OECD Science, Technology and Industry Scoreboard 2013

INNOVATION FOR GROWTH

OECD

OECD Science, Technology and Industry Scoreboard 2013

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Foreword

The OECD Science, Technology and Industry Scoreboard 2013 *draws on the latest internationally comparable data to uncover the strengths of OECD and other leading economies and explore the continuing challenges to overcome the effects of the recent financial and economic crises. 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 STI Scoreboard is not about "ranking" countries or developing composite indicators. It is about giving policy makers and analysts the means of comparing 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 the OECD's efforts to build the data infrastructure needed to link actors, outcomes and impacts; it highlights the potential and the limits of certain metrics and points to directions for further work.

Indicators are pointers. They do not address causal relations. 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 bring new perspectives and advance the measurement agenda. They help to stimulate continuing and new 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 economic crisis. It explores the new geography of growth through the lenses of global value chains, the changing landscape of innovation, the features of science today and the characteristics of innovation beyond formal research and development.*

Six thematic chapters focus on areas of key policy interest:

- **Building knowledge** *looks at the knowledge assets that many firms and governments view as their current and future sources of long-term sustainable growth. It focuses on indicators of knowledge-based capital and on the jobs and employment related to it, scientific skills and education, and investment in research. It also presents experimental indicators of public funding and new estimates of R&D tax incentives.*
- **Connecting to knowledge** *helps inform the policy debate with a set of metrics on the variety and nature of mechanisms for knowledge exchange. Among the indicators presented are the impact of scientific collaboration (based on patent citations) and science-industry linkages (based on citations of non-patent literature in patent documents). Also included are new indicators on*

researcher mobility that track the careers of scientists who publish in scholarly journals and on the extent of firms' collaboration in innovation processes.

- **Targeting new growth areas** *examines the direction of countries' scientific efforts and the technologies on which they build their comparative advantage. It presents R&D and innovation indicators in biotechnology and nanotechnology and in health, environmental and information and communication technologies, and looks at developments in smart ICT infrastructure. It also reveals how the development of technologies accelerates over time and how innovations emerge from the combination of different technologies.*
- **Unleashing innovation in firms** *is concerned with the dynamism of the business sector and shows the strong contribution of young firms to job creation using new microdata-based indicators. It looks at the main ways in which firms innovate and proposes a novel indicator on the intellectual property bundle to point to firms' joint use of patents, trademarks and industrial designs to protect their innovations. New data on registered designs provide information on how countries protect creativity. Other indicators address the extent to which governments create the conditions for young innovative firms to grow and the broader policy environment for innovation.*
- **Competing in the knowledge economy** *looks at how countries seek to build their competitive strengths and uses a wide range of more sophisticated indicators than those that are generally available. It considers industrial specialisation and diversification, R&D and trade specialisation, technological advantages and relative strengths, as well as the characteristics of innovative firms and their use of new technologies in business processes.*
- **Participating in the global economy** *draws out the implications of structural characteristics for economies' participation in global value chains. Indicators related to firms' size, survival and growth and to foreign affiliates accompany employment patterns in key industries and linkages between manufacturing and services. Novel indicators building on the OECD-WTO Trade in Value Added Database shed new light on economies' participation in global trade and value chains and the implications of this participation for jobs.*

The main audience of the STI Scoreboard is policy analysts with a good understanding of the use of indicators and all those engaged in producing indicators for analytical or policy-making purposes. A few paragraphs introduce each indicator and offer some interpretation. They are accompanied by a box called "Definitions" for those less familiar with the methods used. A box titled "Measurability" summarises measurement challenges, gaps and recent initiatives.

All charts and underlying data can be downloaded via the Statlinks (hyperlink to a webpage). For the first time, additional data that expand the coverage of countries and time periods are available in the Statlinks. New tools to visualise indicators and help users develop thematic and country profiles based on their own interests will be available on the STI Scoreboard website.

Acknowledgments

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Reader's Guide

Acronyms

BERD	Business enterprise expenditure on research and development
CIS	Community Innovation Survey
CTM	Community trademark
DSL	Digital subscriber line
EPO	European Patent Office
EU	European Union
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
HERD	Higher education expenditure on R&D
HRST	Human resources in science and technology
ICT	Information and communication technology
IMF	International Monetary Fund
I-O	Input-output
IP	Intellectual property
IPC	International Patent Classification
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
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
KLEMS	Capital, labour, energy, material and service inputs
LFS	Labour Force Survey
MFP	Multi-factor productivity
NACE	Statistical classification of economic activities in the European Community (Nomenclature statistique des activités économiques dans la Communauté européenne)
NPL	Non-patent literature
OHIM	Office for Harmonization in the Internal Market
PCT	Patent Cooperation Treaty
PPP	Purchasing power parity
PRO	Public research organisation
R&D	Research and development

RCD	Registered Community Design
RD&D	Research, development and demonstration
S&E	Science and engineering
S&T	Science and technology
SME	Small and medium-sized enterprise
SNA	System of National Accounts
TM	Trademark
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 charts, this publication uses ISO codes for countries or economies.

ARG	Argentina
AUS	Australia
AUT	Austria
BEL	Belgium
BGR	Bulgaria
BRA	Brazil
BRB	Barbados
CAN	Canada
CHE	Switzerland
CHL	Chile
CHN	People's Republic of China
CYM	Cayman Islands
CYP	Cyprus
CZE	Czech Republic
DEU	Germany
DNK	Denmark
EGY	Egypt
ESP	Spain
EST	Estonia
FIN	Finland
FRA	France
GBR	United Kingdom
GRC	Greece
HKG	Hong Kong, China
HRV	Croatia
HUN	Hungary
IDN	Indonesia
IND	India
IRL	Ireland
IRN	Iran
ISL	Iceland
ISR	Israel
ITA	Italy

JPN	Japan
KOR	Korea
LTU	Lithuania
LUX	Luxembourg
LVA	Latvia
MEX	Mexico
MLT	Malta
MYS	Malaysia
NLD	Netherlands
NOR	Norway
NZL	New Zealand
PAK	Pakistan
PHL	Philippines
POL	Poland
PRT	Portugal
ROU	Romania
RUS	Russian Federation
SAU	Saudi Arabia
SGP	Singapore
SVK	Slovak Republic
SVN	Slovenia
SWE	Sweden
THA	Thailand
TUR	Turkey
TWN	Chinese Taipei
UKR	Ukraine
USA	United States
VGB	Virgin Islands (British)
ZAF	South Africa

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

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Executive summary

With lacklustre growth across much of the globe, promoting new sources of growth has become a global policy priority. Science, technology, innovation and entrepreneurship – which foster competitiveness, productivity, and job creation – are important mechanisms for encouraging sustainable growth.

The 260 science, technology, innovation and industrial performance indicators in this *Scoreboard* show how OECD and major non-OECD economies are performing in a wide range of areas. The *STI Scoreboard* helps governments design more effective and efficient policies and monitor progress towards their desired goals. The following are some of the key findings of the 2013 *Scoreboard*.

Investment in innovation remains a priority, largely through R&D support measures

In 2012, OECD governments on average invested the equivalent of 0.8% of GDP in direct funding of R&D at home or abroad; Korea and Finland invested over 1%. In addition, 27 of the 34 OECD countries and a number of non-OECD economies now indirectly support business R&D via tax incentives. In 2011, the Russian Federation, Korea, France and Slovenia provided the most combined support for business R&D as a percentage of GDP. In Canada and Australia indirect funding of business R&D exceeded direct funding by a factor of five. R&D tax credits were worth USD 8.3 billion in the United States, followed by France and China. New estimates show that the cost to a firm of investing in R&D depends on its size, location and balance sheet. In 2013, Australia, Canada, France, Korea, the Netherlands and Portugal give more generous treatment to SMEs.

Young, dynamic firms contribute more to job creation than previously recognised

Between 2008 and 2011, net employment in the OECD area fell by 2%, or 9 million people, two-thirds of them in the United States. The manufacturing and construction sectors were the hardest hit (an average loss of 32% and 25%, respectively), but information industries – ICT manufacturing, publishing or telecommunication services – suffered too. For many OECD countries, significant losses in employment continued well into 2012 with higher skilled managers affected just as much as the lower-skilled. During the crisis, most jobs destroyed in most countries reflected the downsizing of mature businesses; net job growth in young firms (five years old or less) remained positive. Young firms with fewer than 50 employees represent only around 11% of employment, but they generally account for more

than 33% of total job creation in the business sector; their share of job destruction is around 17%.

Trade in value added provides a new perspective on trading relationships

The OECD-WTO Trade in Value Added (TiVA) indicators reveal that countries have become more dependent on imports from a greater number of economies in order to maintain or improve their export performance. For example, in China, over 1999-2009, gross exports increased about 12-fold at current prices to almost USD 1 300 billion, and the foreign value-added content of exports almost tripled to more than 30%; 20% of the value added of exports originated from OECD countries, half of it from Japan and Korea.

Foreign consumers sustain jobs

As the interdependency of countries grows, consumers in one country sustain jobs in countries further up the value chain. In 2008, 20% to 45% of business sector jobs in most European economies and 20% of jobs in China were sustained by foreign demand. Shares are smaller in Japan and the United States owing to their relatively large size and lower dependency on exports and imports. Nonetheless, initial estimates suggest that in 2008, over 10 million US business sector jobs were sustained by foreign consumers, with East and Southeast Asian consumers sustaining 2 million.

Emerging economies increasingly play a role in science and innovation

In the global landscape of scientific research, the emergence of new players has changed the structure of global collaboration networks. In 2011 China was the second-largest R&D performer after the United States, ahead of Japan, Germany and Korea. It was also the second largest producer of scientific publications, yet in terms of quality-adjusted research output (top cited papers) it lags most OECD countries. China accounted for more than 74 000 scientific collaborations in 2011 up from only 9 000 in 1998. Over the period, the number of Chinese publications co-authored with US-based institutions increased from nearly 2 000 to more than 22 000. The United States continues to be the centre of the international research network, accounting in 2011 for nearly 15% of all scientific collaborations documented in peer-reviewed scientific publications.

University hotspots are still concentrated in a few locations

Worldwide, the top 50 universities with the highest relative impact over 2007-11 are highly concentrated geographically but less so than over 2003-09. Overall, 34 of the top 50 are located in the United States. The rest are in Europe, and, for the first time, two are outside the OECD area, in Chinese Taipei. The United Kingdom is second, with specific strengths in the medical and social sciences. There are notable differences by subject, with US-based universities most likely to excel in biochemistry, computer science, neuroscience and psychology. Universities in non-OECD economies, especially in Asia, play a relatively prominent role in chemical engineering, energy and veterinary research.

Researchers are increasingly mobile

Researcher mobility and collaboration among institutions are increasing. A new indicator tracks changes in the affiliation of scientists who publish in scholarly journals. The top nine international bilateral flows of researchers coming into and leaving a country involve exchanges with the United States. While total US inflows exceed the outflows, more

scientists who start by publishing in the United States move to affiliations in China and Korea than vice versa. The United Kingdom is the second most-connected economy. On average, the research impact of scientists who move affiliations across national boundaries is nearly 20% higher than that of those who never move abroad. For many economies, raising the performance of these "stayers" to the level of their internationally mobile researchers (those who leave and those who return) would allow them to catch up with leading research nations.

1. KNOWLEDGE ECONOMIES: TRENDS AND FEATURES

Sources of growth and the crisis

The new geography of growth

The changing landscape of innovation

Science and innovation today

Notes and References

This chapter presents a range of indicators to highlight the 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 economic crisis? What are the implications for R&D and innovation, global investment and trade flows? What have been the sources of growth in the last two decades? What is the role of knowledge-based capital in our economies? What are the implications of growing economic interdependencies for trade in services and economies' patterns of specialisation? Who are the emerging players in the new geography of growth? 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? What is the impact of the international mobility of scientists? How "collaborative" is the innovation process? Indicators accompanied by short texts develop a narrative to help policy makers understand knowledge, science and innovation today.

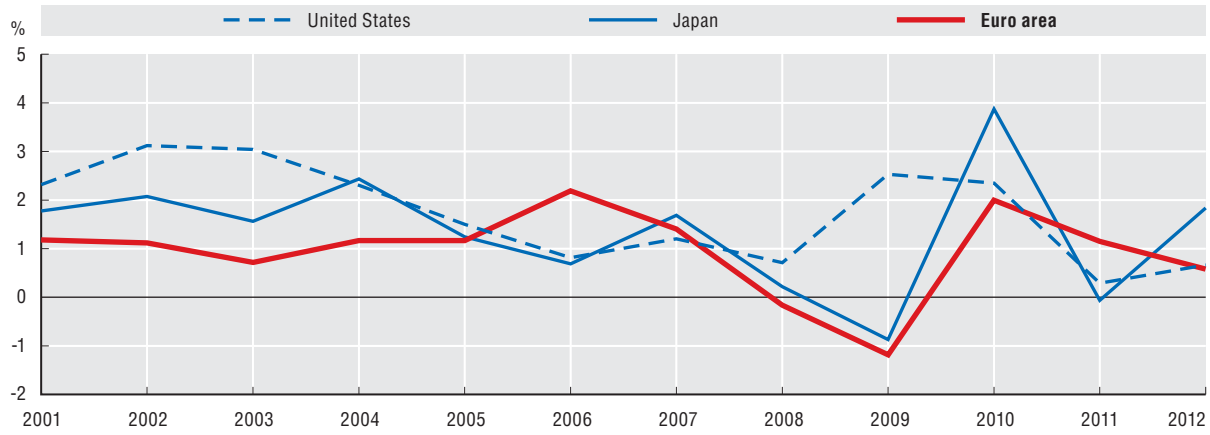
Sources of growth and the crisis

Productivity and the crisis

The world today faces extraordinary challenges, and the effects of the economic downturn are still being felt five years after the start of the crisis. In 2010, strong productivity growth accompanied global recovery. However, the pace of recovery varies across OECD countries and unemployment remains high in many. The BRIICS (Brazil, the Russian Federation, India, Indonesia, the People's Republic of China and South Africa) were less affected by the global slowdown, and productivity continued to grow at over 6% in 2009-12, compared to 1.5% in the OECD area. In China, GDP per employee grew at around 9% a year.

1. Labour productivity growth based on hours worked, total economy level, 2001-12

Average annual growth rates in percentage points

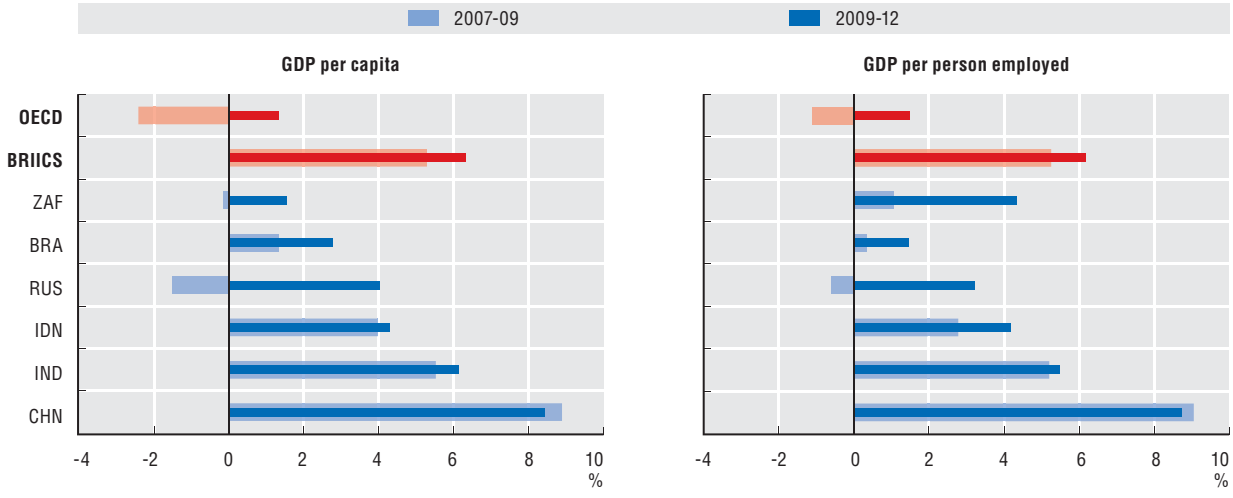


Source: OECD, Productivity Database, August 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889307

2. Growth in GDP per capita and GDP per person employed in the BRIICS and the OECD, 2007-09 and 2009-12

Average annual growth rates in percentage points



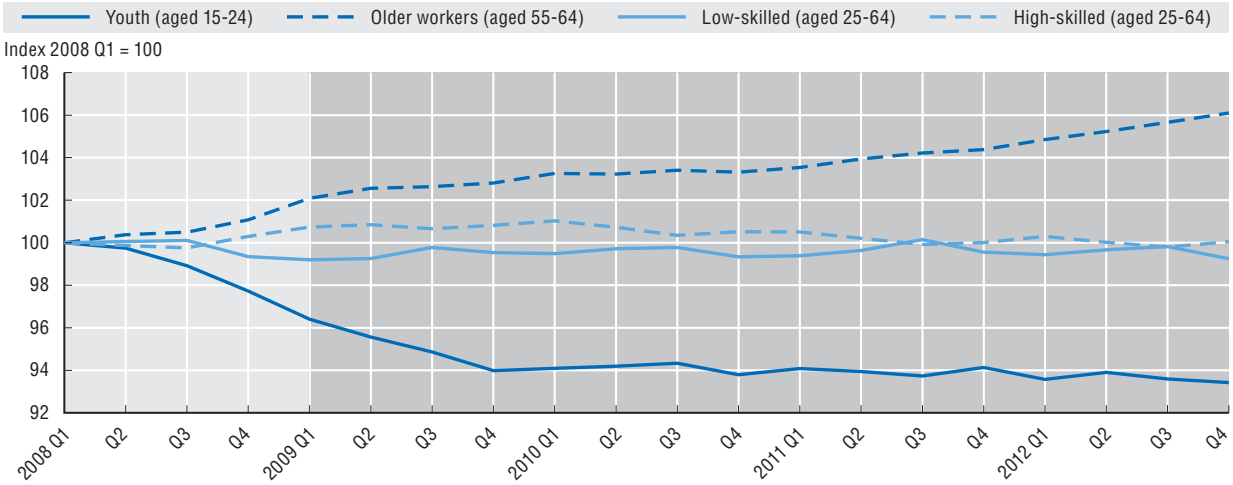
Source: OECD, Productivity Database, *www.oecd.org/std/productivity-stats*, August 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889326

Jobs: The most pressing challenge

For policy makers, unemployment – which is still rising in many economies, particularly among youth – is the most pressing challenge, especially in the euro area. The OECD-wide unemployment rate declined by just a 0.5 percentage point from a post-war high of 8.5% in October 2009 to 8.0% in April 2013. Employment growth in different groups has varied widely during the recovery. Youth employment rates are of particular concern, as they have declined by almost 7 percentage points in relative terms. Moreover, lower- and higher-skilled workers do not show any increase in their relative employment rates.

