical difficulties of the supply-side approach, the OECD and other international organisations have adopted a demand-side approach. Such an approach is not without difficulties, however. As the same services (e.g. transport, education, health) are provided by government in some countries and public or private sector businesses in others, the scope for e-government usage by individuals and firms will differ among countries. These structural differences are likely to affect not only international comparability, but also comparability over time within countries.

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 (OECD, 2014b) and by businesses (OECD, 2014c). Other complementary ways to collect information are also being explored, including by means of information on public administration web-portals.

8. R&D for social challenges

R&D budgets for energy and the environment, 2014

As a percentage of government budgets for R&D



Source: OECD, *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274905

Data on R&D investment efforts by socio-economic objective and in specific technology domains can provide useful information about the priorities of governments and the firms and institutions within a given country. Data on government budget appropriations or outlays for R&D (GBAORD) give an overview of public resource allocation for R&D in areas relevant to a number of societal challenges.

In 2014, the governments of Japan, the United States and Germany were the largest providers of funds for R&D on energy and the environment. Over the last decade, spending increased on energy and environment-related programmes in the OECD area (as % of GDP). However, some countries such as Japan and Spain experienced significant reductions.

R&D and innovation can also improve the capacity of health systems to address problems such as rising health care costs for ageing populations, finding a cure for dementia and fighting global pandemics. Direct government support for health-related R&D in OECD countries was about 0.1% of GDP in 2014. Health R&D funding is highest in the United States, in both absolute and relative terms, at around 0.2% of GDP. However, adjusting for general funding of R&D that is ultimately used for medical science reveals smaller cross-country differences in funding of health related R&D.

Some technology domains have become priorities for a number of countries given their potential to be general-purpose technologies that enable innovations in a number of areas. In 2013, businesses in the United States devoted nearly 10% of their total R&D expenditures to biotechnology. Other major investors in biotechnology for which data are available are France and Switzerland. Similar data on nanotechnology R&D show the United States as the largest investor, followed by Korea, Germany and Japan.

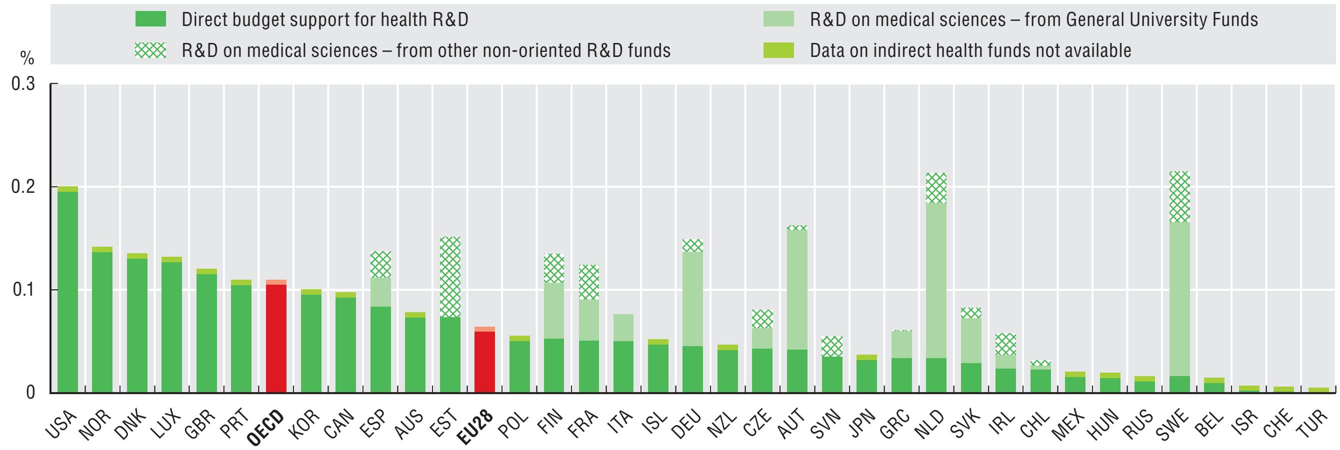
Definitions

Government budget appropriations or outlays for R&D (GBAORD) measure the funds that governments allocate to R&D for various socioeconomic objectives. These are defined according to the primary objective of the funder. *Direct budget support for health* R&D comprises government R&D budgets primarily committed to the objective of protecting and improving human health. In some countries, a medical science component can be identified from non-oriented funds for research, including from general university funds.

The OECD defines *biotechnology* as the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services (OECD, 2005). This definition is accompanied by a list-based definition as an interpretative guideline. There is no internationally agreed statistical definition of *nanotechnology*.

Government budget funding of health-related R&D, 2014

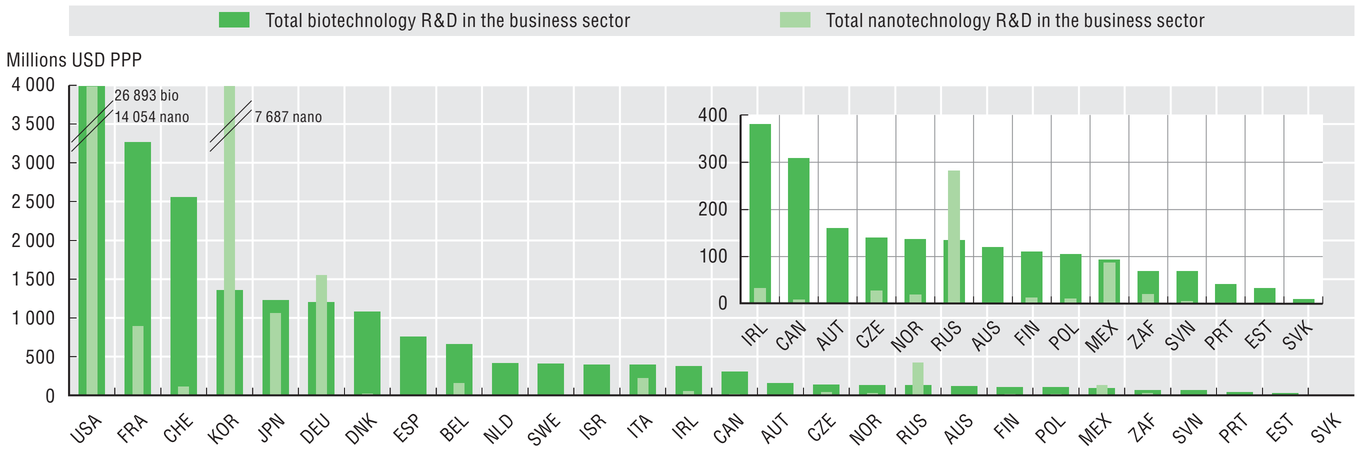
As a percentage of GDP



Source: OECD, *Research and Development Statistics Database*, *www.oecd.org/sti/rds*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274912

Biotechnology and nanotechnology R&D in the business sector, 2013



Source: OECD, Key Biotechnology Indicators, *http://oe.cd/kbi*; and OECD, Key Nanotechnology Indicators, *http://oe.cd/kni*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274921

Measurability

OECD Government R&D budget data provide a breakdown of government R&D funding by socioeconomic objective. Comparability depends on how governments present R&D priorities. *R&D budgets for control and care for the environment* include research on controlling pollution and developing monitoring facilities to measure, eliminate and prevent pollution. *Energy R&D budgets* include R&D on the production, storage, transport, distribution and rational use of all forms of energy, but exclude prospecting and propulsion R&D.