3. Job recovery across socio-economic groups, 2008 Q1-2012 Q4



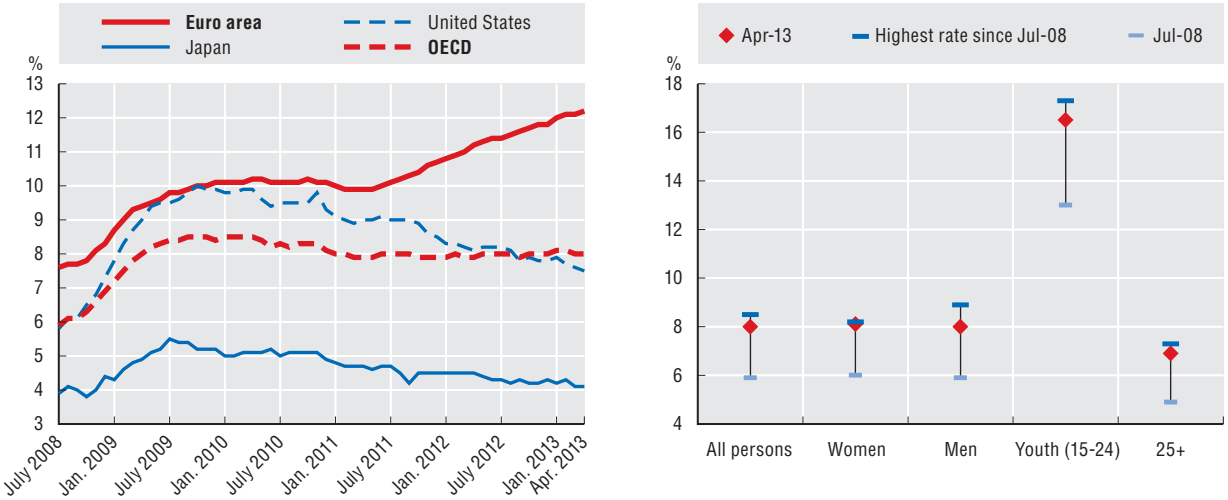
Notes: Ratio of each group's employment rates to overall employment rate. OECD is the weighted average of 34 countries for data by age, and of 30 countries for data by education (excluding Australia, Chile, Japan and New Zealand). Grey shading refers to the recovery period starting from the trough in OECD-wide GDP.

Source: OECD calculations based on OECD Short-Term Labour Market Statistics Database and National Labour Force Surveys, June 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889345

4. Harmonised unemployment rates, OECD, Euro area, United States and Japan, July 2008-April 2013

Percentage points



Source: OECD Short-Term Labour Market Statistics, June 2013. See chapter notes.

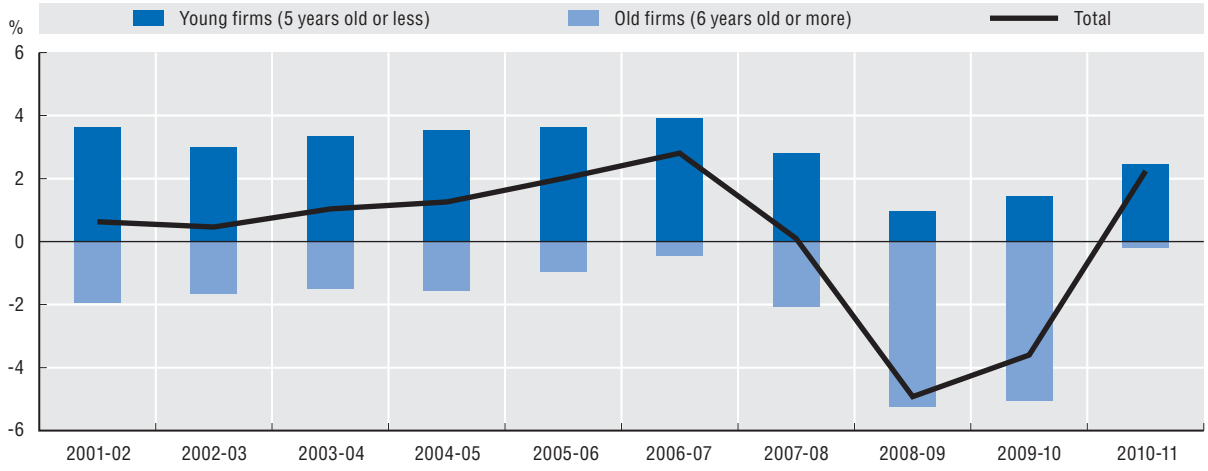
StatLink http://dx.doi.org/10.1787/888932889364

Young innovative firms and job creation

New evidence from 15 OECD countries for 2001-11 shows that young businesses play a crucial role in employment creation. During the financial crisis, the majority of jobs destroyed in most countries reflected the downsizing of old businesses, while net job growth in young firms remained positive.

5. Net job growth, younger versus older firms, 2001-11

Average over 15 countries



Note: Preliminary results from the OECD DYNEMP project. Average over the following countries: Austria, Belgium, Brazil, Finland, France, Hungary, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Spain, Sweden and the United States. The sectors of the economy considered are: manufacturing, construction and services (except for financial services). Owing to methodological differences, figures may deviate from officially published national statistics. Net job growth is defined as the ratio of the difference in employment for each group of firms (young, old and total) in two subsequent years to the average employment in the two years considered.

Source: OECD calculations based on the OECD DYNEMP data collection, July 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932889383*

DYNEMP, a new OECD project on firm-level dynamics

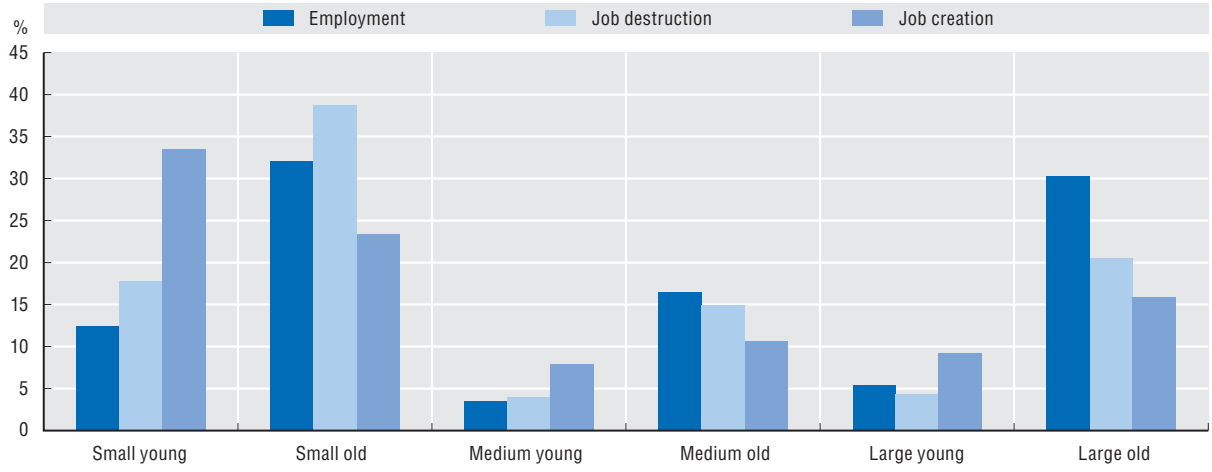
The OECD has collected cross-country evidence from countries' business registers to identify the sources of job creation across countries and over time. The project – called DYNEMP – currently involves 18 countries: Austria, Belgium, Brazil, Canada, Finland, France, Hungary, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States. The number of participants continues to increase. DYNEMP aims to quantify the extent to which firms that differ in terms of age, size and sector of activity contribute to job creation and job destruction and to see how firm entry, growth and exit shape employment dynamics across countries and over time. The resulting statistics also provide insights on the effect of the recent international financial crisis on business dynamics. The project relies on a special collection of micro-aggregated data extracted mainly from national business registers (BR) or comparable official sources that provide comprehensive coverage of economic activity. As the information contained in these sources is often confidential in nature, and national data need to be harmonised for cross-country analysis, the DYNEMP project has developed an automated routine that allows national representatives to construct harmonised micro-aggregated data based on BR. DYNEMP is currently extending and deepening its analysis by gathering a wider range of employment-related information at a more disaggregated level on the overall distribution of firms (and not only on high-growth or average firms); by involving representatives from other economies; and by starting the collection of a range of new statistics related to productivity.

Young, innovative firms and job creation

Firm-level data also show that, across all countries in the sample, young firms are more dynamic than older firms. Young firms systematically create more jobs than they destroy. In particular, young firms with fewer than 50 employees represent only around 11% of employment, they generally account for more than 33% of total job creation in the business sector, while their share in job destruction is around 17%.

6. Employment, job creation and job destruction, by firm age and size, 2001-11

Non-financial business sector, average over 15 countries

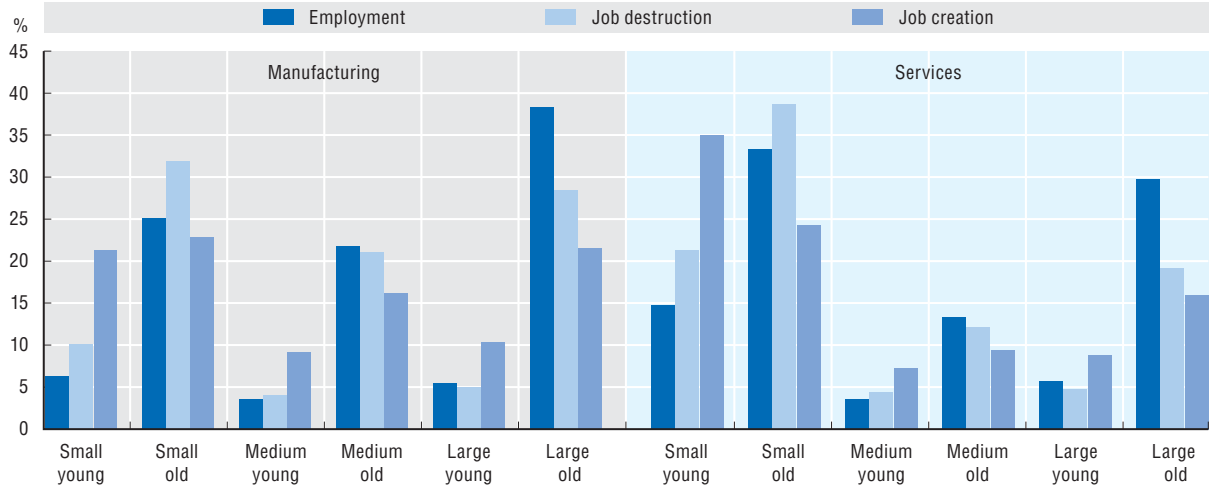


Source: OECD calculations based on the OECD DYNEMP data collection, July 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889402

7. Employment, job creation and job destruction, manufacturing and services 2001-11

By firm age and size, average over 15 countries



Source: OECD calculations based on the OECD DYNEMP data collection, July 2013. See chapter notes.

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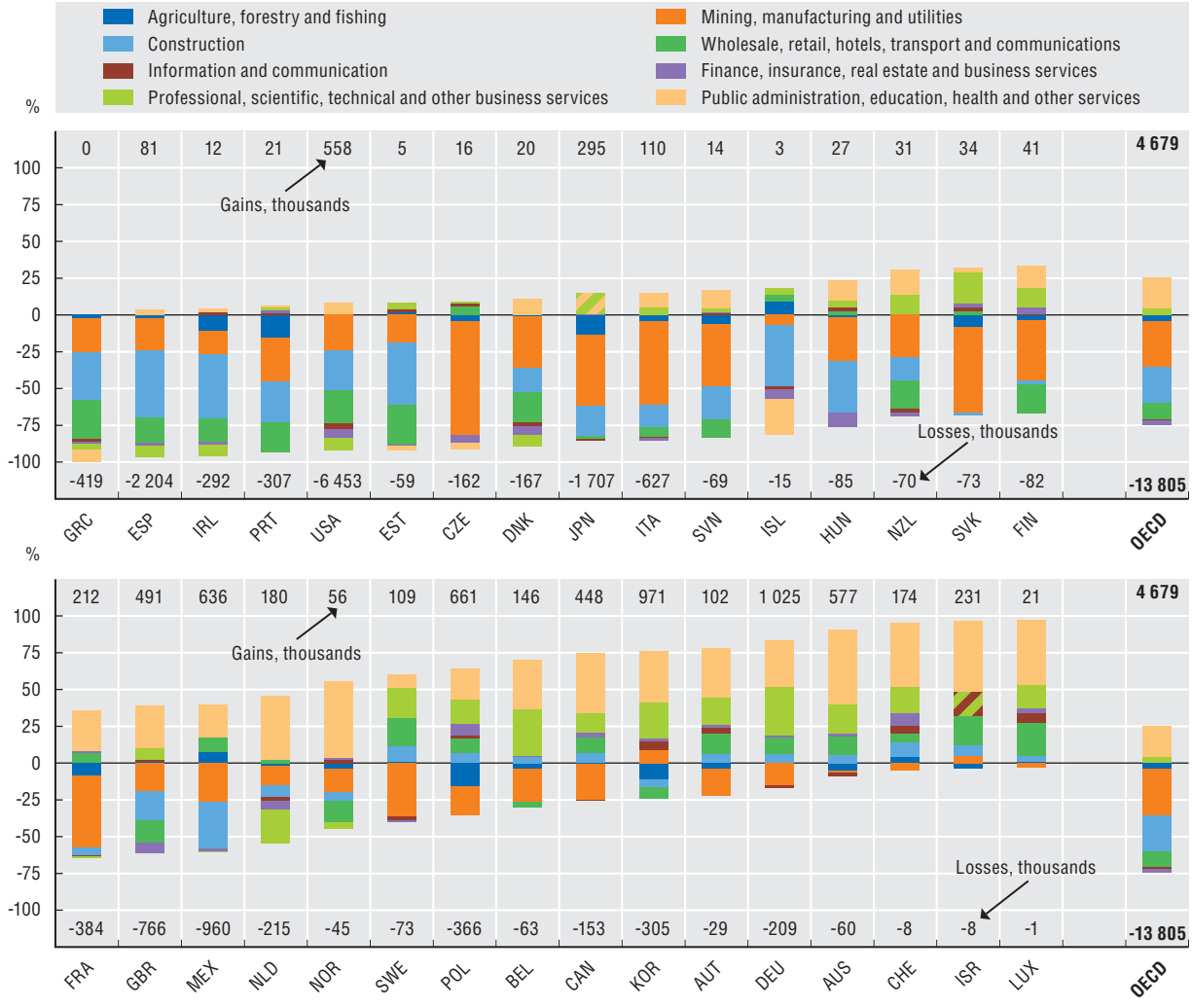
Jobs in the crisis

Between 2008 and 2011, the OECD area as a whole suffered a net loss of about 9 million jobs. Although this represents an overall drop of less than 2%, Estonia, Greece, Ireland and Spain suffered losses of over 8%. The United States alone shed about 6 million jobs over the period, a fall of about 4%. The construction and manufacturing sectors were the hardest hit, with significant declines in most OECD countries. Wholesale, retail, hotels, food services and transport sectors also struggled. In many countries, the losses were partly offset by gains in "Public administration, education, health and other services". Along with business services, this sector ensured that Australia, Germany, Israel, Korea and Switzerland saw jobs increase during this period.

8. Where people lost their jobs, 2008-11

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



Note: For Israel and Japan certain industry breakdowns are not available. See chapter notes.
Source: OECD, Structural Analysis (STAN) Database, May 2013; OECD National Accounts (SNA) Database and national statistical institutes, June 2013. See chapter notes.

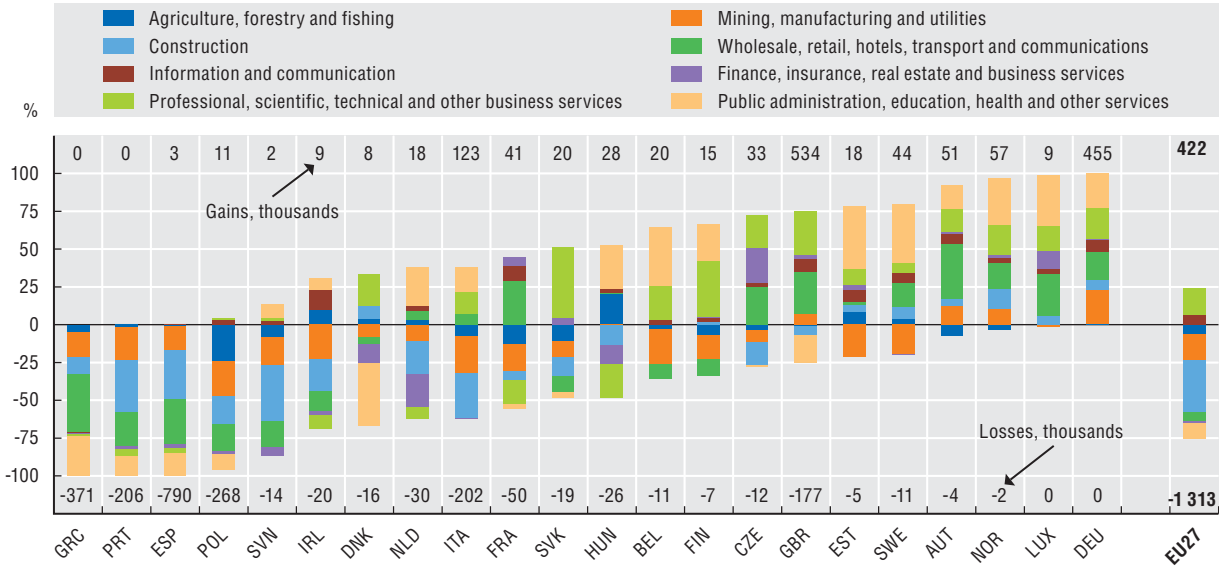
StatLink http://dx.doi.org/10.1787/888932889440

Jobs in the crisis

For many OECD countries, employment continued to decline well into 2012. Available data for Europe show that Greece, Portugal and Spain endured further falls of more than 4% from 2011. In several countries, including Greece, Portugal, Spain, Poland, Denmark and the United Kingdom, public sector employment declined substantially in this period.

9. Where people lost their jobs in Europe, 2011-12

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



Source: OECD, National Accounts (SNA) Database and national statistical institutes, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889459

How to read these figures

To assess the impact of the recent economic crisis on employment in different sectors of activity, sectoral changes in levels of employment can be "normalised" in order to highlight their relative contributions, in each country, to the total change in employment between two years. 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 gains and losses, in thousands, represent the sum of the aggregate sectors with positive changes and the sum of the aggregate sectors with negative changes, respectively. With a finer activity breakdown (for example, 2-digit ISIC Rev.4), the estimates for total gains and losses would be different. For example, the apparent loss of about 12 000 jobs between 2008 and 2011 in the Mining, manufacturing and utilities (B-E) sector in Australia actually includes gains of 57 000 in Mining (B) and 27 000 in Utilities (D-E) that are offset by losses of 96 000 in Manufacturing (C).

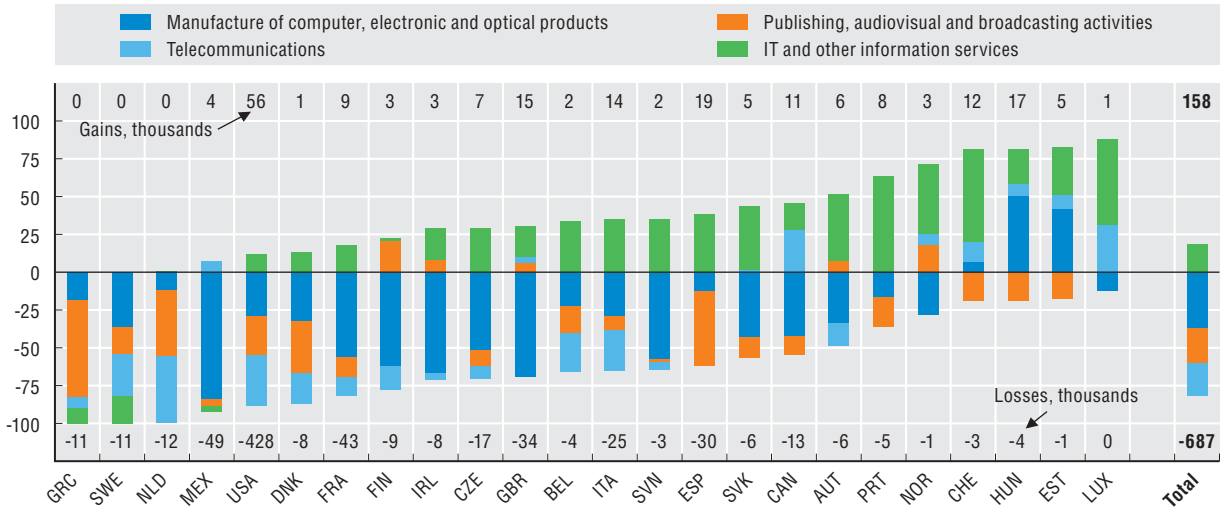
The employment data are mostly drawn from National Accounts (SNA) sources and are measured in terms of persons except for Canada, Japan, New Zealand and United States which provide figures for jobs. Care should be taken when comparing the changes in structural employment in these four countries with the others. In general, for countries that measure employment in both persons and jobs, declines were greater in jobs than in persons employed, as people switched to part-time work and job sharing.