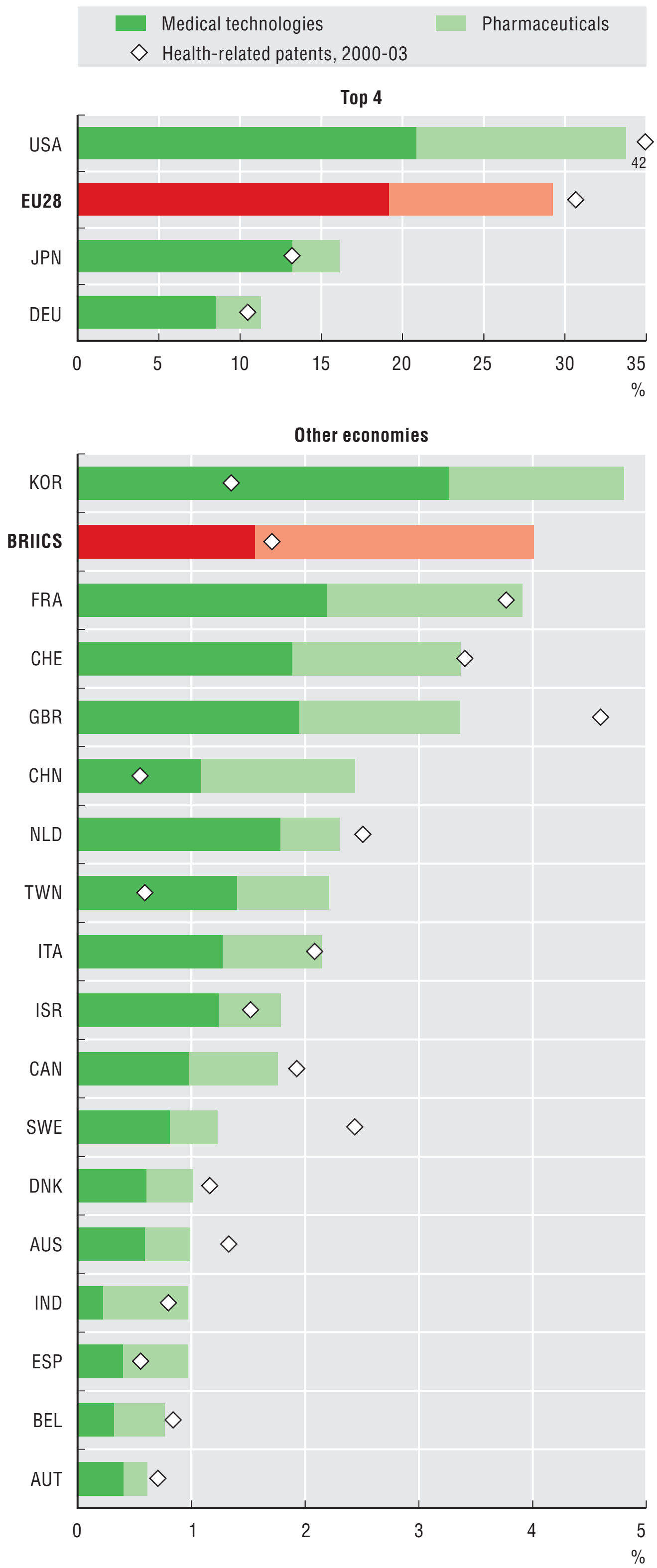
R&D budgets dedicated to health may underestimate total government funding of health-related R&D. Efforts to account for funding of medical sciences via non-oriented research and general university funds helps provide a more complete picture. Analysis of public funding at the project and researcher level would allow for more consistent categorisation. Such data are becoming increasingly available and support the analysis of R&D in specific domains, such as individual diseases.

The measurement of R&D in enabling technologies such as *biotechnology* and *nanotechnology* is becoming increasingly widespread. However, many countries still do not report such data on a regular basis.

9. Enabling technologies

Health-related patents, 2000-03 and 2010-13

Economies' shares in IP5 patent families



Source: OECD, *STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274930

Economies worldwide face grand challenges such as providing healthcare to an aging population while reducing inequality and preserving the environment. Advances in information and communication technologies (ICTs) and health and environment-related technologies are key to addressing these challenges and providing new development opportunities.

In the economies considered, health-related patenting increased by 10% between 2000-03 and 2010-13. While inventive activities in the field continued to be led by the United States, the European Union (EU) and Japan, their overall share of health-related patents decreased by 7 percentage points (from 86% to 79%), despite a 3% increase in Japan over the last decade. Japan's growing efforts to address health and ageing-related challenges were accompanied by a general increase in health patents by most Asian economies, including Korea, China and India.

In environmental technologies, while EU countries increased their patenting and accounted for 28% of total activities in 2010-13, Japan and the United States experienced a relative decline in the field, linked to increased activities in Asia, especially in Korea and China.

Patenting in ICTs grew by almost 60% between 2000-03 and 2010-13. While the proportion of ICT patents in Japan, the United States, Korea and China remained stable (72.2% of total patenting over the two periods considered), the extent to which these ICT technology leaders contributed to the field varied substantially. Japan and the United States decreased their relative share by over 5% and 8%, respectively, whereas Korea and China increased theirs by about 7%.

Definitions

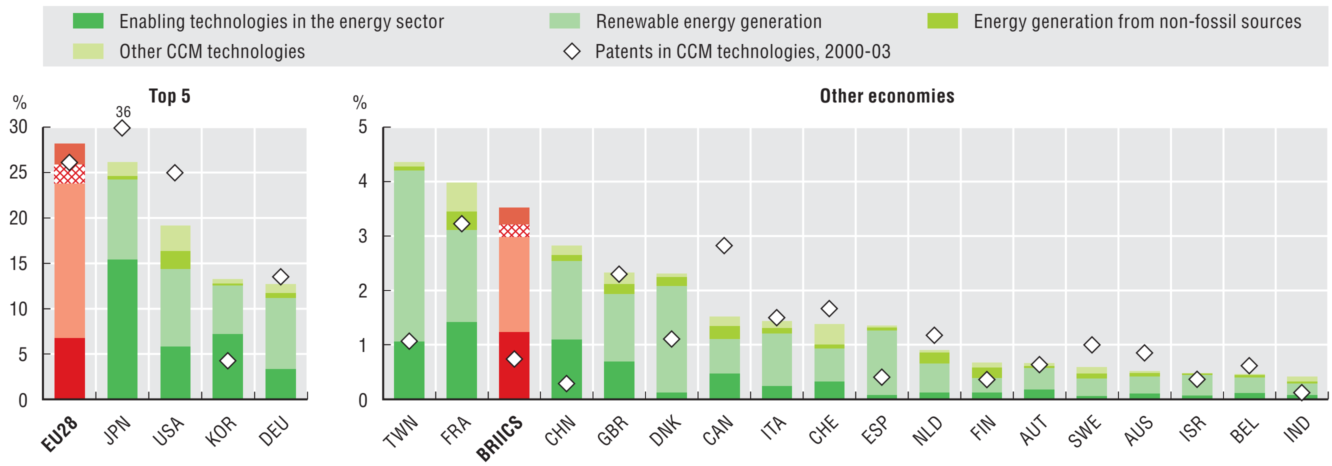
Health-related patents are identified in line with the WIPO concordance (2013). Pharmaceutical patents are filed under Class A61K of the International Patent Classification (IPC), excluding A61K8/* (cosmetics). Medical technology patents relate to IPC Classes A61 (B, C, D, F, G, H, J, L, M, N) and H05G.