Jobs in the crisis

The information industries are considered by many as an important source of growth in OECD countries. Between 2008 and 2011, in nearly all countries, IT and other information services saw gains in employment while employment in manufacturing of computer, electronic and optical products fell significantly. Losses were also apparent in publishing and telecommunication services. Over the period, Mexico and the United States had job losses in the information industries of about 8% and 6%, respectively.

10. Job creation and destruction in the information industries, 2008-11

Relative contribution to change in total employment in information industries by type of activity



Source: OECD, Structural Analysis (STAN) Database, ISIC Rev.4, May 2013; Eurostat National Accounts and national sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889478

The new industry classification and the information industries

For this analysis, "Information industries" is defined according to ISIC Rev.4. To allow for better measurement of information and communication services, ISIC Rev.4 introduced Section J, which consists of Publishing activities (Division 58), Audiovisual and broadcasting activities (59-60), Telecommunications (61), and IT and other information services (62-63). It brings together elements of four ISIC Rev.3 sections as summarised below. The hierarchy of ISIC Rev.4 also means that as a high-level section, information and communication is now more likely to feature in statistical collections for which countries typically only report aggregate economic activities, such as labour force surveys and annual National Accounts (SNA). For the definition of information industries used here, Section J is joined by ISIC Rev.4 Division 26, Manufacture of computer, electronic and optical products. This corresponds approximately to ISIC Rev.3 Divisions 30, 32 and 33.

Approximate ISIC Rev.4 to ISIC Rev.3 2-digit correspondence for ISIC Rev.4 Sector J

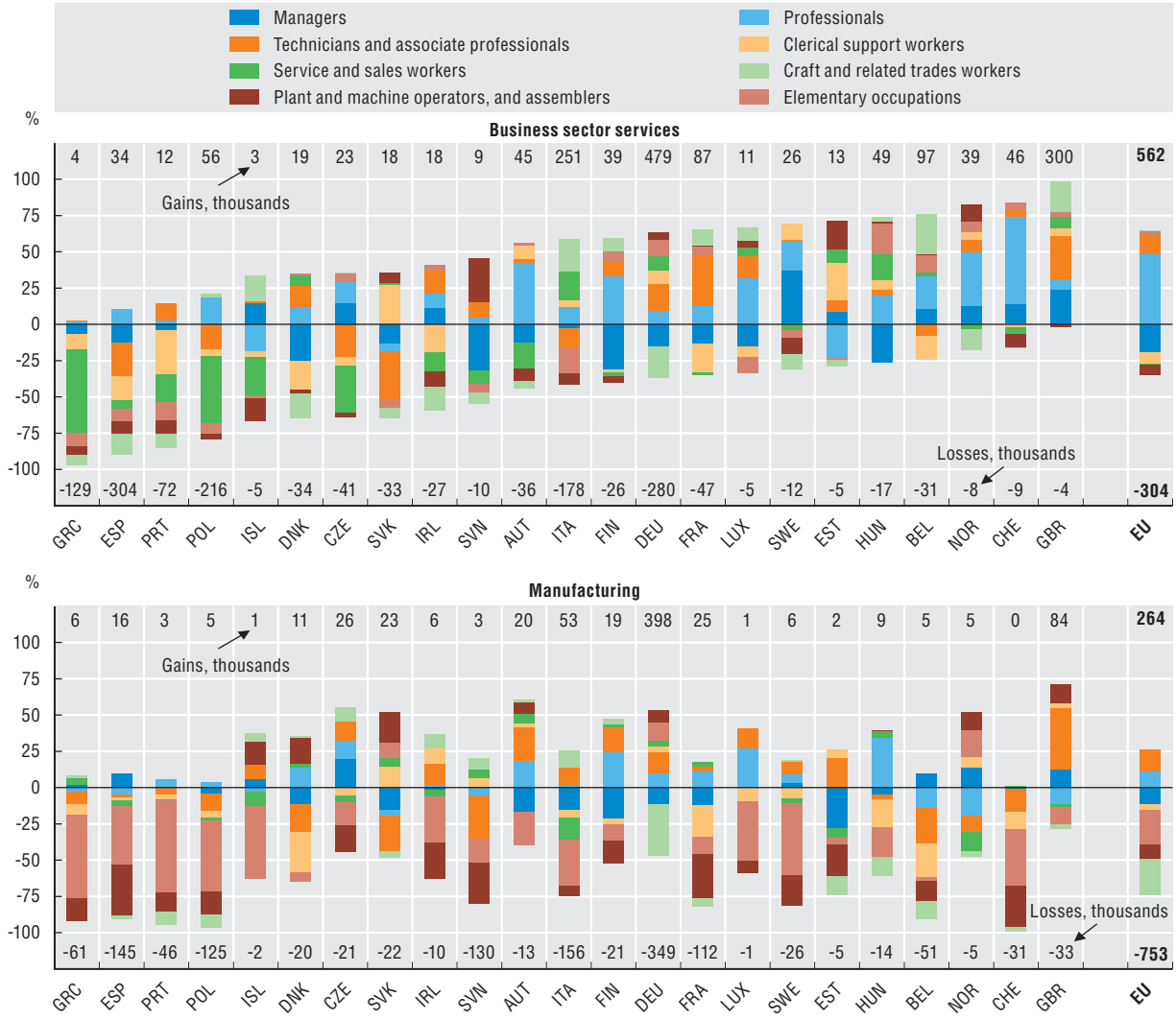
ISIC Rev.4		ISIC Rev.3	
18	Printing and reproduction of recorded media	22	Publishing, printing and reproduction of recorded media
58	**Publishing activities**		
59-60	**Audiovisual and broadcasting activities**	92	Recreational, cultural and sporting activities
90-93	Arts, entertainment and recreation		
53	Postal and courier activities	64	Post and telecommunications
61	**Telecommunications**		
62-63	**IT and other information services**	72	Computer and related activities

The skills challenge

Occupations provide another way of looking at changes in employment. Analysis of European labour force statistics suggests that during 2011-12, while there were some hints of recovery in employment, opportunities for managers declined. There was also a drop in lower-skilled jobs in both business services and manufacturing. However, employment rose for Professionals and for Technicians and associate professionals, i.e. higher-skilled "non-managerial" occupations.

11. Change in the skill mix in Europe, services and manufacturing, 2011-12

Relative contribution to changes in total employment by major occupation groups



Source: OECD, based on Eurostat,8 European Labour Force Surveys, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889497

How to read this figure

To see the occupations most affected by rises and falls in employment between 2011 and 2012, changes in the levels of employment in occupation groups were "normalised" to show their relative contributions to the total change in each country. This is achieved, for each country, by expressing changes in the level of occupation groups as a percentage of the sum of absolute change.

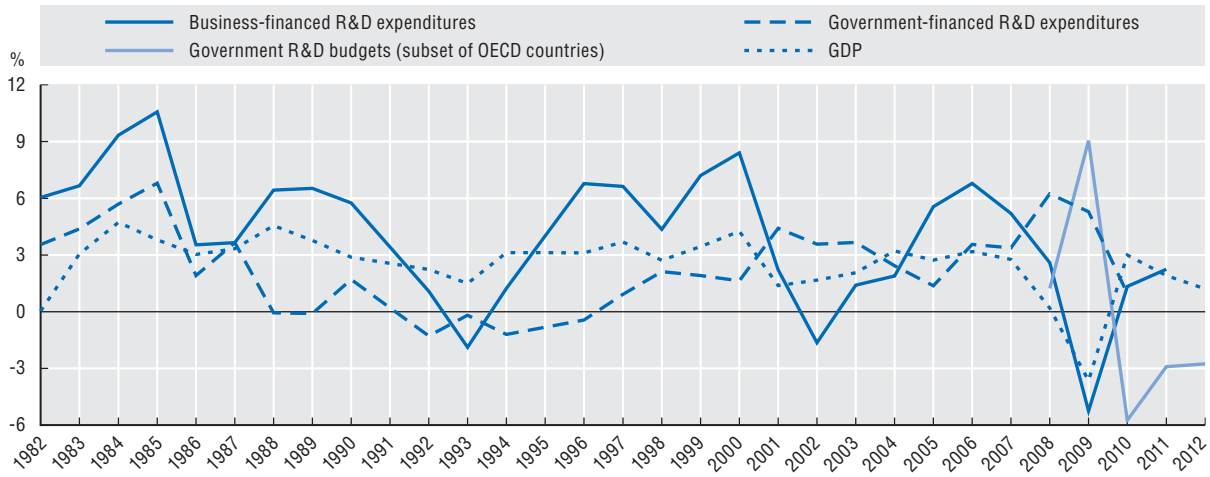
Occupations are defined according to the International Standard Classification of Occupations 2008 (ISCO-08). Gains and losses, in thousands, represent the sum of the occupations with positive changes and the sum of the occupations with negative changes, respectively. With a finer activity breakdown (for example, 3-digit ISCO-08), estimates of total gains and losses would differ, although the balance would remain the same.

R&D and innovation: emerging from the crisis?

Like other types of investment activity, expenditures on R&D and innovation are pro-cyclical. As data from 1982 to 2012 demonstrate, they mirror and amplify the economic performance of the OECD area. R&D financed by the business sector is particularly affected by the business cycle and reflects changes in financing constraints and aggregate demand. The unprecedented 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 appears to have recovered somewhat, counterbalancing to some extent what appears to be a significant reduction in government funding of R&D. Recent data also show that trademark activity in goods and services was strongly affected by the economic crisis, with drops that slightly preceded the inflection of GDP in the cycle. Several trademark categories that account for a large share of US trademarks (ICT and audiovisual, advertising and business services) have been on a downward trend since the beginning of 2012.

12. R&D growth over the business cycle by source of financing, OECD area, 1982-2012

Average annual real growth rate, percentage

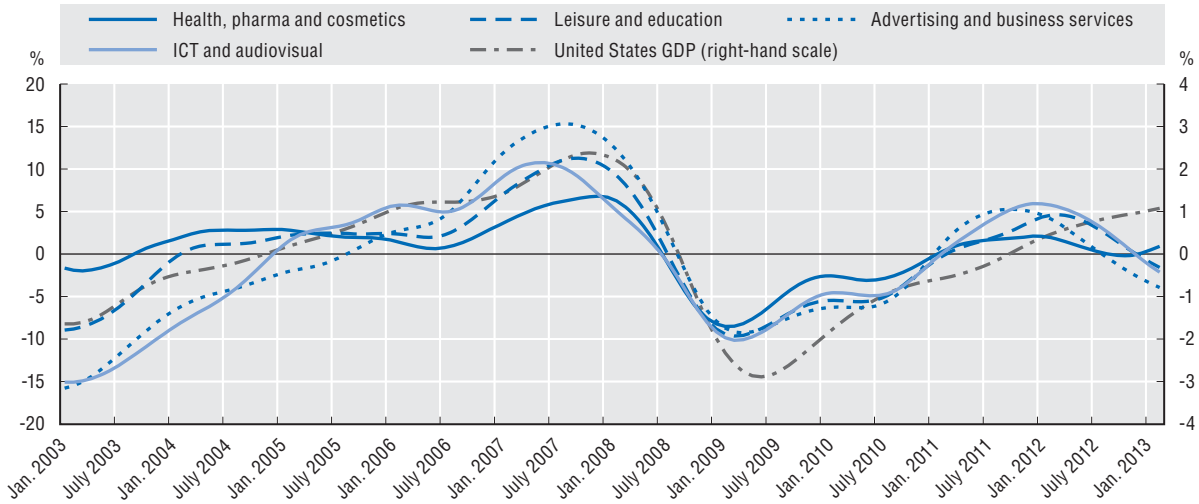


Source: OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932889516*

13. US GDP and trademark applications at the US Patent and Trademark Office, 2003-13

Comparing cycles, by type of trademarks, percentage deviation from the long-term trend



Source: OECD, based on US Patent and Trademark Office, Trademark Electronic Search System (TESS), June 2013; and OECD, Quarterly National Accounts Database, June 2013. See chapter notes.

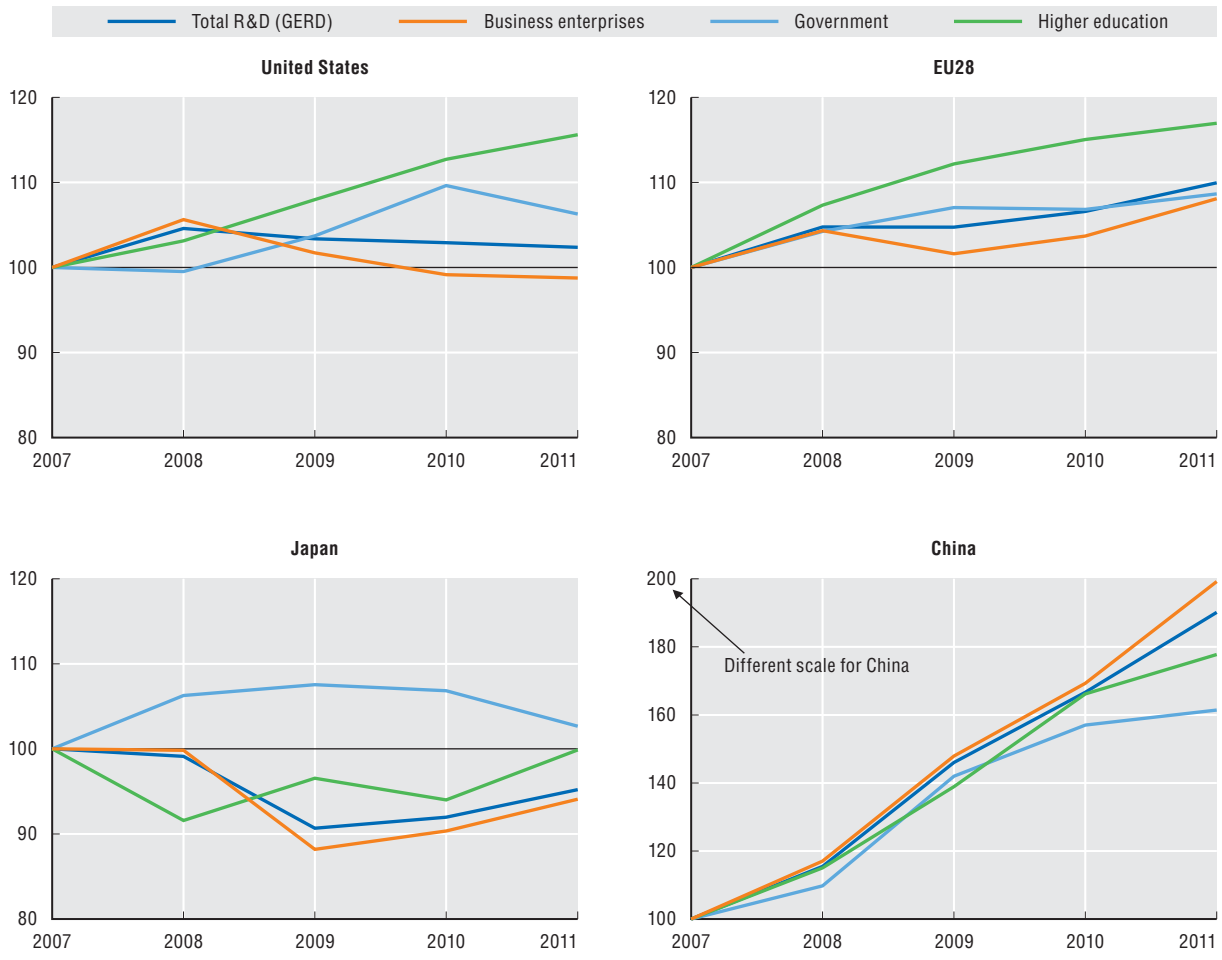
StatLink *http://dx.doi.org/10.1787/888932889535*

R&D through the recession

The performance of R&D from 2007 to 2011 has differed significantly across economies and sectors. In Europe, total GERD – measured in constant USD PPP – grew about 10 percentage points , while in Japan, it has still to recover its 2007 level, largely owing to the poor performance of the business sector. In the United States, GERD has been on a downward trend since 2008, due to the fall in business R&D, partly offset by increasing R&D in the higher education and government sectors. The EU28 performance has been more robust, mainly owing to the recovery of business R&D from a trough in 2009. This is principally due to growth in Germany's business R&D, which has more than offset reductions in other countries. In China, R&D expenditure has nearly doubled in real terms in the space of five years, principally boosted by the business sector. From 2009, R&D growth in the government and higher education sectors began to slow down but R&D levels continued to increase at a time when other countries were beginning to implement R&D budget cuts.

14. Recent R&D trends by sector of performance, 2007-11

Constant USD PPPs, index 2007 = 100



Source: OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013.

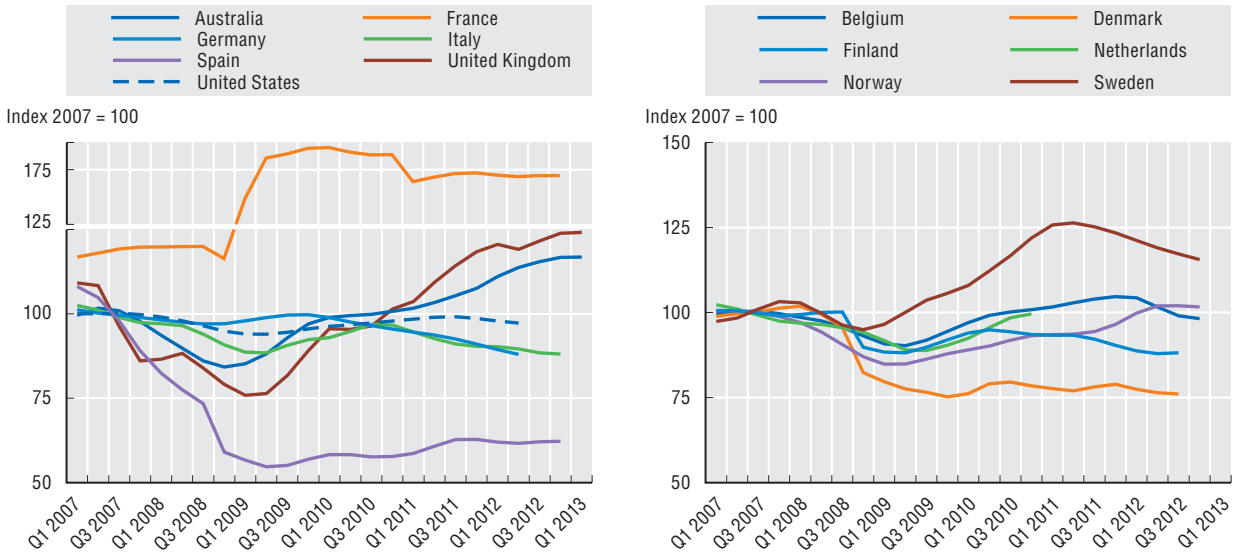
StatLink http://dx.doi.org/10.1787/888932889554

Creative destruction in the crisis

"Creative destruction" – the process whereby economic growth and structural change force less productive firms to exit and allow more innovative firms to enter – can help improve overall economic performance. The process of creative destruction slowed with the onset of the global financial crisis. Business register data show a decline in the rate of enterprise creation as early as 2007 for some of the largest economies. In 2009, the downward trend became more pronounced in several European countries. After six years only a few countries have returned to pre-crisis levels of enterprise creation. Trends in bankruptcies are broadly indicative of the cash flow situation of enterprises. However, as the length of countries' bankruptcy procedures varies, insolvent enterprises are not declared bankrupt at the same pace and this may affect the statistics shown. In several countries, bankruptcies continued to rise until 2011 and in nearly all of them remained much higher than in 2007.

15. New enterprise creations, selected OECD countries, 2007-13

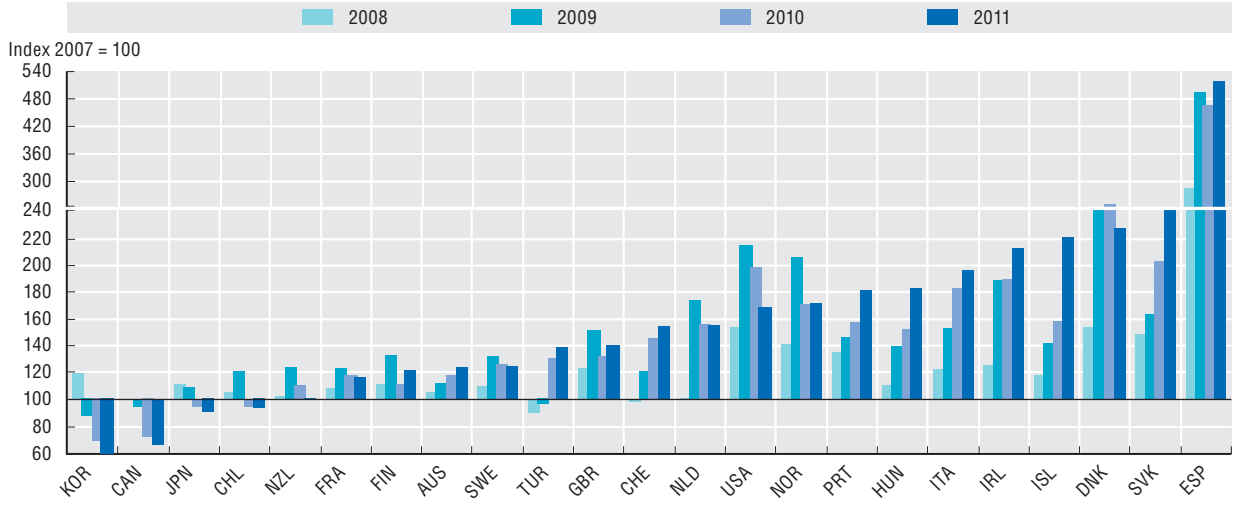
Trend cycle average



Notes: For France, there is a break in series in Q1-2009 when new legislation supporting *auto-entrepreneurs* led to a substantial increase in individual start-ups.
Source: OECD (2013), *Entrepreneurship at a Glance 2013*, OECD Publishing. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889573

16. Trends in bankruptcies, 2007-11



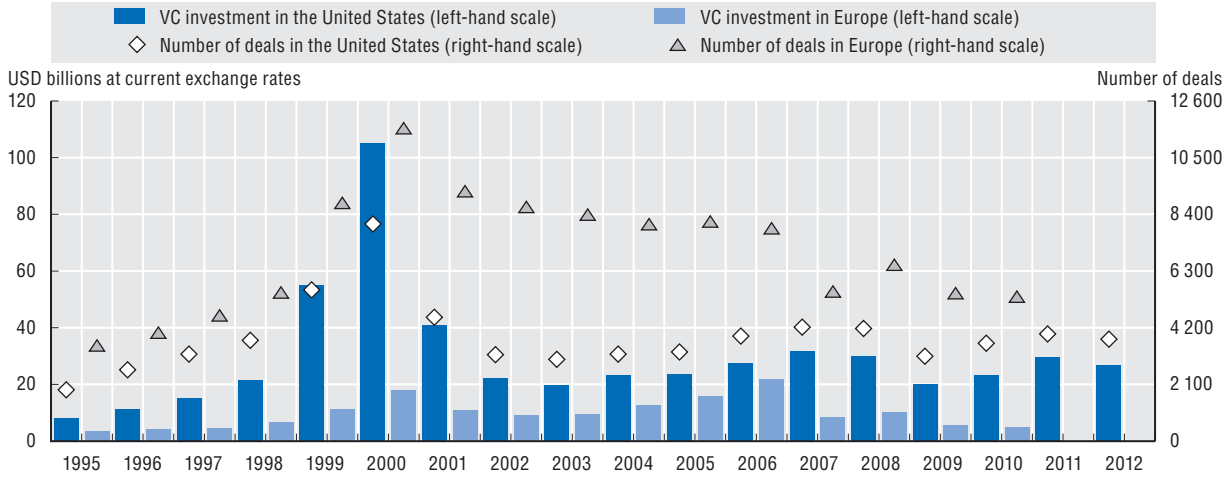
Note: Differences in national sources may affect international comparability.
Source: OECD (2013), *Financing SMEs and Entrepreneurs 2013: An OECD Scoreboard*, OECD Publishing and OECD (2013), *Entrepreneurship at a Glance 2013*, OECD Publishing. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889592

Financing of young innovative firms

Access to finance for new and innovative small firms involves both debt and equity finance. Venture capital (VC) is an important source of funding, especially for young technology-based firms. Even before the recent financial crisis, banks were reluctant to lend to small, innovative firms owing to their perceived riskiness and lack of collateral. The financial crisis widened the existing gap at the seed and early stage, as bank lending to start-ups fell and VC firms turned to later investment stages where risks are lower. In Europe venture capital markets appear less developed than in the United States, in terms both of the amounts invested and the amount per deal. Exits from VC and other private equity investments, through trade sales (mergers and acquisitions) or initial public offerings (IPOs) on stock markets, provide an opportunity for investors to realise returns from their investment and potentially free up funding for further investment in innovative young firms. As a consequence of the financial crisis, both trade sales and IPOs have declined significantly. Exit markets have not yet recovered (especially in Europe) and further improvement in these markets remains a challenge.

17. Venture capital investment in the United States, 1995-2012 and in Europe, 1995-2010

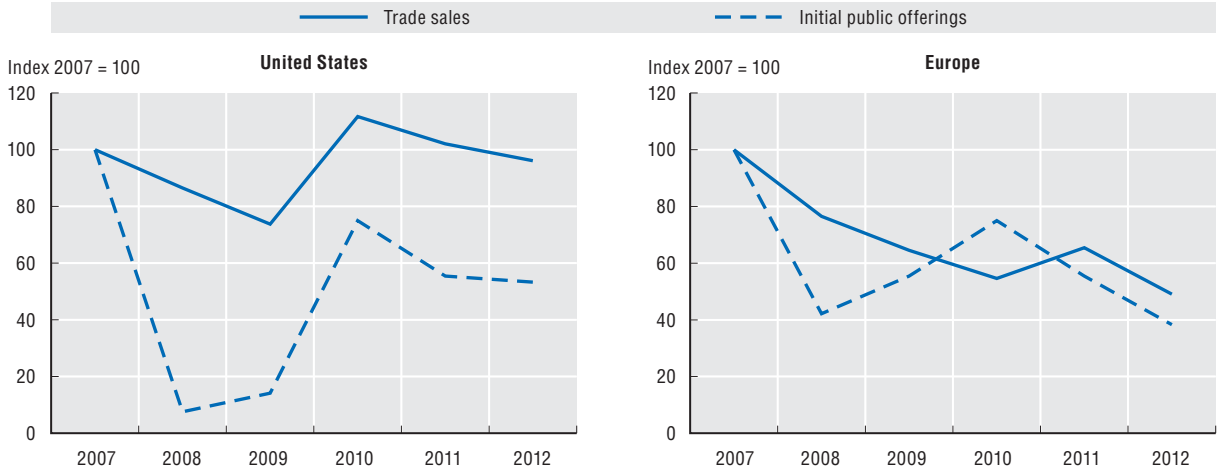


Source: OECD calculations based on PwCMoneyTree, EVCA/Thomson Reuters/PwC and EVCA/PEREP_Analytics, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889611

18. Venture capital exits in the United States and Europe, 2007-12

Trade sales and initial public offerings



Source: OECD calculations based on EVCA/PEREP_Analytics and Thomson Reuters/National Venture Capital Association, June 2013. See chapter notes.

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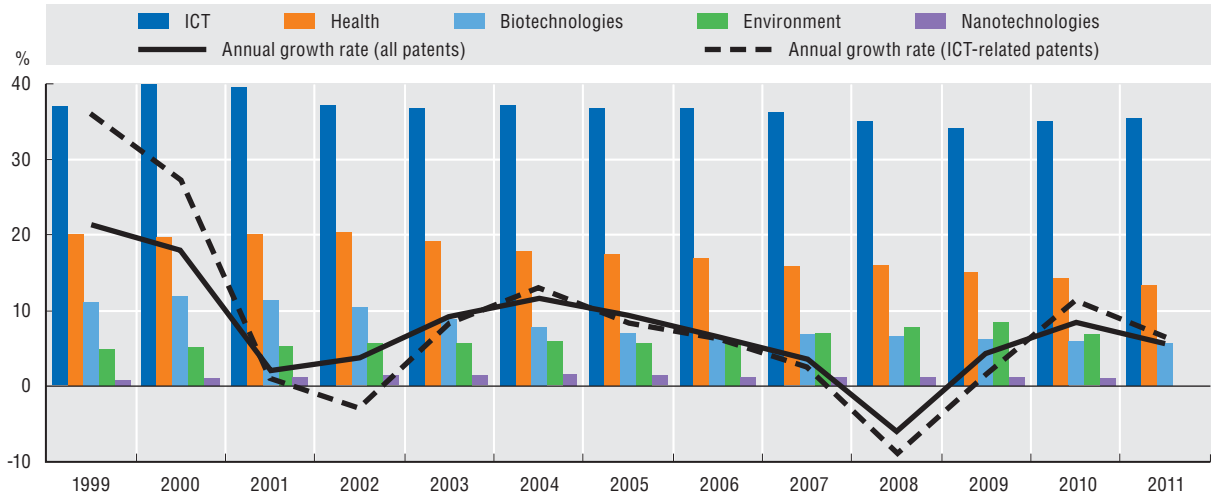
Technology development

Data on patent applications can be used to investigate the extent to which inventions occur in different technology areas, and the pace at which these fields develop and mature. Patents in ICT, health and biotechnologies account for the majority of patent applications worldwide, although their relative importance has decreased from almost 72% in 2000 to 54% in 2011. This decline has been mainly driven by a gradual reduction in the number of patent applications in health- and biotechnology-related technologies. Patents in nanotechnologies and the environment, instead, which in 2000 accounted for about 6% of all patents, saw their relative share increase to almost 10% in 2010.

19. Patents by technology fields, 1999-2011

As a percentage of total patent applications



Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889649

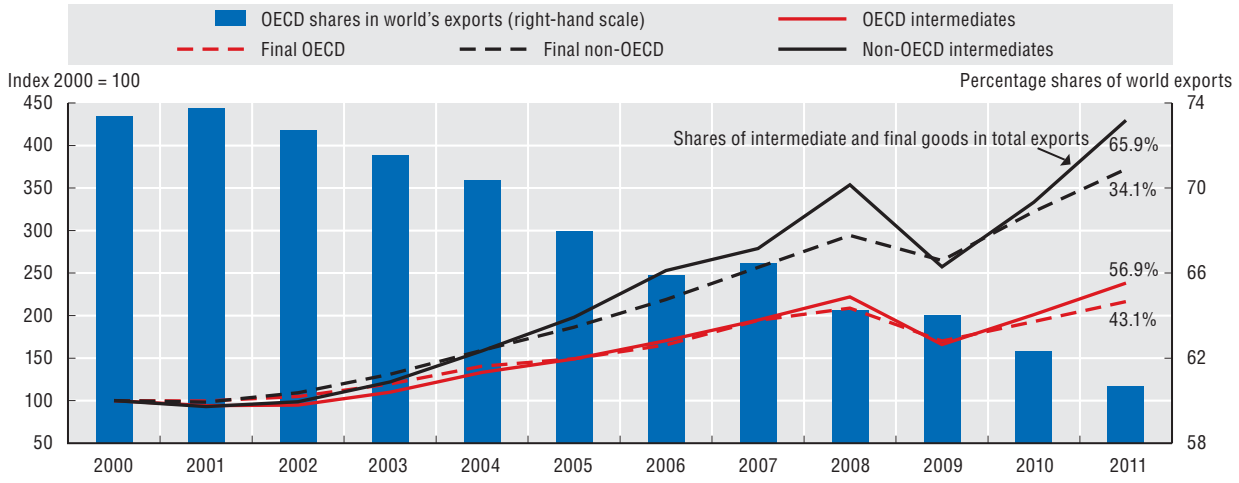
Classifying patents into technology areas

Information contained in patent documents – the invention's International Patent Classification (IPC) and national patent classification fields, its title, the abstract describing it, and its list of claims – can be used to classify a patent in the relevant technology. In the case of IPC classes, one or several codes may be attributed during the patent examination process. However, for emerging and rapidly evolving technologies, specific categories or classes may not be available when needed. This can make it difficult to identify patents relating to such technologies at a later date. A careful examination of the IPC classes and subclasses, combined with searches for appropriate keywords in the text fields of the patent document, makes it possible to define the boundaries of a given technology domain. A comprehensive allocation of patented inventions based on 4-digit IPC codes was developed by Schmoch (WIPO, 2008, revised in 2013), who subdivided patents into 35 technology classes. Additionally, groups of experts have identified key domains on the basis of IPC classes and the ad hoc tagging system of the European Classification System (ECLA) to highlight the areas of application of patented inventions.

Trade in the crisis

Growth of international trade has greatly outpaced growth of GDP over the past decade. Between 2000 and 2008, and before the financial crisis triggered a worldwide slump in 2009, there was a nearly threefold increase in reported global exports of goods and services. Movements of intermediate goods were the hardest hit but were also the first to recover. Between 2000 and 2011 growth of exports from emerging economies outpaced exports of OECD countries. By 2011, the OECD's share of goods exports had fallen by about 12 percentage points from 2000 and its share of exports of services had fallen by 10 percentage points. In general, services were less affected by the collapse. By 2011, in both OECD and non-OECD economies, global trade in goods and services had recovered, supported by increases in commodity prices. The amplitude of the crisis underscored the depth and breadth of global interdependencies and prompted calls for better tools to link trade, demand and output flows across countries, sectors and commodities. The recent development of the OECD-WTO Trade in Value Added (TiVA) Database has made it possible to analyse trade dynamics and relations from a new perspective.

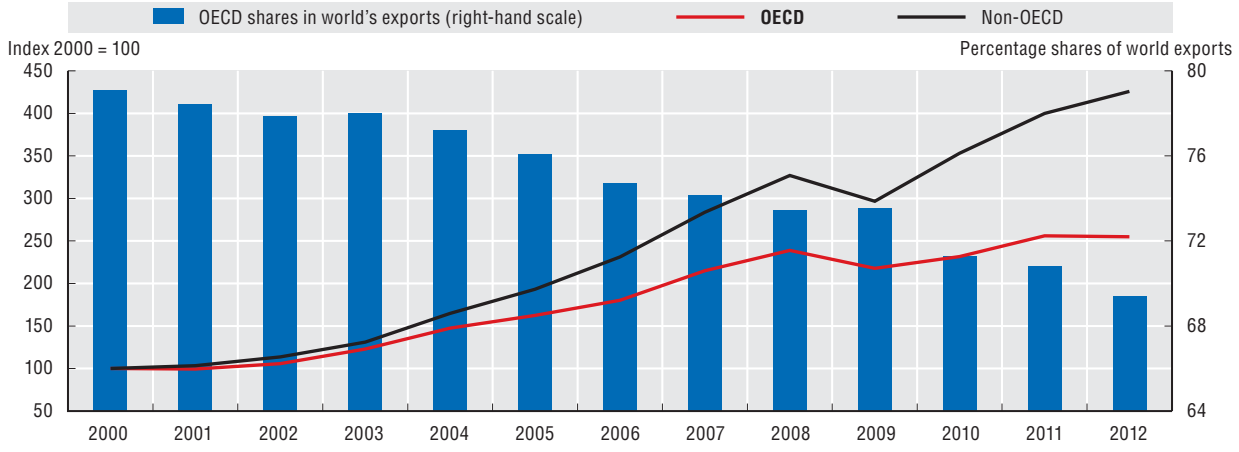
20. The dynamics of merchandise exports in OECD and non-OECD economies, 2000-11



Source: OECD, STAN Bilateral Trade Database by Industry and End-use (BTDIxE), *www.oecd.org/sti/btd*, May 2013. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932889668*

21. The dynamics of trade in services in OECD and non-OECD economies, 2000-12



Source: UNCTAD, UNCTADstat, June 2013.

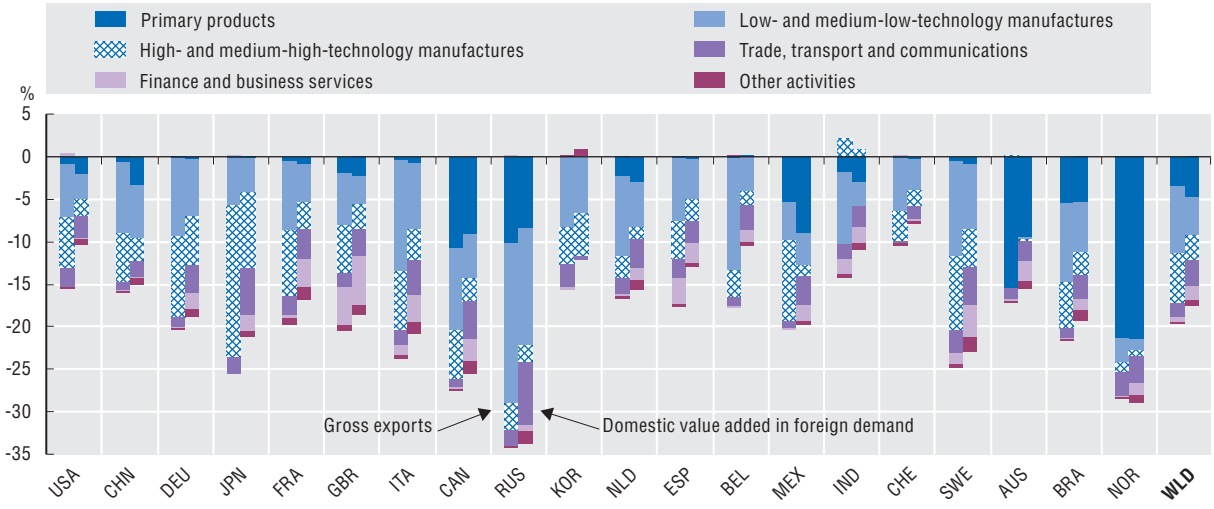
StatLink *http://dx.doi.org/10.1787/888932889687*

Trade in the crisis

Measuring international trade in value added terms makes it possible to avoid counting flows of embodied intermediate goods and services more than once and offers a new perspective on the 2009 global collapse in trade. Drops in countries' value added in foreign final demand (value added exports) were slightly less severe than declines in exports measured in "traditional" gross terms. A value added measure also reveals that falls in exports of primary goods and of services had a greater impact on the 2008-09 contraction than gross measures would indicate. The influence of manufactured exports on the trade crisis appears significantly weaker once the widespread fall in flows of intermediate goods is better accounted for.