Environmental technology patents are identified using refined search strategies based on the IPC and the Cooperative Patent Classification (CPC), and draw upon the expertise of patent examiners at the European Patent Office (EPO), as described at *www.oecd.org/env/consumption-innovation/indicator.htm.*

ICT-related patents are identified using a new experimental classification (see also Chapter 5, Section 5) that aims to reflect recent developments in ICT. They are grouped into 13 technology fields, including networks, mobile communication, security, data analysis, computing and storage, and human interface.

Patents in climate change mitigation (CMM) technologies, 2000-03 and 2010-13

Economies' shares in IP5 patent families

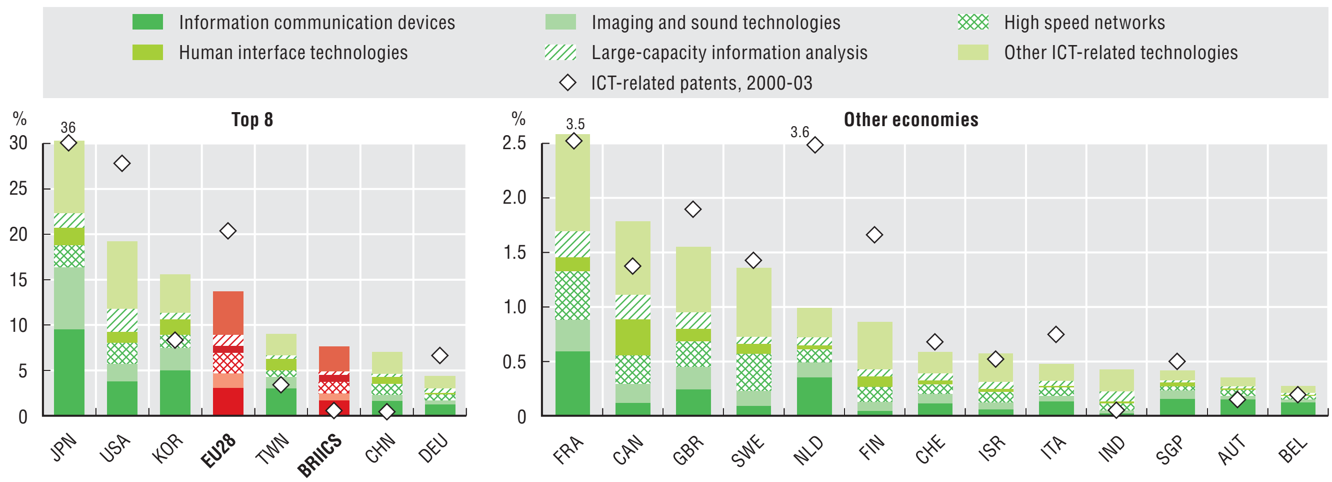


Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274948

ICT-related patents, 2000-03 and 2010-13

Economies' share in IP5 patent families



Source: OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274954

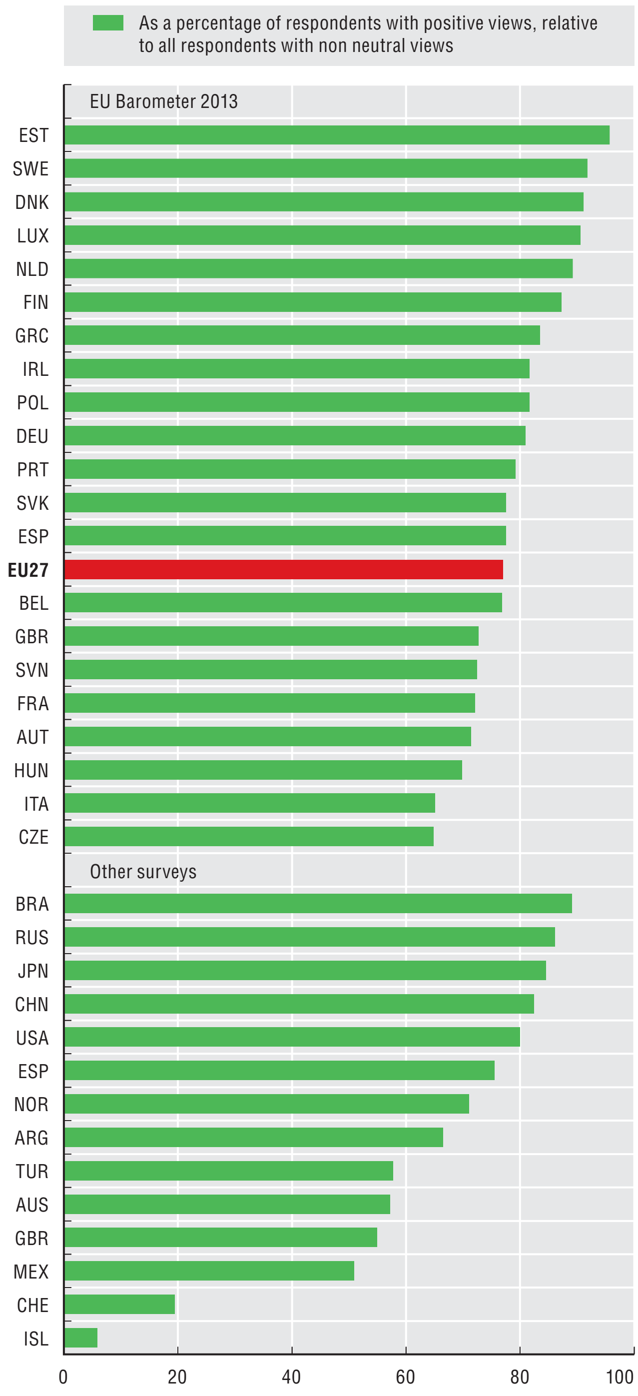
Measurability

The notion of enabling technologies evolves over time reflecting public perceptions regarding the usefulness of different technologies in addressing global challenges (e.g. health-related concerns, ageing populations, climate change) and in facilitating economic and societal development and growth. Patent data help to identify enabling technologies and can provide a wealth of relevant information. Data supplied by different patent authorities, including the location where the patent application was first filed, can be used to follow the development of technologies and their diffusion across countries. Statistics are compiled using information on patent families within the *Five IP offices (IP5)*, with patent family members filed at the EPO or US Patent and Trademark Office (USPTO) and attributed to economies on the basis of location of the patent owner. This approach maximises comparability in terms of the prospective value of inventions. Pharmaceuticals are considered an area of application rather than a specific technology, while medical technologies generally refer to products and technologies such as operating tables.

10. Public perceptions of science and technology

Public perception of impacts of science and technology on society, 2013

Net relative balance on: "Is the overall impact of science and technology on society positive or negative?"



Note: This is an experimental indicator. International comparability may be limited.

Source: OECD calculations based on European Commission (2013), Special Eurobarometer 401; and other national sources, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274965

Developments in science and technology have visible impacts on people's lives. Surveys carried out across countries indicate that the public has a mainly positive view of the societal impact of science and technology. However, they also find a significant proportion of the population with mixed or critical views.