22. Worldwide collapse in exports, in gross and value added terms between 2008 and 2009

Contributions to total percentage fall by major groups of activity, for top 20 exporting OECD/BRIICS countries



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932889706*

Measuring trade in value added

The goods and services people buy are composed of inputs from various countries around the world. However, the flows of goods and services within these global production chains are not always reflected in conventional measures of international trade. Reporting the total value of an export often means counting embodied imported intermediates every time they cross borders.

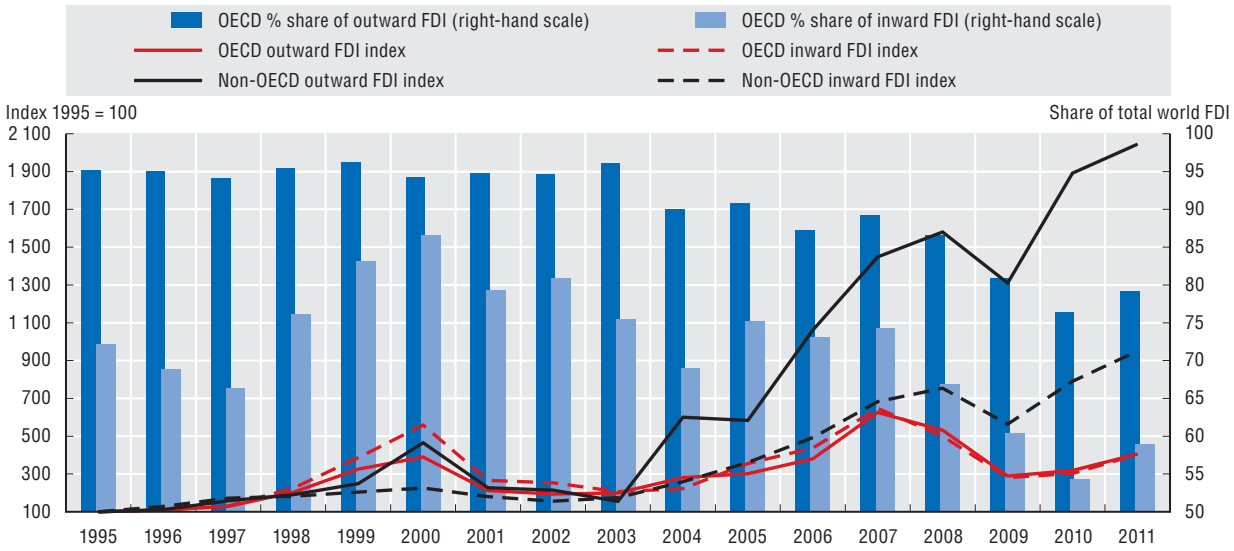
The joint OECD–WTO Trade in Value Added (TiVA) Database considers the value added by each country in the production of the goods and services consumed worldwide. It recognises that growing global value chains mean that a country's exports increasingly rely on significant intermediate imports. TiVA indicators are designed to inform policy makers by providing new insights into the commercial relations between nations. The TiVA database (May 2013) presents indicators for 57 economies (including all OECD countries) for the years 1995, 2000, 2005, 2008 and 2009, broken down by 18 industries. The indicators include: breakdown of gross exports by industry into their domestic and foreign content; origin of value added in countries' final demand; the services content of gross exports by exporting industry (broken down by foreign/domestic origin); bilateral trade balances based on flows of value added embodied in domestic final demand; intermediate imports embodied in exports.

For example, the indicator FDDVA (domestic value added embodied in [foreign] final demand) accounts for the fact that industries export value both directly, via exports of final goods and services, and indirectly, via exports of intermediates embodied in other countries' exports to meet foreign final demand (household and government consumption or capital investment). It shows the connection of industries (upstream in a value chain) to consumers in other countries, even when no direct trade relationship exists. It can thus contribute to a better understanding of the impact on domestic output of changes in final demand in foreign markets. Indicators of trade in value added are derived from the OECD's input-output tables, which are integrated into the global Inter-Country Input-Output (ICIO) system using additional information from the OECD's Bilateral Trade in Goods by Industry and End-Use (BTDIxE) Database, the bilateral Trade in Services (TIS) Database, the Structural Analysis (STAN) Database, and aggregate annual National Accounts (SNA) and Balance of Payments statistics.

Investment in the crisis

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 in the following years their share fell 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 severe slump (about 20%) in 2009 followed by an immediate recovery. In the OECD area as a whole, both inward and outward flows were already falling in 2008 and by 2011 had still not reached their pre-crisis levels.

23. Trends in world foreign direct investment flows 1995-2011



Source: IMF, Balance of Payments Database, June 2013. See chapter notes.

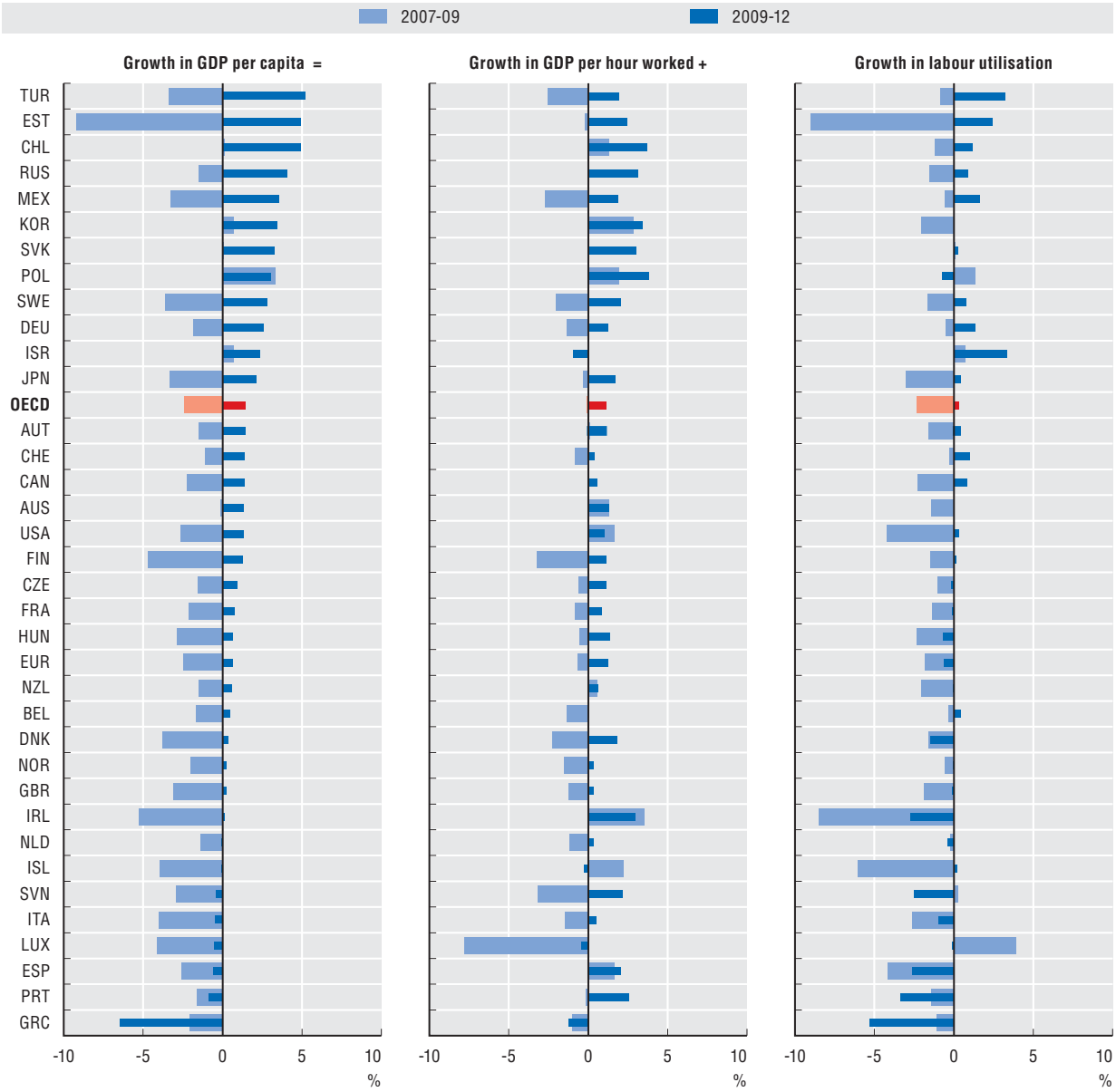
StatLink http://dx.doi.org/10.1787/888932889725

GDP per capita

GDP per capita is a measure traditionally used to gauge a nation's welfare. Changes in this measure can result from changes in labour productivity (GDP per hours worked) and labour utilisation (hours worked per employee and employment per capita). Differences in GDP per capita growth in OECD countries can be mainly attributed to differences in labour productivity growth, as labour utilisation has generally increased only marginally over the past 15 years. The picture has been slightly different since the onset of the financial crisis. In most countries, the decline in GDP per capita was primarily due to substantial declines in labour utilisation, only partly offset by increases in productivity. These were due to falls both 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 in OECD countries and obliges them to find new and sustainable sources of growth.

24. Decomposition of growth in GDP per capita, 2007-09 and 2009-12

Total economy, annual percentage change



Source: OECD, Productivity Database, *www.oecd.org/std/productivity-stats*, August 2013. StatLink contains more data. See chapter notes.

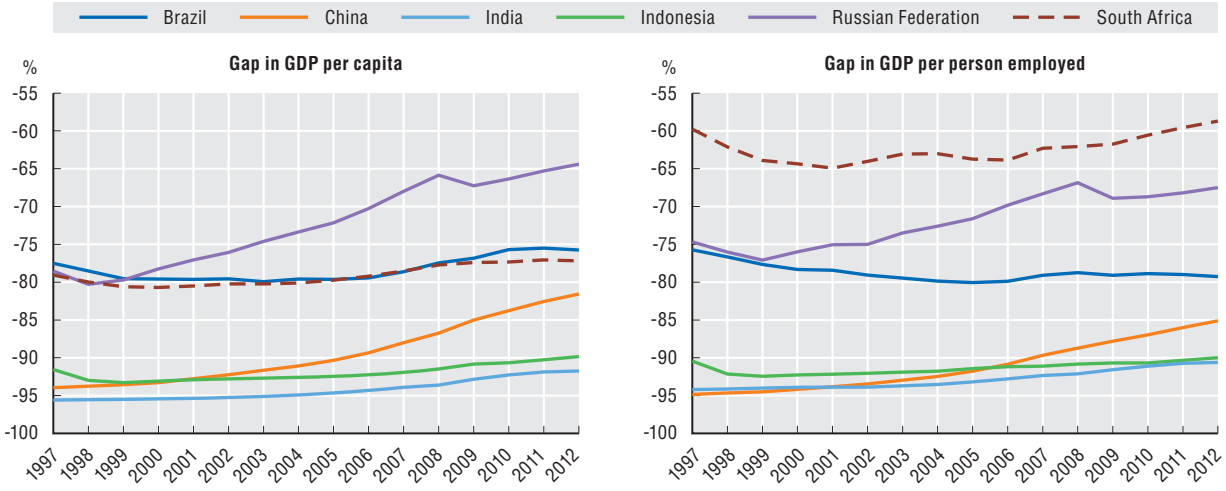
StatLink *http://dx.doi.org/10.1787/888932889744*

GDP per capita

What stands out from the breakdown of GDP per capita is the importance of labour productivity in explaining the cross-country dispersion in income per capita. Despite rapid convergence in some of the BRIICS, all still have income gaps of between 65% and 92%, mainly due to large labour productivity shortfalls compared to the United States. Among the BRIICS, China's GDP per capita soared during the years of the crisis, narrowing the gap by over 6 percentage points; its labour force participation rates remained above the OECD average and the difference in income per capita is essentially due to lower capital per worker and lower multifactor productivity. In Brazil the GDP per capita gap is slowly diminishing, but it remains large and is mainly due to comparatively weak labour productivity performance.

25. Gap in GDP per capita and GDP per person employed in the BRIICS, with respect to the United States, 1997-2012

In percentage points



Source: OECD, Productivity Database, *www.oecd.org/std/productivity-stats*, August 2013. See chapter notes.

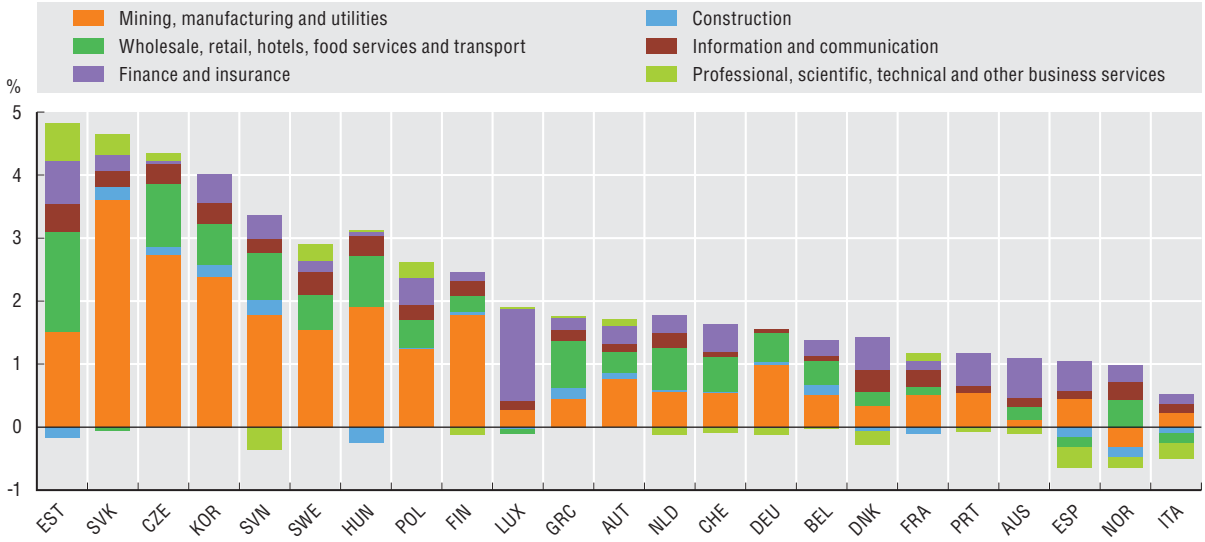
StatLink http://dx.doi.org/10.1787/888932889763

Labour productivity

Understanding the drivers of productivity growth at the total economy level requires an understanding of the contribution of each industry. An individual sector's contribution depends not only on its productivity growth but also on its share of value added and employment. In the years up to the economic crisis, productivity growth was almost entirely driven by manufacturing and business-sector services. The contribution of manufacturing was generally due to increasing productivity and not to the growth of the sector. The strong contribution of business-sector services reflected their increasing share in overall activity; excluding real estate, business-sector services accounted for 35% to 50% of value added across OECD countries.

26. Labour productivity growth in non-agricultural business sector before the crisis, 2001-07

Contribution to average annual percentage change by industry



Source: OECD, National Accounts (SNA) Database and Structural Analysis (STAN) Database, ISIC Rev.4, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889782

How to read this figure

Labour productivity growth is defined as the rate of growth in real value added per hour worked. Differences in labour productivity growth across sectors may relate, for instance, to the intensity with which sectors use capital and skilled labour in their production, the scope for product and process innovation, the absorption of external knowledge, the degree of product standardisation, the scope for economies of scale, and involvement in international competition.

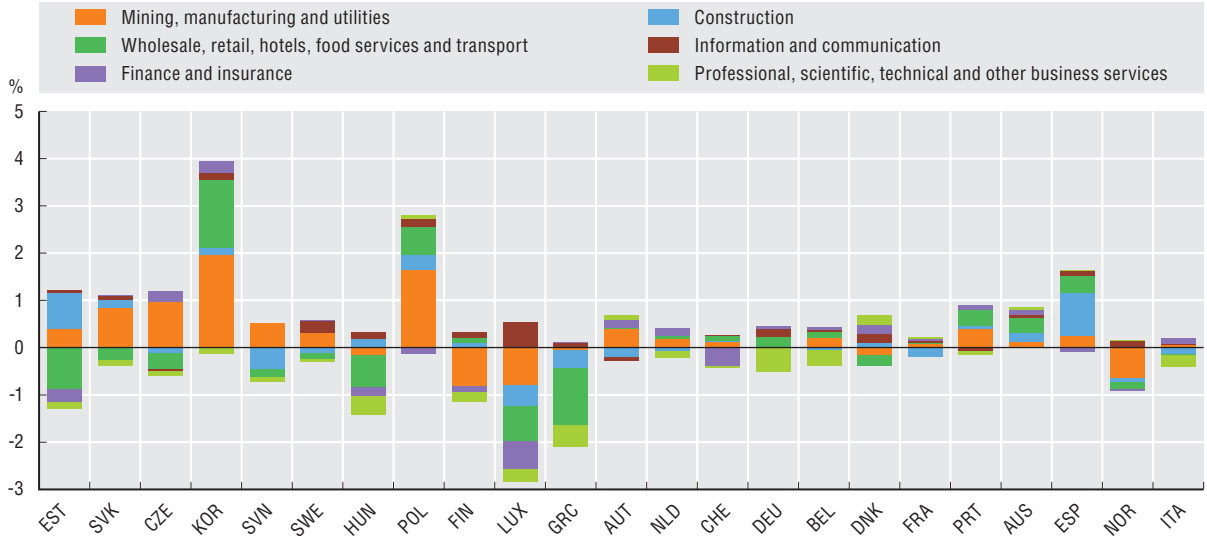
Productivity growth rates differ widely across industries. High growth rates are found particularly in the manufacturing sector but also in some business-sector services. The differences in sectors' productivity performances do not appear to explain all of the differences in productivity growth across countries. For instance, in manufacturing, productivity growth rates ranged from less than 1% in Italy to 8% in the Czech Republic between 1995 and 2011. For most OECD countries for which data are available, labour productivity growth has declined since the onset of the financial crisis, and the decline is broadly spread across sectors. Spain is a notable exception, but its labour productivity growth was due to significantly larger falls in employment than in output.

Labour productivity

Since the crisis, productivity growth has been sluggish in many OECD countries; positive growth, however small, has typically occurred in manufacturing, information and communication, and, to a lesser extent, finance and insurance. However, many recent gains, especially in manufacturing, stem from aggregate efficiency increases following heavy job losses in the sector.

27. Labour productivity growth in non-agricultural business sector after the crisis, 2007-11

Contribution to average annual percentage change by industry



Source: OECD, National Accounts (SNA) Database and Structural Analysis (STAN) Database, ISIC Rev.4, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889801

Measuring labour productivity by sector

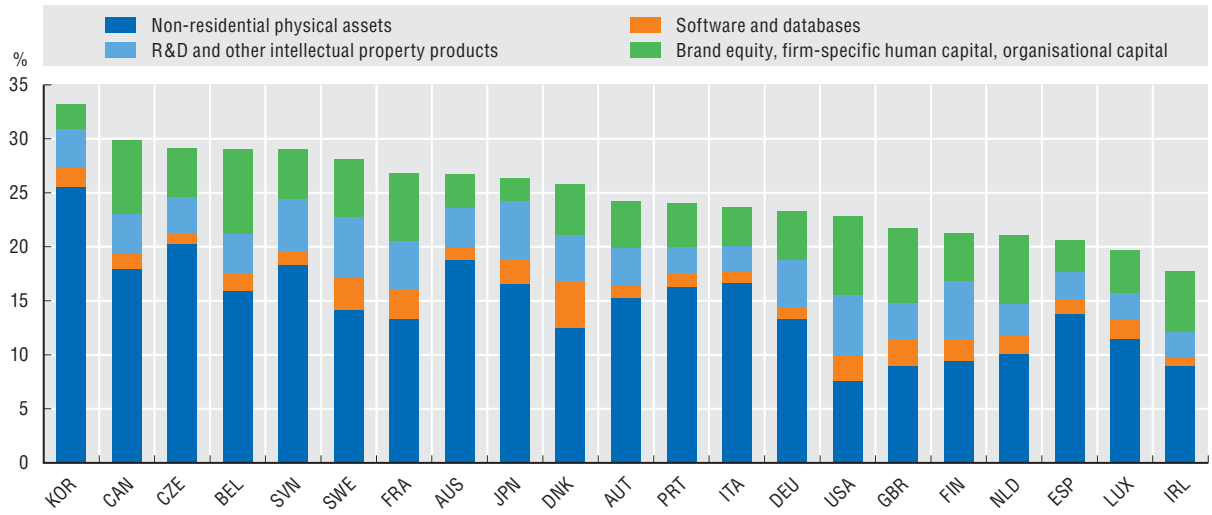
The comparability of productivity growth across industries and countries may be affected by problems in measuring real value added. This is particularly relevant for services, as it is difficult to isolate price effects due to changes in the quality or the mix of services from pure price changes. In spite of the substantial progress made in the past ten years in compiling service producer price indices (SPPIs), the methods used to compute real value added still vary across OECD countries. In many of them, estimates of real value added in some industries are based on a sum-of-costs approach, which deflates compensation of employees using assumptions about labour productivity growth. For example, most countries assume no change in labour productivity for public administration activities, which is why this sector is not included here. Also excluded are real estate services, as the output of this sector mainly reflects 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 (2012) *Compendium of Productivity Indicators* 2012, OECD Publishing.

Knowledge-based capital

Innovation stems from more than investment in R&D. It requires complementary assets such as software, design, human capital and appropriate organisational structures. Investment in such knowledge-based capital (KBC) has been rising in many OECD economies, often at a faster pace than investment in traditional physical capital. In the United States, the country with the longest time series, investment in KBC has been rising almost continuously for more than 40 years to reach some 15% of GDP by 2010. In Denmark, Finland, France, the Netherlands, the United Kingdom and the United States, these investments exceeded investment in machinery and equipment in 2010. R&D and other innovative property assets only represent between 26% and 55% of total KBC investments.

28. Investment in physical and knowledge-based capital, 2010

As a percentage of value added of the business sector



Source: Statistics on knowledge-based investment based on INTAN-Invest Database, *www.intan-invest.net*, and national estimates by researchers. Estimates of physical investment are based on OECD Annual National Accounts (SNA) and INTAN-Invest Database, May 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932889820*

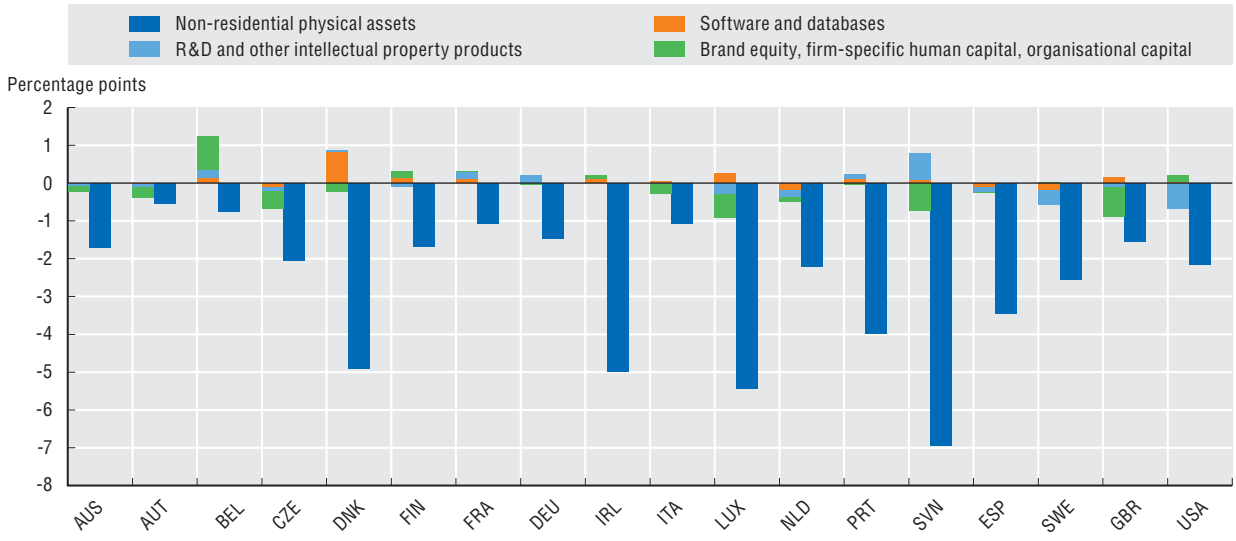
What do we mean by "knowledge-based capital"?

Sometimes referred to as "intangible assets" or "intellectual capital", knowledge-based capital has been defined as "claims on future benefits that do not have a physical or financial embodiment" (Lev, 2001). Much of the focus has been on R&D, key personnel and software, but the range of assets in the bundle of KBC is considerably broader. One classification, offered by Corrado et al. (2009), groups intangible investments into three main types: computerised information (such as software and databases); innovative property (such as scientific and non-scientific R&D, copyrights, designs, trademarks); and economic competencies (including brand equity, aspects of advertising and marketing, firm-specific human capital, and the organisational know-how that increases enterprise efficiency). On the basis of that study, researchers in several countries have computed aggregates for KBC investment. Some intangibles – software and, more recently, R&D – are now recognised by the international statistical community as capital assets and will be accounted for in the System of National Accounts (see the 2010 *OECD Handbook on Deriving Capital Measures of Intellectual Property Products*, OECD Publishing). More work is needed to harmonise the definition of KBC and collect data on an internationally comparable basis for better identification and measurement of new sources of growth.

Dynamics of knowledge-based assets

Evidence suggests that business investment in KBC relates to growth and productivity. KBC can be the source of increasing returns to scale in production by allowing firms to make use of existing knowledge without re-incurring the costs of developing it. In addition, some of the knowledge created by assets such as R&D, design and new business processes can spill over into other parts of the economy, spurring growth. Growth accounting studies for the European Union and the United States show that business investment in KBC is the source of 20% to 27% of average labour productivity growth. Recently gathered data suggest that, at least in the early phase of the global economic crisis, business investment in KBC either grew faster than, or did not decline to the same extent as, investment in physical capital. This characteristic of aggregate investment in KBC may depend in part on the nature of the expenditures measured, primarily wages, which tend to be stickier than other forms of business expenditures.

29. Change in business investment intensity between 2008 and 2010



Source: Statistics on knowledge-based investment are based on INTAN-Invest Database, *www.intan-invest.net*, and national estimates by researchers. Estimates of physical investment are based on OECD Annual National Accounts (SNA) and the INTAN-Invest Database, May 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932889839*

How to read this figure

Since the start of the global economic crisis, business investment has suffered, although not equally across different types of assets. This figure shows the change in investment in KBC and in physical assets between 2008 and 2010. For example, in the United States, investment in physical assets fell from 9.7% to 7.6% of business-sector value added, a drop of 2.1 percentage points. Investment in innovative property fell by 0.67 percentage points, while investment in economic competencies increased by 0.16 percentage points.

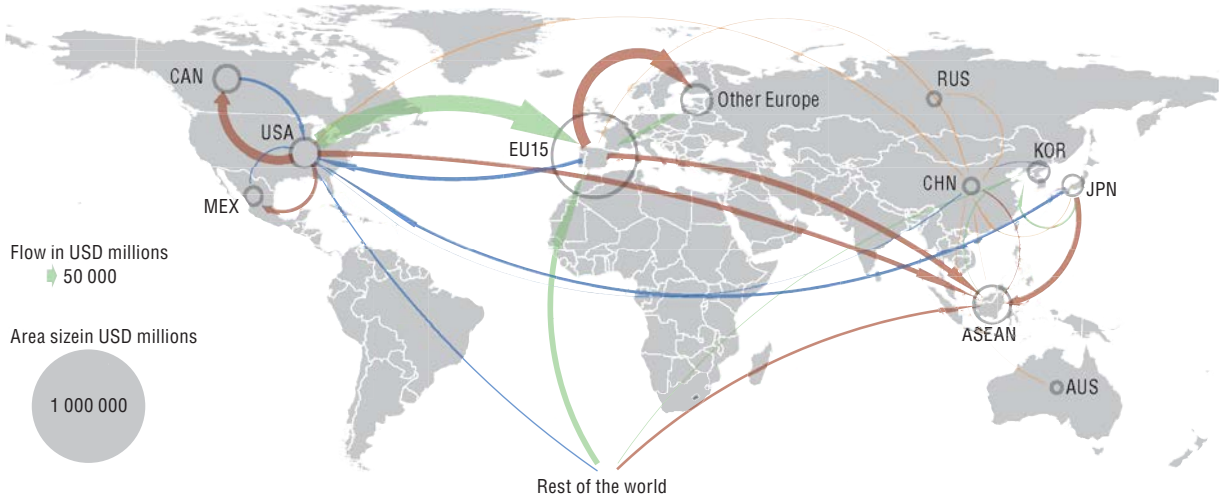
The new geography of growth

Evolving global value chains

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

30. Foreign value added content of exports, 1995

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



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013; map source: ARTICQUE© – all rights reserved. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932889858*

How to read these figures

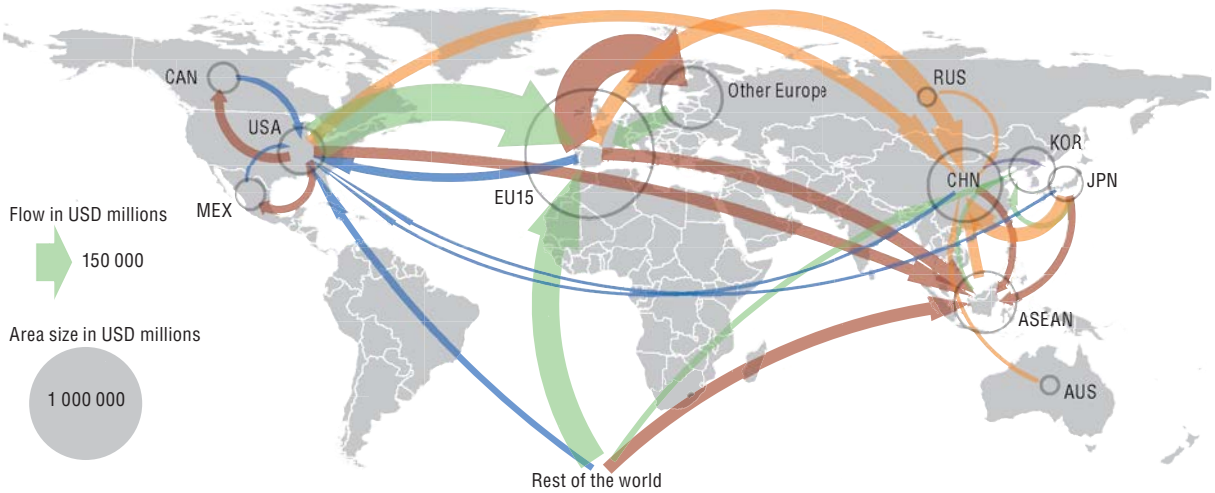
The size of the bubble represents the total amount of foreign value added embodied in an economy's or a region's total exports of goods and services for final demand (e.g. household and capital consumption). This is broken down to reveal the origin of the imported (intermediate) content (arrows). As the following figure for 2009 shows, the size of the bubbles and the thickness of the arrows increase considerably between 1995 and 2009, the latest available year in the TiVA Database, and demonstrate countries' increased dependency on imports.

Evolving global value chains

In most economies, the share of foreign value added in exports has increased in the last decade, a clear sign of the growing and evolving reliance on foreign intermediates in production. Among other factors, geography (proximity to markets), size of the economy (ability to source intermediates from domestic suppliers), and natural endowments of mineral resources all play a role. For example, in recent years China has increasingly relied on imports, notably from Europe, Japan and other OECD economies, to produce final goods for export. The foreign value added content of Chinese exports rose from 12% to 33% between 1995 and 2009.

31. Foreign value added content of exports, 2009

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



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013; map source: ARTICQUE© – all rights reserved. StatLink contains more data. See chapter notes.

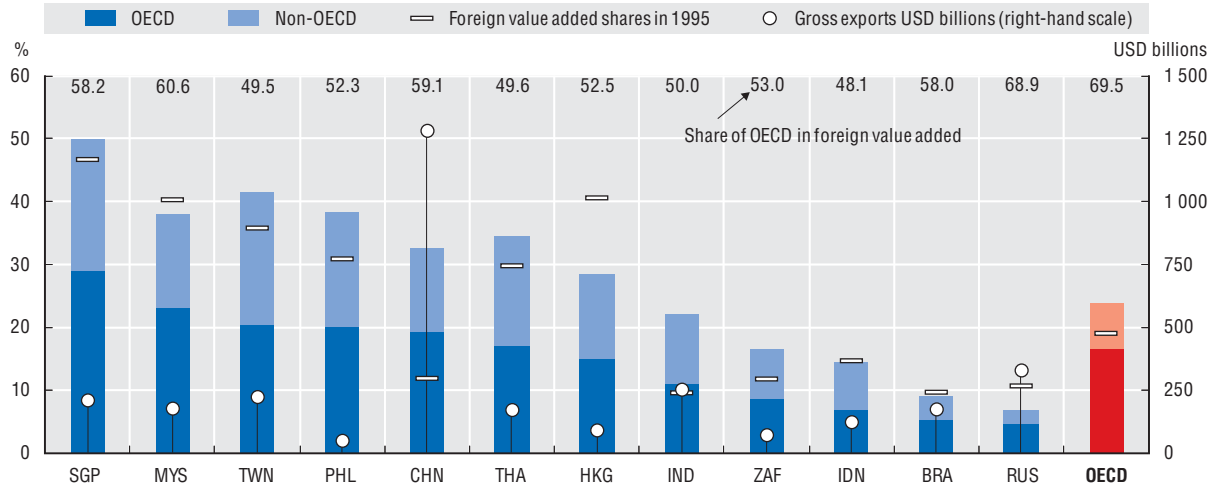
StatLink *http://dx.doi.org/10.1787/888932889877*

Evolving global value chains

The exports of countries with relatively open and liberal trade regimes and high shares of foreign direct investment are likely to have higher foreign value added content. The exports of larger economies that have significant mineral resources or are relatively far from foreign markets and suppliers tend to have relatively higher domestic (and lower foreign) value added content than those of smaller economies. Similarly, the exports of countries that specialise in activities upstream in the value chain, such as mining and agriculture, and those that specialise in services typically have higher domestic value added content. For the OECD area, foreign value added represented 24% of the value of gross exports in 2009, up from 19% in 1995. For the largest non-OECD exporters, it ranged from less than 10% in the Russian Federation and Brazil, where the weight of natural resources in exports is high, up to 50% in Singapore. In China, where gross exports increased about 12-fold at current prices to almost USD 1 300 billion, this measure of interdependence almost tripled to more than 30%, with 60% of the foreign value added of exports originating from OECD countries, half of which from Japan and Korea.

32. Foreign value added content of exports, non-OECD economies, 2009

As a percentage of total gross exports



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932889896*

How to read this figure

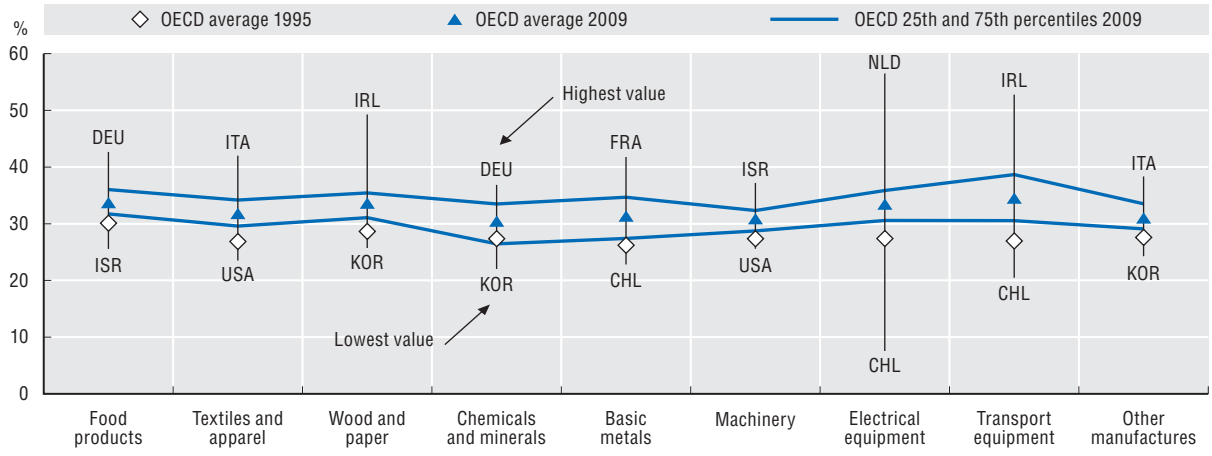
The height of the stacked bars represents the percentage of foreign value added included in gross exports in 2009. Economies are ordered according to the share of foreign value added originating from the OECD area. The right-hand scale indicates the value of gross exports in USD billions in 2009.

A new look at service trade

Services represent more than 70% of GDP in most OECD countries, while reported trade in services accounts for just over one-quarter of total international trade in goods and services. However, accounting for the value added by services in the production of goods reveals that the services sector plays a much more significant role in international trade, surpassing 50% of total exports in the United States, the United Kingdom, France, Germany and Italy. The OECD-WTO Trade in Value Added (TiVA) Database can provide insights into the role of services in global value chains by revealing, for example, the extent to which exports of manufactured goods depend on the inputs from various service activities that are required to produce them. In 2009, about a third of the value of OECD exports of manufactured goods could be attributed to services, a significant rise since 1995. Services content varies across industries and countries; electrical and transport equipment (high- and medium-high technology) manufactures have large shares of services content in many countries, often owing to business services such as IT services. Service content can be further split into domestic and foreign origin. Foreign services content in high- and medium-high-technology manufactures can represent between 40% and 50% of total services value added content.