Personal attitudes towards science and technology can be influenced by a number of personal and contextual characteristics. Most studies in the area find a consistent difference based on gender, whereby men consistently rate science and technology more favourably than women.

While analysis of science, technology and innovation often focuses on its direct economic impacts, it can be relevant to analyse other pathways to societal impacts as well as how perceptions of science are formed and influenced by personal values. An experimental indicator explores the degree of correlation within countries between measures of attitudes towards science and selected measures of well-being and personal values. For a majority of countries, individuals who place a higher value on science in their daily lives also tend to report higher levels of health and satisfaction with life, altruism, freedom of choice and control over their own lives and importance of creativity. In Argentina, Brazil, Chile, China, Mexico and India, individuals reporting science as important are less likely to see themselves as "world citizens", while in the United States, many European countries, Japan and Korea the opposite applies.

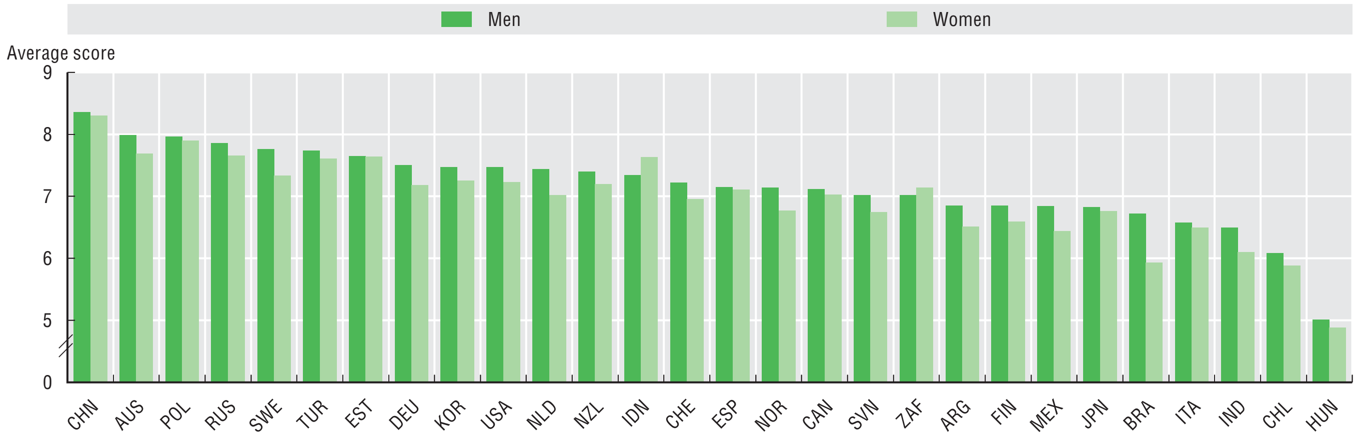
Definitions

Comparison of responses from surveys that provide different response options (see chapter notes) is undertaken by calculating a summary indicator as the ratio of the difference between positive and negative views, divided by the sum of both groups. This excludes respondents with a neutral position ("positive and negative are equal") and those who selected "Don't know" if surveys provided such options. This approach may retain some bias if neutral respondents, when unable to select such an option, are more likely to provide a positive answer than a negative one.

From the World Values Survey, responses to the following questions are used. *Importance of science*: "Is learning about science important to your daily life?" *Subjective well-being*: "How would you describe your state of health?"; "How satisfied are you with your life as a whole?"; "How much freedom of choice and control do you feel you have over your life?"; selected value items are based on the Schwarz value item for self-direction ("It is important to this person to think up new ideas and be creative; to do things one's own way") and global identity is based on agreement with statement ("I see myself as a world citizen").

Gender differences in attitudes towards science and technology, 2011

Average scores based on responses to: "The world is better off because of science and technology?"

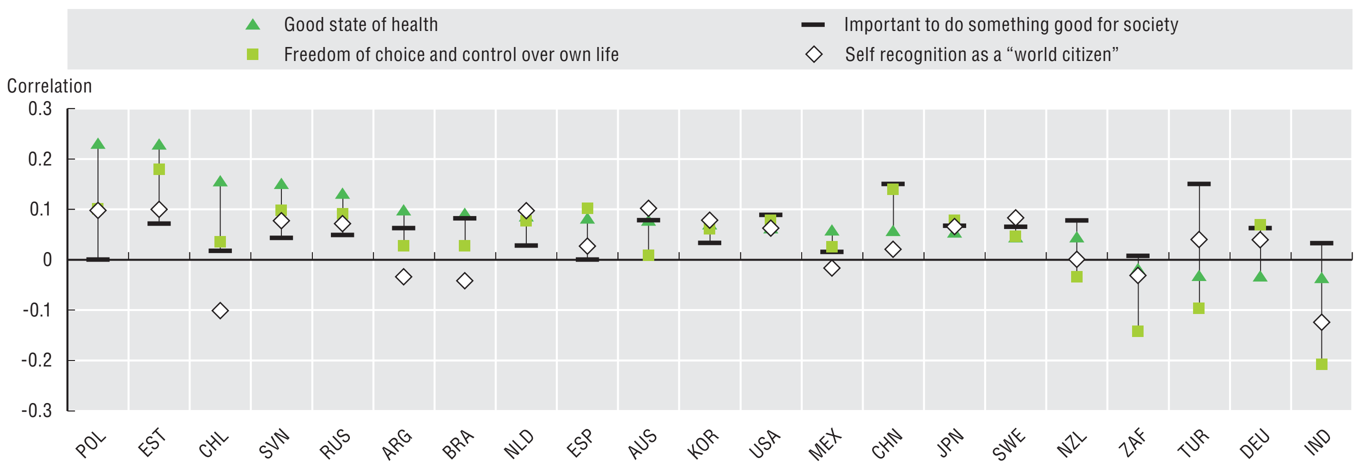


Note: This is an experimental indicator. International comparability may be limited.
Source: OECD, calculations based on World Values Survey, *www.worldvaluessurvey.org*, June 2015. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274978

The link between attitudes towards science, personal values and subjective well-being, 2011

Within-country correlations with personal scores on the importance of science in daily life



Note: This is an experimental indicator. International comparability may be limited. Correlations with other variables are available as "more data".
Source: OECD, calculations based on World Values Survey micro-data (v.20150418), *www.worldvaluessurvey.org*, June 2015. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888933274982

Measurability

An OECD project has reviewed the scope for international comparability and the methodological challenges faced by surveys on the public perception of attitudes towards science and technology. In particular, available national data sources use slightly different questions and possible answers, while responses can vary according contextual factors.

The World Values Survey Association, a non-profit organisation comprising a global network of social scientists, carries out the World Values Survey. The survey was undertaken principally by means of face-to-face interviews, and targeting representative samples of a few thousand adult individuals per country. Publicly available micro-data were used to analyse gender patterns and correlations between science attitudes and measures of subjective wellbeing. While these are simple correlations, they point to potential pathways for understanding the drivers of public attitudes towards science and technology.

Notes and references

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 recognises 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 of the European Union Member States of the OECD and the European Union:

"The Republic of Cyprus is recognised 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."

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

6.1. Enabling connectivity

Fixed broadband penetration by technology, December 2014

For Germany, DSL includes VDSL (FTTC), Cable excludes cable infrastructure based on FTTB/FTTH, FTTB/FTTH includes fibre lines provided by cable operators.

For Israel, Switzerland and the United States, data for 2014 are estimates.

For Mexico, data for 2014 are preliminary. Mexico is currently reviewing the Fixed broadband data in relation to implementation of the methodology.

For the United Kingdom, DSL includes FTTH, FTTP, FTTB and FTTC as the breakdown between these technologies is not yet available.

Mobile broadband penetration by technology, December 2014

For Mexico, data for 2014 are preliminary. Mexico is currently reviewing the Mobile broadband data in relation to implementation of the methodology.

For Israel and Switzerland, data for 2014 are estimates.

Penetration of machine-to-machine (M2M) SIM cards, December 2014

For Korea, data are based on the current M2M definition. Korea is in the process of reviewing the M2M definition by comparing the national definition with that of the OECD.

6.2. Online devices and applications

Devices used to access the Internet at home, 2014

The following national sources are used: for Canada, the Internet Use Survey 2012, as published in The Daily on 28 October 2013; for Korea, the Survey on the Internet Usage 2014 from the Korea Internet and Security Agency and the Ministry of Science, ICT and Future Planning of Korea; for Japan, the Communication Usage Trend Survey 2013 issued by the Ministry of Internal Affairs and Communications of Japan; and for the United States, the US Bureau of the Census.

Unless otherwise stated, "Mobile device other than portable computer" includes mobile phone or smartphone, media or games player and e-book reader.

For Canada, data refer to 2012 and relate to the percentage of households with Internet access by Internet access device. Data for laptop computers/netbooks refer to laptops only. "Mobile device other than portable computer" includes wireless handheld devices. Data on connected TV (Smart TV) are not available.

For Japan, data refer to 2013. Devices per user data are based on the Communication Usage Trend Survey 2013 and relate to the percentage of individuals (aged 6 and over) accessing the Internet using the corresponding device. Data refer to computer use at home instead of desktop computers. Data on laptop computers/netbooks are not available. "Mobile device other than portable computer" includes only smartphones. Data for connected TV (Smart TV) refers to "TV set capable of connecting to the Internet".

For Korea, data originate from the Survey on the Internet Usage 2014. Devices per user data relate to the percentage of households with Internet access by Internet access device. "Mobile device other than portable computer" includes only smartphones and mobile phones. Data for connected TV (Smart TV) refers to "Digital TV".

For the United States, data refer to 2011, relate to individuals aged 15 and over, and originate from the US Bureau of the Census. The category laptop computers/netbooks includes laptops only. The category "mobile device other than portable computer" refers to all cellular phones, smartphones, tablets and e-books. Games console refers to "game system or console". Connected TV (Smart TV) refers to "TV based device".

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.

Individuals using cloud computing services, by age, 2014

Cloud computing refers to the use of storage space on the Internet to save or share documents, pictures, music, video or other files.

6.3. Digital natives

Individuals who participated in an online course, 2009 and 2013

For Chile, data refer to 2012 and 2014 with a recall period of 12 months.

For Korea, data refer to 2014.

For Poland, data refer to 2008 and 2011.

6.4. Internet users

General notes for all figures:

Unless otherwise stated, Internet users are defined for a recall period of 12 months. For China and Switzerland, the recall period is six months. For Brazil, Costa Rica, Indonesia, Israel and the Russian Federation, the recall period is three months. For South Africa and the United States, no time period is specified.

Total, daily and mobile Internet users, 2014

Notes for all users:

For Australia, data refer to the fiscal years 2005/06 and 2012/13, ending 30 June.

For Brazil, data refer to 2005 and 2013 and to individuals aged 10 and over and 15 and over, respectively. Data are sourced from the Instituto Brasileiro de Geografia e Estatística (IBGE).

For Canada, data refer to 2006 and 2012.

For China, data refer to individuals aged 6 and over using the Internet at least one hour per week. Data are sourced from the China Internet Network Information Center (CNNIC).

For Costa Rica, data refer to 2005 and 2012 and to individuals aged 5 and over. Data are sourced from ITU.

For India, data refer to Internet subscribers instead of Internet users. 2006 and 2014 data are sourced from ITU and the Telecom Regulatory Authority of India, respectively.

For Indonesia, data refer to 2005 and 2013. 2013 data refer to individuals aged 5 and over and are sourced from Statistics Indonesia. Data for 2005 are sourced from ITU.

For Israel, data refer to 2013 and to individuals aged 20 and over.

For Japan, data refer to 2013.

For New Zealand, data refer to 2006 and 2012.

For the Russian Federation, data refer to 2013 and to individuals aged 15-72 and over using the Internet at least once a week. Data are sourced from ITU.

For South Africa, data refer to 2005 and 2012, and to individuals aged 15 and over. Data are sourced from Research ICT Africa.

For the United States, data refer to 2013 and to individuals aged 18 and over living in a house with Internet access.

Notes for daily users:

For Canada and Japan, daily users refers to Internet users accessing the Internet "at least once a day". For Chile, Korea, Mexico and Switzerland, it refers to users accessing the Internet "every day or almost every day". For the United States, it refers to the percentage of individuals answering "yes" to the question "did you use the Internet yesterday?".

For Brazil, data refer to 2013 and are OECD estimates based on ITU and IBGE data.

For Canada, data are sourced from Statistics Canada (CANSIM Table 358-0155) and refer to individuals aged 16 and over.

For Japan, data for daily users refer to 2012 and are OECD estimates based on data sourced from the "Communication Usage Trend Survey", MIC (Ministry of Internal Affairs and Communications).

For the United States, data refer to 2012 and are sourced from the PEW Internet Project.

Notes for mobile users:

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

For Korea, New Zealand and Switzerland, data refer 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, in the last three months (last 12 months for New Zealand).

For Brazil, data refer to 2013 and to individuals aged 10 years old and over. Data are sourced from IBGE.

For Canada, data refer to 2012 and to the percentage of individuals using the Internet with a wireless handheld device, aged 16 and over. Data are source from Statistics Canada (CANSIM Table 358-0219).

For Colombia, data refer to individuals who have used a mobile phone/smartphone device to access the Internet. Data are OECD estimates based on data sourced from the "Encuesta de Condiciones de Vida 2014", Departamento Administrativo Nacional de Estadística (DANE).

For Korea, data refer to individuals aged 3 and over. Data refer to 2013 and are sourced from the KISA Survey on Internet Usage.

General notes:

Internet users, by age, 2014 and;
Women Internet users, by age, 2014

For Australia, data refer to the fiscal year 2012/13, ending 30 June and to individuals aged 65 and over instead of 65-74.

For Brazil, data refer to 2013 and to individuals aged 15 and over, 15-24 and 50 and over instead of 16-74, 16-24 and 65-74. Data are sourced from the Instituto Brasileiro de Geografia e Estatística (IBGE).

For Israel, data refer to 2013 and to individuals aged 20 and over instead of 16-74, and 20-24 instead of 16-24.

For Costa Rica, data refer to 2012 and to individuals aged 5 and over instead of 16-74. Data are sourced from ITU.

For the Russian Federation, data refer to 2013 and to individuals aged 15-72 and over instead of 16-74 using the Internet at least once a week. Data are sourced from ITU.

Additional notes:

Internet users, by age, 2014

For Canada and New Zealand, data refer to 2012.