33. Services value added in manufacturing exports by industry, 1995 and 2009

Range of values as a percentage of gross exports



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013.StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932889915*

How to read this figure

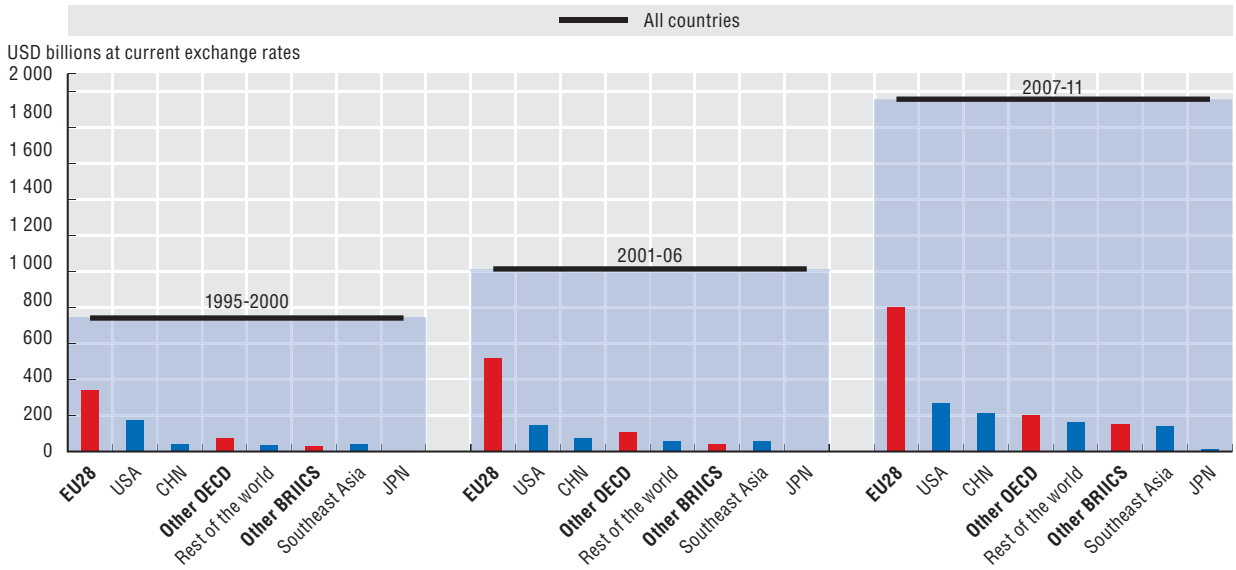
The indicator of services value added in manufacturing exports reflects the share of services value added in manufacturing production. The distance between 1995 and 2009 average values shows that the average content of services rose about 5 percentage points during the period to a value ranging from 30% to 35% across all industries. Half of the OECD economies (between the 25th and 75th percentiles) differ by only 5 to 10 percentage points. Lowest and highest country values in each industry are much more diversified, and their interpretation depends on the industry and the economy under consideration. Differences among countries are very small for machinery manufacturing but very wide for electrical equipment. For the latter, the share of services in the Netherlands' manufacturing exports largely concerns R&D and marketing services while Chile has very little manufacturing in this industry.

FDI shifting east

Foreign direct investment may provide recipient countries with access to new technologies and generate knowledge spill-overs for domestic firms and additional investment in R&D. In the last 15 years FDI flows have tripled. FDI inflows to Europe still exceed those to the rest of the world, but FDI flows to China and the rest of Southeast Asia have leapt from an average of about USD 81 billion a year in 1995-2000 to about USD 353 billion a year in 2007-11. According to preliminary OECD 2012 estimates, 44% of global FDI inflows were hosted by just five countries. China, with a five-fold increase in average annual inflows over 2008-11 became the largest FDI recipient in 2012, followed by the United States, Brazil, the United Kingdom and France. Rising global FDI outflows are driven by OECD countries and more than doubled between the early and late 2000s. At the same time, FDI by the BRIICS increased substantially as these economies became more integrated in the global economy.

34. Foreign direct investment inflows, 1995-2000, 2001-06 and 2007-11

Yearly averages

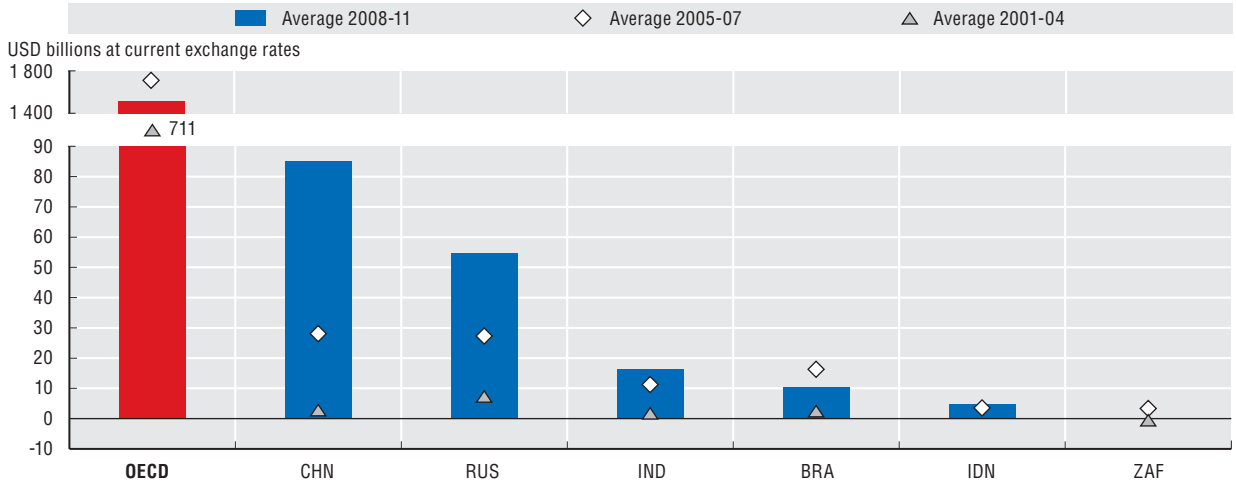


Source: IMF, Balance of Payments Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889934

35. Outward foreign direct investment flows from BRIICS, 2001-04, 2005-07 and 2008-11

Billions of USD, current exchange rates, yearly averages



Source: IMF, Balance of Payments Database, June 2013. See chapter notes.

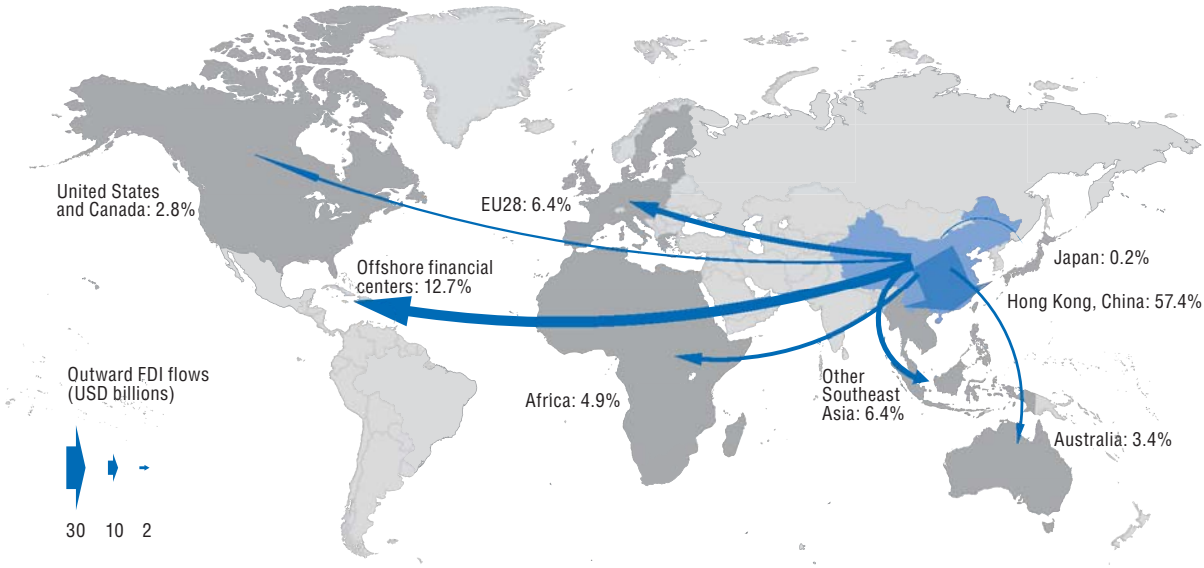
StatLink http://dx.doi.org/10.1787/888932889953

FDI shifting east

Average outward foreign direct investment (OFDI) from India increased more than nine-fold between the early and late 2000s while that of China increased 30-fold. Asia, and particularly Hong Kong, China, remains the largest recipient of Chinese investment, but the Caribbean countries also receive large amounts of Chinese OFDI. The routing via Hong Kong, China, and the Caribbean makes it difficult to build a reliable picture of the geographical distribution of China's OFDI. In terms of the stocks of inward and outward FDI, the United States remains the top investor and largest destination for FDI, with an inward stock of about USD 4 trillion, or about 20% of US GDP. Japan and Germany have the largest net active position, and Brazil is the largest net receiver. Besides Hong Kong, China, the top 20 economies measured by the sum of inward and outward positions include some very small economies such as Ireland, Singapore and the British Virgin Islands. Larger economies such as Italy and Japan attract little foreign investment, which contributes to their positive net FDI stock balance.

36. Outward foreign direct investment flows from China, yearly average 2007-11

USD billions at current exchange rates

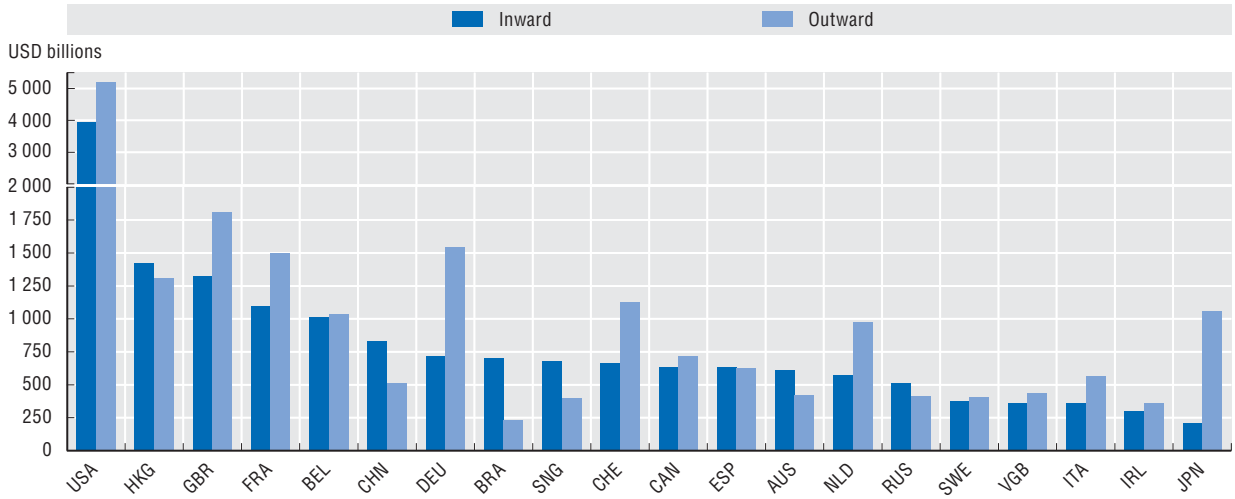


Source: OECD calculations based on Chinese Ministry of Commerce, *Statistical Bulletin of China's Outward Foreign Direct Investment 2011*. Map source: ARTICQUE© – all rights reserved. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932889972

37. Top 20 countries, total stock of foreign direct investment, 2012

Inward and outward positions, USD billions at current exchange rates



Source: UNCTAD, FDI/TNC Database, *www.unctad.org/fdistatistics*, July 2013. See chapter notes.

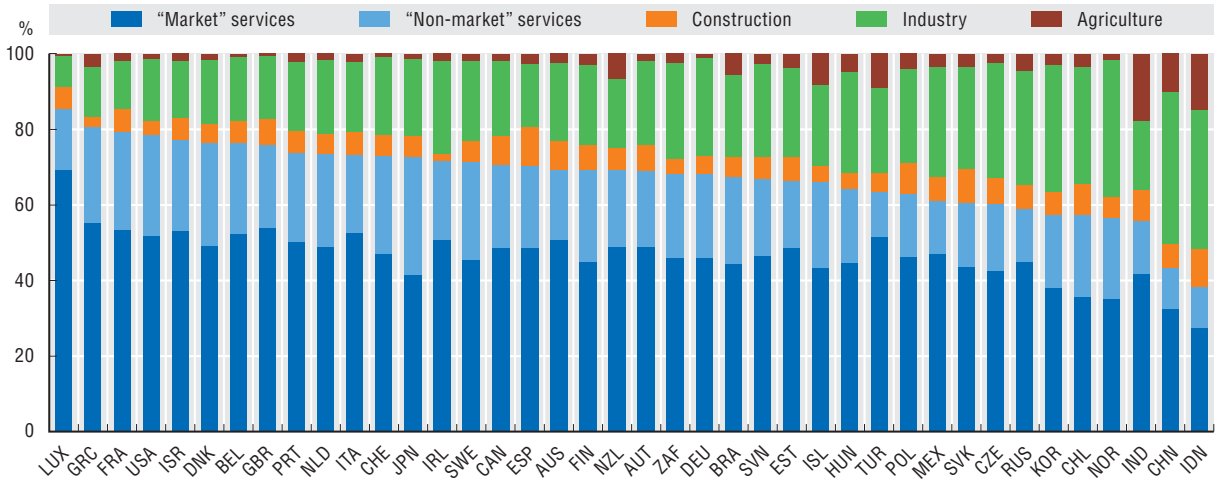
StatLink http://dx.doi.org/10.1787/888932889991

The structure of economies

As manufacturing production declines in OECD countries, the contribution of services to GDP rises: they now represent more than 70% of OECD value added and surpass 75% in eight OECD countries, including France and the United States. Even as manufacturing has expanded in the BRIICS in the last 20 years, natural resources continue to play a significant role in their economies, especially in the Russian Federation. Among OECD countries, Australia, Chile, Norway and Mexico rely heavily on natural resources.

38. Composition of GDP in OECD and BRIICS countries, 2011

Value added of major activity groups as a percentage of total industry value added

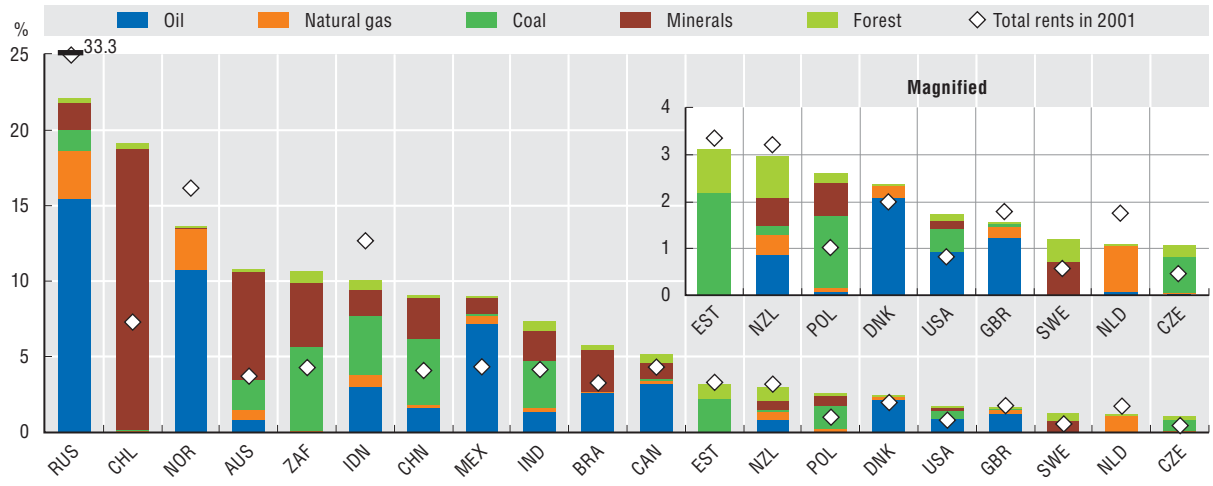


Source: OECD National Accounts (SNA) Database and Structural Analysis (STAN) Database, ISIC Rev.4; and national statistical institutes, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890010

39. Top 20 OECD and BRIICS countries reliant on natural resources, 2011

Natural resource rents as a percentage of GDP



Source: World Bank, World Development Indicators Database, June 2013. See chapter notes.

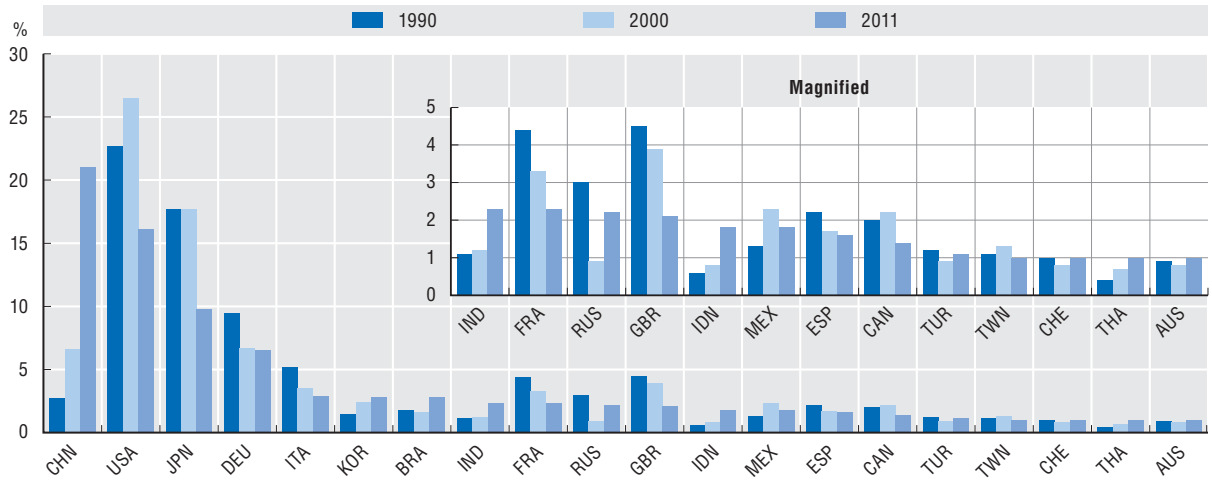
StatLink http://dx.doi.org/10.1787/888932890029

Top manufacturing players

Manufacturing has globalised over the last 20 years. In 1990, the G7 countries accounted for two-thirds of world manufacturing value added but now account for about 40%. In 2010, China passed the United States to become the world's leading manufacturer, and Brazil, India and Korea moved slightly ahead of France and the United Kingdom, two leading European manufacturers. China is also the top exporter of manufactured goods. However in value added terms, its lead over the United States is less clear. In fact, in 2009, the latest year available in the OECD-WTO TiVA Database, the share of the United States still exceeded that of China by a small margin. Japan and the United Kingdom also have higher shares of manufacturing exports in value added terms owing to their exports of high-quality parts and components that are subsequently embodied in other countries' exports.

40. Top manufacturers, 1990, 2000 and 2011

Percentage share of total world manufacturing value added

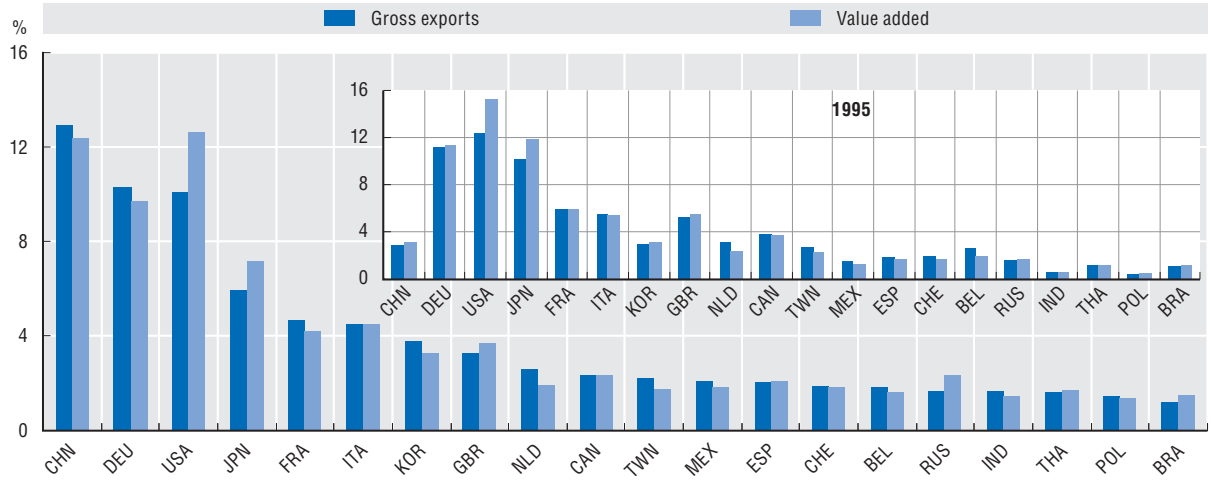


Source: United Nations Statistical Division (UNSD), National Accounts Main Aggregates, May 2013; OECD National Accounts (SNA) Database and Structural Analysis (STAN) Database, ISIC Rev.4, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890048

41. Top 20 exporters of manufactured goods in gross and value added terms, 1995 and 2009

Percentage shares of total world manufacturing goods



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013.