For Chile, data refer to individuals aged 55-74 instead of 65-74.

For China, data refer to individuals aged 6 and over instead of 16-74. Data are sourced from the China Internet Network Information Center (CNNIC).

For Colombia, data refer to individuals aged 55-74 instead of 65-74.

For India, data refer to Internet subscribers instead of Internet users aged 16-74. Data are sourced from the Telecom Regulatory Authority of India.

For Indonesia, data refer to 2013 and to individuals aged 5 and over. Data are sourced from Statistics Indonesia.

For Japan, data refer to 2013 and to individuals aged 15-69 instead of 16-74, 15-28 instead of 16-24 and 60-69 instead of 65-74.

For South Africa, data refer to 2012 and to individuals aged 15 and over. Data are sourced from Research ICT Africa.

For the United States, data refer to 2013 and to individuals aged 18 and over, living in a house with Internet access and to individuals aged 18-34 instead of 16-24 and 65 and over instead of 65-74.

Women Internet users, by age, 2014

For Canada, data refer to 2010.

For Japan, data refer to 2012 and to individuals aged 15-69 instead of 16-74, 15-28 instead of 16-24 and 60-69 instead of 65-74.

For New Zealand, data refer to 2012.

For the United States, data refer to 2011 and to individuals aged 18 and over living in a house with Internet access and to individuals aged 18-34 instead of 16-24 and 65 and over instead of 65-74.

6.5. User sophistication

Diffusion of selected online activities among Internet users, 2014

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 web-based radio/television data refer to 2012. For job search and software download categories data refer to 2013. 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 the countries in the European Statistical System, Chile, Korea and Mexico, data refer to 2014.

For Australia, data refer to the fiscal year 2012/13, ending 30 June.

For Canada and New Zealand, data refer to 2012.

For Australia, Chile and New Zealand, for any interaction with public authorities, data refer to obtaining information from public authorities.

For Israel, data refer to 2013.

For Japan, data refer to 2013, except for job search (2012), and to individuals aged 15-69.

For Korea, data for e-mail, social networking and e-banking categories refer to a recall period of one year instead of three months. Data for the telephoning/video calling category just refer to telephoning.

For the United States, data refer to 2013. The gaming and audio-video category only includes video, the job search category also includes job training and the e-banking category also includes investing or stock or futures trading.

Number of activities performed online, 2014

Data refer to the following 12 activities: using e-mail, telephoning or video calling over the Internet, participation 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.

Data by educational attainment level refer to 2013.

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.

For Switzerland, data by educational attainment are not available.

For Turkey, data refer to 2013.

Individuals who purchased online in the last 12 months, by age class, 2014

The recall period is the last 12 months, with the exception of Israel and Switzerland, where the recall period is three and six months. For the United States, no time period is specified.

For Australia, data refer to the fiscal years 2009/10 and 2012/13, ending 30 June.

For Brazil and the Russian Federation, data refer to 2013 and are sourced from ITU.

For Canada, data refer to 2012 and to individuals aged 25-44 and 55-64 instead of 25-54 and 55-74, ordering goods or services over the Internet from any location (for personal or household use only).

For Chile, no recall period is specified in 2009.

For Costa Rica, data refer to 2012 and are sourced from ITU.

For Japan, data refer to 2013.

For Israel, data refer to 2013 and to all individuals aged 20 and over instead of individuals aged 16-74.

For New Zealand, data refer to 2006 and 2012 and relate to e-purchases for personal use only requiring an online payment.

For Switzerland, data refer to 2005 and 2014.

For the United States, data refer to 2013 and correspond to OECD estimates based on the proportion of all individuals who live in a household with Internet access and the proportion of individuals aged 3 and over, who have used the Internet for consumer services (e.g. online shopping, travel or household services).

6.6. E-consumers across borders

Enterprises having undertaken cross-border e-commerce sales, 2012

For Germany, data refer to 2010.

Individuals having undertaken cross-border online purchases, 2014

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.

Individuals having purchased digitised products, 2009 and 2014

Internet users refers to individuals who used the Internet within the last 12 months.

Digitised products refers to films/music, books/magazines/e-learning material, or computer software, delivered or upgraded online.

For Germany, data refer to 2008 and 2014.

For Sweden, data refer to 2011.

6.7. E-government use

Individuals using the Internet to interact with public authorities, by age, 2014

E-government here refers to the usage of on-line public services and related information. These include notably citizen obligations (e.g. tax declaration, notification of moving), rights (e.g. social benefits), official documents (e.g. ID card, birth certificate), public educational services (e.g. public libraries, information on/and enrolment in public schools and universities) and public health services (e.g. services of public hospitals).

For Australia, data refer to the fiscal years 2010/11 and 2012/13, ending 30 June, and to individuals who have used the Internet either for downloading completing/submitting filled in forms from government organisation websites, in the last 12 months.

For Brazil, data refer to 2013 and to individuals who have used the Internet to obtain information from general government organisations. Data are sourced from ITU.

For Canada, data refer to 2009 and 2012. 2009 data refer to individuals who have used the Internet to obtain information from government organisation websites. 2012 data refer to individuals who visit or interact with Canadian municipal, provincial or federal government websites.

For Chile, Colombia and Korea, data refer to individuals aged 55-74 instead of 65-74.

For Colombia, data do not include individuals who have used the Internet just to obtain information from government or public services websites.

For Costa Rica, data refer to 2012 and to individuals who have used the Internet to obtain information from general government organisations. Data are sourced from ITU.

For Israel, data refer to 2010 and 2013 and to individuals aged 20 and over instead of 16-74 who used the Internet to obtain services online from government offices including downloading or completing official forms. National estimates for 2013 are based on the 2010 survey results.

For New Zealand, data refer to 2006 and 2012 and to individuals who have accessed a local or central government website in the last 12 months to download or complete a form.

For the Russian Federation, data refer to 2013 and to individuals who have used the Internet to interact with general government organisations. Data are sourced from ITU.

For Switzerland, data refer to 2010 and 2014 and to individuals who have used the Internet to obtain information from government organisation websites in the last 12 months.

For Turkey, data refer to 2010 and 2014.

Satisfaction with e-government services (left-hand panel) and problems linked to their use (right-hand panel), 2013

The category “At least one problem” includes website technical failure, unclear or outdated information, lack of support (online or offline), and other problems (unspecified).

Businesses using the Internet to interact with public authorities, by size, 2012

Interaction may include: obtaining information or documents (e.g. tax declaration) from public authority websites, returning filled in forms electronically (e.g. for customs, value added tax declaration) and undertaking an administrative procedure completely in electronic form (e.g. declaration, registration, authorisation request). Interaction may occur via a third party (e.g. accounting company).

Unless otherwise stated, only enterprises with ten or more persons employed are considered. Size classes are defined as: small (from 10 to 49 persons employed) and large (250 and more).

For countries in the European Statistical System, sector coverage consists of all activities in manufacturing and non-financial market services.

For Australia, data refer to the fiscal years 2009/10 and 2011/12, ending 30 June. Data include agriculture, forestry and fishing activities.

For Canada, data refer to 2013 and to businesses interacting online with government organisations to obtain information/download forms (excluding any interaction via e-mails). Large enterprises have 300 or more employees.

For Colombia, data refer to enterprises with ten or more persons employed in the manufacturing sector (excluding ISIC Rev. 4 Divisions 12-14, 17, 21 and 33) and enterprises with 75 or more persons employed in the non-financial market services (excluding Divisions 49-51, 58, 75 and 77). For industry G – Wholesale and retail trade, data refer to enterprises with 20 or more persons employed; for industries H – Transportation and storage (Divisions 52 and 53), I – Accommodation and food service activities and J – Information and communication (Divisions 59-61), data refer to enterprises with 40 or more persons employed.

For Korea, data refer to 2009 and 2013 and to businesses interacting online with government organisations to obtain information/download forms (excluding any interaction via e-mails).

For Mexico, data refer to 2008 and 2012. For 2008, data refer to businesses with 20 or more persons employed. For 2012, data refer to establishments with ten or more persons employed. Size categories refer to establishments with 10 to 50 and 251 and more persons employed.

For New Zealand, data refer to the fiscal years 2009/10 and 2013/14 ending 31 March and to businesses interacting online with government organisations to obtain information/download forms (excluding any interaction via e-mails).

For Switzerland, data refer to 2008 and 2011. For 2008, data refer to businesses with five or more persons employed.

For Turkey, data refer to 2009 and 2013.

6.8. R&D for social challenges

R&D budgets for energy and the environment, 2014

For Belgium, Chile, Estonia, the EU28 aggregate, Ireland, Israel, Korea, the OECD aggregate, Poland, Spain and the United Kingdom, data refer to 2013

For Canada and Switzerland, data refer to 2012.

For Hungary, data refer to 2005.

For Italy, data refer to 2005 and 2013.

For Mexico, data refer to 2011.

For New Zealand, data refer to 2006.

For the Russian Federation, data refer to 2001 and 2009.

For Turkey, data refer to 2008.

For Australia, Austria, Canada, Japan, Korea and the United States, government budget appropriations or outlays for R&D come from federal or central government only.

For Chile, around 9% of the total GBAORD is not allocated to any of the 14 socio-economic objectives.

For Iceland, significant methodological changes were introduced over the period 2003-13, which can distort the comparison of data over time.

Government budget funding of health-related R&D, 2014

Direct health GBAORD includes government budget appropriations or outlays for R&D primarily committed to the socio-economic objective of protecting and improving human health.

R&D related to Medical sciences and funded by General University Funds or other sources are drawn from a breakdown of funds under the general objective of "Advancement of knowledge".

R&D intensity ratios are normalised using official GDP figures. These are compiled according to the *System of National Accounts* (SNA) 2008 except for Chile, Japan, the Russian Federation and Turkey, where figures are available on the basis of SNA 1993.

For Belgium, Chile, Spain, Estonia, the EU28 aggregate, Finland, Ireland, Israel, Italy, Korea, Poland, Slovenia and the United Kingdom, data refer to 2013.

For Canada and Switzerland, data refer to 2012.

For Mexico, data refer to 2011.

For the Russian Federation, data refer to 2009.

For Sweden, data refer to 2015.

For Australia, Austria, Canada, Japan, Korea and the United States, government budget appropriations or outlays for R&D come from federal or central government only.

Biotechnology and nanotechnology R&D in the business sector, 2013

In Belgium, Denmark, France, Italy and the United States biotechnology and nanotechnology R&D are not mutually exclusive categories. Some R&D may be reported as both relating to biotechnology and nanotechnology R&D. These countries allow firms to report the same R&D in multiple research areas (e.g. biotechnology, nanotechnology, IT technology, etc.).

Notes for the biotechnology data: Biotechnology firms use biotechnology to produce goods or services and/or to perform biotechnology R&D. These firms are captured by biotechnology firm surveys.

Biotechnology R&D firms perform biotechnology R&D. These firms are captured by R&D surveys.

Dedicated biotechnology firms devote at least 75% of their production of goods and services, or R&D, to biotechnology. These firms are captured by biotechnology firm surveys.

Dedicated biotechnology R&D firms devote at least 75% of their total R&D to biotechnology. These firms are captured by R&D surveys.

For Canada, this includes medical biotechnology, environmental biotechnology, industrial biotechnology and agricultural biotechnology.

For Denmark and France, data are preliminary.

For Germany, 2013 Business Expenditures on R&D (BERD) was used to calculate the biotech R&D intensity, 2014 BERD was not available.

For Mexico, data refer to firms with 20 or more employees only.

For the Netherlands and Sweden, data refer to firms with 10 or more employees only.

For the Russian Federation, a proxy indicator is used: R&D expenditure by priority areas of S&T (Life sciences) which includes: Bioengineering; Biocatalysis, biosynthesis and biosensor technologies; Biomedical and veterinary technologies; Genomics and pharmaco-genetics; Living cell technologies.

For the United States, data refer to firms with five or more employees only.

Notes for the nanotechnology data: This is an experimental indicator. International comparability may be limited.

Nanotechnology firms use nanotechnology to produce goods or services and/or to perform nanotechnology R&D. These firms are captured by nanotechnology firm surveys.

Nanotechnology R&D firms perform nanotechnology R&D. These firms are captured by R&D surveys.

Dedicated nanotechnology firms devote at least 75% of their production of goods and services, or R&D, to nanotechnology. These firms are captured by nanotechnology firm surveys.

Dedicated nanotechnology R&D firms devote at least 75% of their total R&D to nanotechnology. These firms are captured by R&D surveys.

For Denmark and France, data are preliminary.

For Japan, number of business enterprises with a paid-in capital of JPY 100 million or more.

For Korea, data are underestimated. These numbers are based on the enterprises that responded and not all enterprises answered the question on R&D.

For the Russian Federation, data refer to preliminary estimates based on data gathered by the R&D survey.

For the United States, data refer to firms with 5 or more employees only.

6.9. Enabling technologies

General notes for all figures:

Data refer to IP5 patent families with members filed at the EPO or at the USPTO, by first filing date, according to the applicant's residence using fractional counts.

Data from 2012 are estimates.

Additional notes:

Health-related patents, 2000-03 and 2010-13

Patents are allocated to health-related fields on the basis of their International Patent Classification (IPC) codes, following the concordance provided by WIPO (2013). Only economies with more than 500 patents in health in 2010-13 are included.

Patents in climate change mitigation (CCM) technologies, 2000-03 and 2010-13

Environment-related patents are defined on the basis of their International Patent Classification (IPC) codes or Cooperative Patent Classification (CPC) codes. Only economies with more than 100 patents in CCM technologies in 2010-13 are included.

ICT-related patents, 2000-03 and 2010-13

Patents in ICT are identified following a new experimental classification based on their International Patent Classification (IPC) codes. Only economies with more than 1 000 patents in ICT in 2010-13 are included.

6.10. Public perceptions of science and technology

General note for all figures:

This is an experimental indicator. International comparability may be limited.

Public perception of impacts of science and technology on society, 2013

In order to summarise responses from surveys providing different options, this figure represents the ratio of the difference between positive and negative views on the impacts of science and technology, divided by the sum of respondents expressing non neutral views. The calculation thus excludes the view of respondents who hold a neutral position ("positive and negative are equal") and choose "Don't know" where surveys provide such options.

International comparability may be limited due to the fact that available national data sources use slightly different questions and possible responses. The first cluster of countries in the figure is based on EU barometer 2013, which does not provide a neutral category ("positive and negative are equal"), while the second cluster of countries, except Mexico, offered such an option. The approach used for calculation may retain some bias if neutral respondents, if deprived of a neutral response option, are more likely to provide a positive answer than a negative one.

Original data are derived from surveys conducted by means of face-to-face interviews. Results for Australia and Japan are based on a web-based questionnaire. Results for Brazil are based on CATI (Computer Assisted Telephone Interviewing).

For China, Norway, Turkey, Switzerland, and Iceland, data refer to 2010. For Argentina, data refer to 2012. For Japan and the Russian Federation, data refer to 2014. For Brazil, data refer to 2015.

EU27 includes the countries in EU28 except Croatia.

Surveys have been conducted for individuals aged 15 and over (Austria, Belgium, the Czech Republic, Denmark, Estonia, EU27, 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); 16 years and over (Brazil, the United Kingdom (national survey), the Russian Federation); 18 years and over (Argentina, Mexico, the United States) and individuals aged 20-69 (Japan).

In the EU Barometer 2013, the respondents were asked "Do you think that the overall influence of science and technology on society is positive or negative?". They were invited to choose from among the following options: "Very positive", "Fairly positive", "Fairly negative", "Very negative" and "Don't know".

For national surveys carried out in Argentina, Brazil, Japan, Spain, the Russian Federation and the United States, respondents were asked "Have the benefits of scientific research outweighed the harmful results?". For Japan, the Russian Federation and the United States, they were invited to choose from among the following options: "Benefits are much greater than harm", "Benefits are slightly greater than harm", "Benefits and harm are about equal", "Harm is slightly greater than benefits", "Harm is much greater than benefits", and "Don't know". In the case of Spain, respondents had to choose from among the options: "Benefits outweigh its harms", "Benefits and Harms are about equal", "Harm is greater than benefits", and "Don't know". For Argentina and Brazil, respondents were asked to choose from among the following options: "Only benefits", "More benefits than harm", "Both benefits and harm", "More harm than benefits", "Only harm", and "Don't know".

For Australia, China, Iceland, Mexico, Norway, Switzerland, Turkey and the United Kingdom (National survey), the question invited respondents to express their (dis)agreement with the statement "The benefits of science are greater than any harmful effects it may have". For Australia, respondents were asked to score their agreement from 0 to 10. For China, Iceland, Norway, Switzerland, Turkey and the United Kingdom (National survey), respondents were asked to choose from among "Totally agree", "Tend to agree", "Neither agree nor disagree", "Tend to disagree", "Totally disagree", and "Don't know". In Mexico, respondents were asked to choose from among "Strongly agree", "Agree", "Disagree", "Strongly disagree", and "Don't know".

National sources consisted of the following publications: Argentina: *Red de Indicadores de Ciencia y Tecnología – Iberoamericana e Interamericana (RICYT)* (2014). Australia: the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2014); Brazil: Centro de Gestão e Estudos Estratégicos (2015); China: Ministry of Science and Technology of the People's Republic of China (2010); Iceland, Norway, Switzerland and Turkey: European Commission (2010); Austria, Belgium, the Czech Republic, Denmark, Estonia, EU27, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom: European Commission (2013); Japan: National Institute of Science and Technology Policy (2014); Mexico: Instituto Nacional de Estadística y Geografía (2014); the Russian Federation: National Research University – Higher School of Economics (2014); Spain (National Survey): Spanish Foundation for the Science and Technology (2014); the United Kingdom (National Survey): Ipsos MORI (2014); and the United States: National Science Board (2014).

Gender differences in attitudes towards science and technology, 2011

Respondents were asked to provide a score from 1 to 10, regarding their view on the statement "The world is better off or worse off, because of science and technology". A score of 1 means that "the world is a lot worse off," and 10 means that "the world is a lot better off".

For Argentina and South Africa, data refer to 2013.

For Australia, China, Mexico, the Netherlands and Poland, data refer to 2012.

For Brazil and India, data refer to 2014.

For Canada and Indonesia, data refer to 2006.

For Finland and Italy, data refer to 2005.

For Hungary, data refer to 2009.

For Japan and Korea, data refer to 2010.

For Switzerland and Norway, data refer to 2007.

Data are based on surveys conducted by means of face-to-face interviews. Results for Australia and New Zealand are based on postal questionnaire. For the Netherlands and the United States, data are based on an online questionnaire. For Norway, data are based on a combination of face-to-face and telephone surveys.

Surveys are conducted among individuals aged 18 and over. For Indonesia and South Africa, data refer to individuals aged 16 and over. For Korea, data refer to individuals aged 19 and over.

The link between attitudes towards science, personal values and subjective well-being, 2011

Estimates report correlations between a self-reported measure of the daily importance of science and measures of subjective well-being based on micro-data of the World Values Survey. Correlations are computed across individuals within each country.

For Japan and Korea, data refer to 2010. For Australia, China, Mexico, the Netherlands and Poland, data refer to 2012. For Argentina and South Africa, data refer to 2013. For Brazil and India, data refer to 2014.

Original data are based on surveys conducted by means of face-to-face interviews. Results for Australia and New Zealand are based on a postal questionnaire. Data for the Netherlands and the United States are based on an online questionnaire.

Surveys are conducted for individuals aged 18 and over. For Korea, data refer to individuals aged 19 and over.

Science importance question: Respondents were asked to provide a score from 1 to 10, regarding whether learning about science is "not" important to their daily life. A score of 1 means "Completely disagree (science is important)" and 10 means "Completely agree (science is not important)".

Subjective well-being and value-related questions:

a) State of health (subjective): Respondents were asked "All in all, how would you describe your state of health these days?", and invited to choose from "very good (1), good (2), fair (3) and poor (4)". A positive correlation implies that better subjective health level is associated with a more positive valuation of science in daily life.

b) Satisfaction with life: Respondents were asked to provide a score from 1 to 10, regarding their satisfaction level with life. A score of 1 means "completely dissatisfied" while 10 means "completely satisfied". To facilitate comparison of the results with other indicators, the negative of the correlation value is reported. A high reported value implies a positive association between science importance and life satisfaction.

c) Freedom of choice and control over own life: Respondents were asked to provide a score from 1 to 10. A score of 1 means "no choice at all" while 10 means "a great deal of choice". To facilitate comparison of the results with other indicators, the negative of the correlation value is reported. A high reported value implies a positive association between science importance and freedom of choice/control over life.

d) Importance of creativity: Respondents were asked to compare themselves with the following description "It is important to this person to think up new ideas and be creative; to do things one's own way" and invited to choose from "very much like you (1), like you (2), somewhat like you (3), a little like you (4), not like you (5), or not at all like you (6)". A positive correlation implies the greater emphasis on creativity is associated with a more positive valuation of science in daily life.

e) Important to do something good for society: Respondents were asked to compare themselves with the description "It is important to this person to do something for the good of society", and invited to choose from "very much like you (1), like you (2), somewhat like you (3), a little like you (4), not like you (5), or not at all like you (6)". A positive correlation implies that a greater sense of the importance of doing something good is associated with a more positive valuation of science in daily life.

f) Self-recognition as a "world citizen": Respondents were asked to compare themselves with the following statement "I see myself as a world citizen", and invited to choose from "strongly agree (1), agree (2), disagree (3), strongly disagree (4)". A positive correlation implies that a greater sense of being a "world citizen" is associated with a more positive valuation of science in daily life.

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