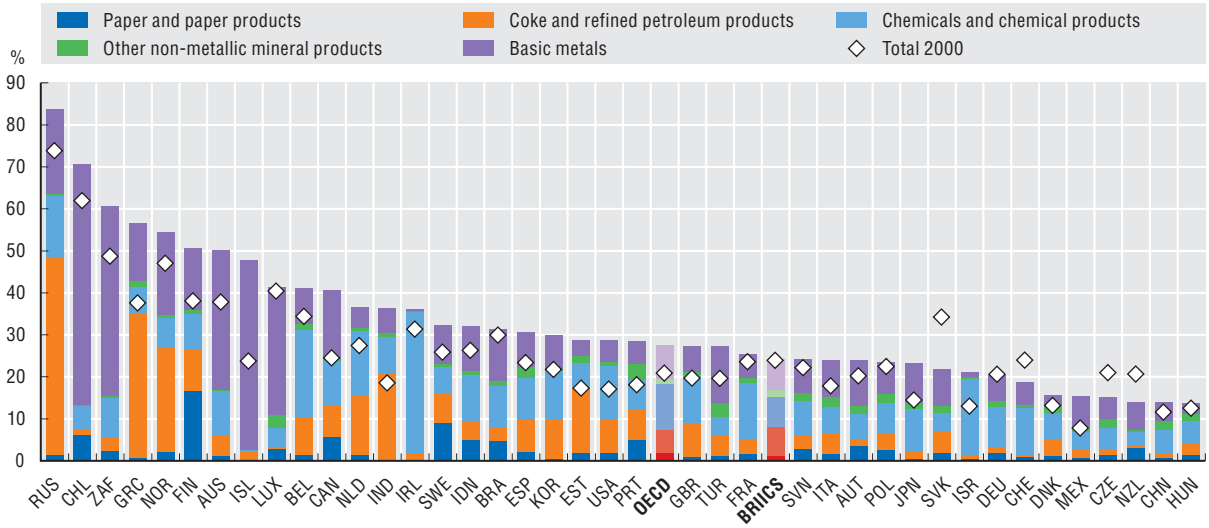
StatLink http://dx.doi.org/10.1787/888932890067

Relying on energy

Energy-intensive products make up over a quarter of total OECD exports of manufactures. For most OECD countries the share has increased since 2000, partly because of price increases in commodities. Energy-intensive does not necessarily mean carbon-intensive, but for many countries, industrial production is an area in which efforts to reduce the carbon content of output can still be made.

42. Exports from energy-intensive manufacturing industries, 2011

As a percentage of total manufacturing exports



Source: OECD, STAN Bilateral Trade Database by Industry and End-use (BTDIxE), May 2013. See chapter notes.

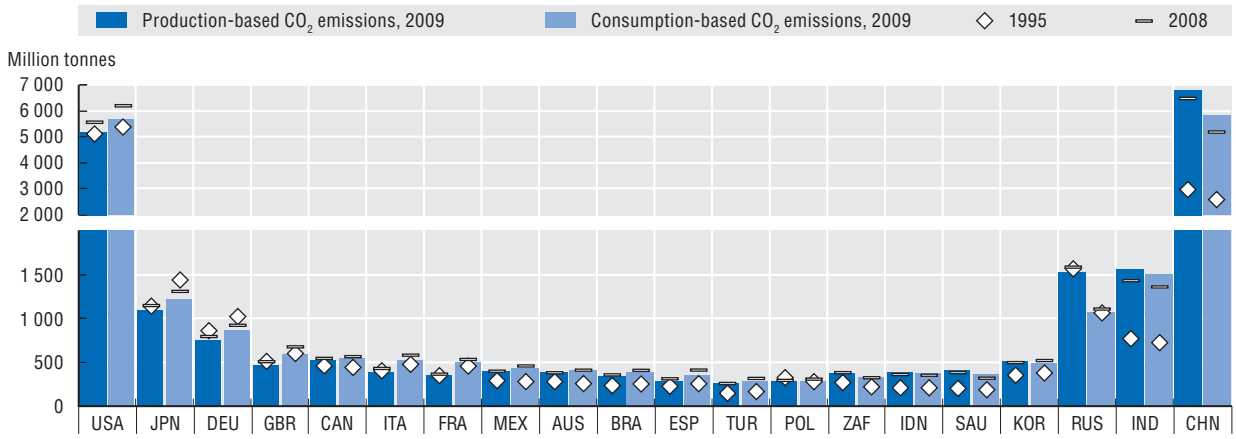
StatLink *http://dx.doi.org/10.1787/888932890086*

Growth and carbon emissions

The gains from growth, while distributed unevenly around the world, have been dramatic. Over the past 150 years life expectancy increased by around 30 years in most regions, including some of the world's least developed. The growth dynamic that has yielded these improvements in living standards has imposed substantial costs on the physical environment on which human well-being ultimately depends. It is increasingly apparent that the current use of natural resources could put higher living standards and even conventionally measured growth at risk. Without decisive action, energy-related emissions of CO_2 will double by 2050. Efforts to mitigate greenhouse gas (GHG) emissions, such as the Kyoto Protocol, will be less effective in reducing global emissions of GHG if countries with emission commitments source their carbon-intensive production activities from economies without such commitments, particularly if production in the latter countries is GHG-intensive.

43. Biggest net CO_2 importers and net CO_2 exporters, 2009

Estimates of production-based CO_2 emissions and consumption-based CO_2 emissions, selected countries, million tonnes



Source: OECD, Inter-Country Input-Output Database, May 2013. International Energy Agency (2013), CO_2 emissions from fuel combustion. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890105

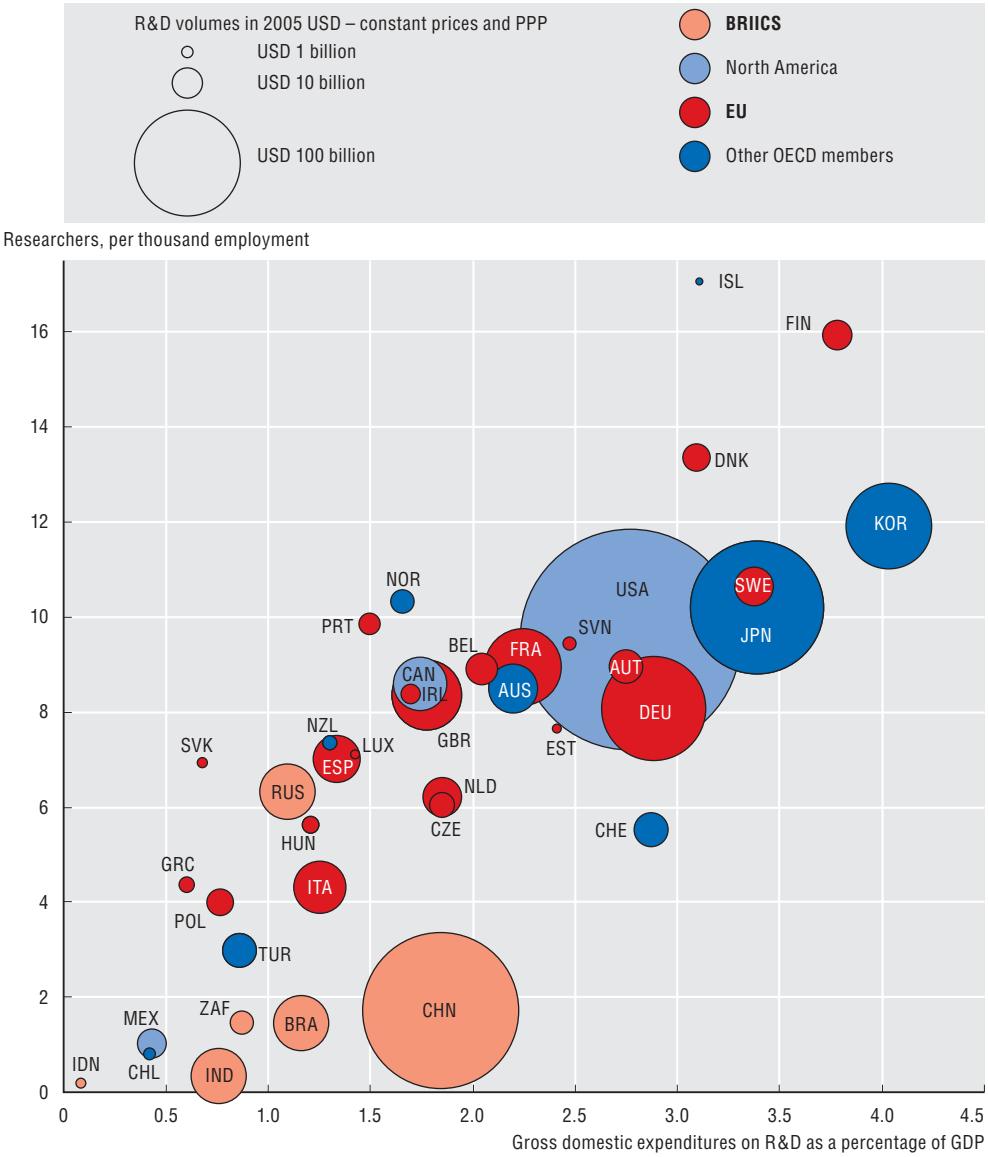
How to estimate imports and exports of CO_2

The OECD's input-output tables, bilateral trade in goods and services statistics, and energy statistics (e.g. fuel-combustion-based CO_2 and international electricity transfer), together with other industry statistics, can be used to estimate the effects of international transfers of CO_2 emissions. The results highlight differences among countries in production-based and consumption-based emissions. Consumption-based CO_2 emissions of OECD countries were, on average, about 15% higher in 2009 than conventional measures of production-based emissions would suggest. The divergence exceeds 25% in France, Italy and the United Kingdom. The magnitude of the difference increased in the late 1990s as trade in goods and services increased, except in Japan and Germany where both the production and the consumption of CO_2 emissions decreased between 1995 and 2009. The emissions structure of countries varies owing to differences in consumption activities, sources of electricity generation and the carbon intensity of imported goods. Electricity-sourced emissions are relatively high in emerging economies (e.g. China and India), whereas emissions due to transport activity and consumption of imported goods are relatively high in developed OECD economies (e.g. Japan and Germany).

R&D in the global landscape

The United States is the world's largest R&D performer, with nearly USD 415 billion of domestic R&D expenditures in 2011. This is about twice the amount of R&D performed in China, which is now the second largest performer, ahead of Japan, Germany and Korea. Korea has 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 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 future use.

44. R&D in OECD and key partner countries, 2011



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*, Brazil's Ministry of Science, Technology and Innovation and UNESCO Institute for Statistics, June 2013. See chapter notes.

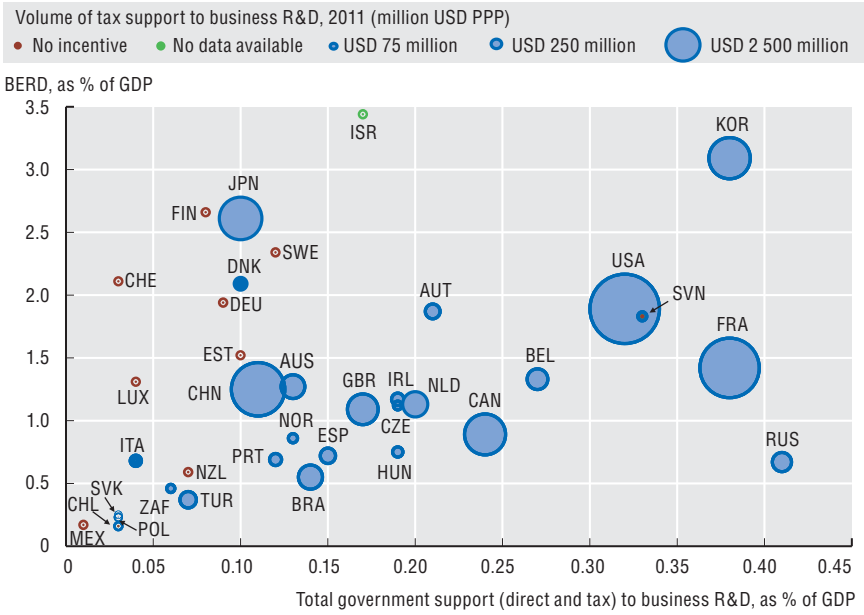
StatLink http://dx.doi.org/10.1787/888932890124

The policy mix for R&D

Governments can choose among various instruments to promote business R&D. In addition to giving grants or loans and procuring R&D, many also provide fiscal incentives. Today, 27 of the 34 OECD countries and a number of non-OECD economies give preferential tax treatment to R&D expenditures. New estimates of the cost of these incentives have been combined with data on direct R&D funding (R&D grants and purchases), as reported by firms, to provide a more complete picture of government efforts to promote business R&D. Across countries, R&D intensity in the business sector is significantly correlated with total government support for business R&D. This does not imply a causal relationship and there are notable exceptions. Germany and Korea have relatively high business R&D intensity compared to their degree of government support, while Canada, the Russian Federation and Turkey have high rates of support relative to countries with similar business R&D-to-GDP ratios. In 2011, Finland, Germany, Sweden and Switzerland did not offer tax incentives but had very R&D-intensive business sectors. In 2013, Finland introduced a new R&D tax allowance.

45. Business R&D intensity and government support to business R&D, 2011

As a percentage of GDP



Note: This is an experimental indicator. International comparability may be limited. For more information, see *www.oecd.org/sti/rd-tax-stats.htm*.
Source: OECD, based on OECD R&D tax incentives questionnaire, publicly available sources and OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890143

How to read this figure

Bubble sizes represent the total amount of tax incentive support for R&D expenditures in USD PPP. For example, in the Netherlands, tax support for R&D is just above USD 1 billion. Total government support for business R&D is just above 0.2% of GDP and business R&D is close to 1% of GDP. Across countries, the correlation between the two variables is 29%.

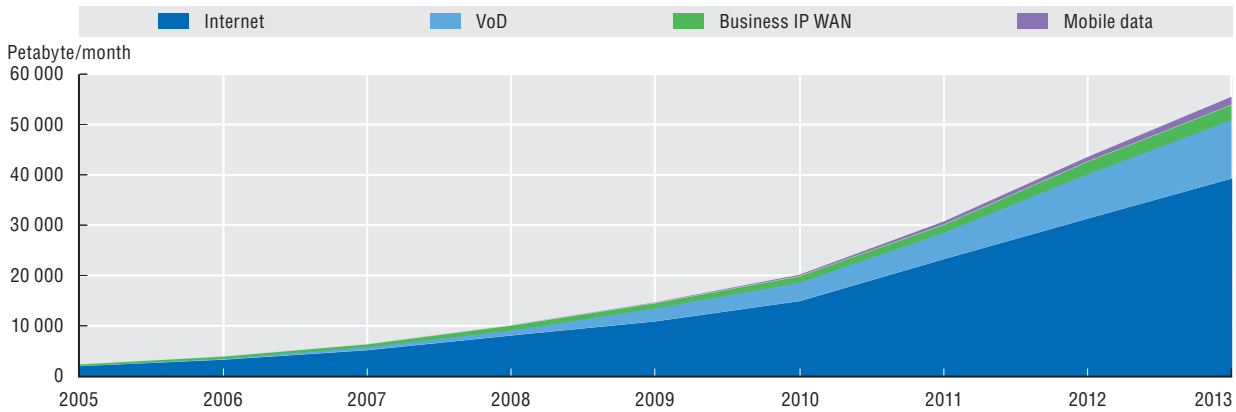
How to measure the cost of tax incentives

The OECD data collection on R&D tax incentives, now in its fourth 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 whenever possible. Estimates reflect the sum of foregone tax revenues – on an accrual basis – and refunds where applicable. However, many authorities can only report the cost of government tax liabilities realised in a given period (cash basis).

Smart infrastructure

The Internet is a key infrastructure for businesses, individuals and the public sector alike and continues to expand rapidly. Global Internet Protocol (IP) traffic rose from 20 000 Petabytes a month in 2010 to 55 000 in 2013 and has increased 19-fold since 2005. Always-on and mobile connectivity are already reshaping people's daily behaviour and will continue to do so in coming years. Originally designed as a research network, the Internet's subsequent widespread commercialisation and expansion have meant that the Internet Protocol, IPv4, no longer meets today's needs. In fact, freely available IPv4 addresses ran out in early 2011. IPv6 was designed to succeed IPv4 and its deployment began in 1999. It provides significantly greater address space, but it is being implemented slowly. While it appears that over half of the equipment deployed on the wired Internet is capable of supporting IPv6 today, less than 1% of it connects to a service that provides IPv6. Only four countries – France, Luxembourg, Japan and the United States – are above the OECD average in this respect.

46. Global Internet Protocol (IP) traffic, 2005-13

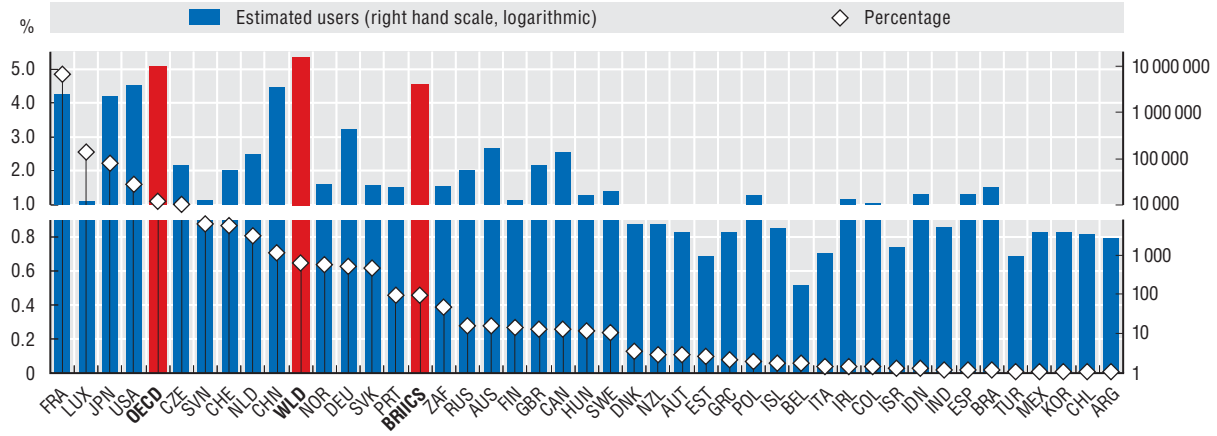


Source: Cisco Visual Networking Index (VNI), June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890162

47. IPv6 deployment by country, November 2012

As a percentage of Internet users



Source: OECD (2013), *OECD Communications Outlook 2013*, OECD Publishing, based on *www.potaroo.net/reports/oecd* and report files published by the regional Internet registries (RIRs), November 2012. See chapter notes.

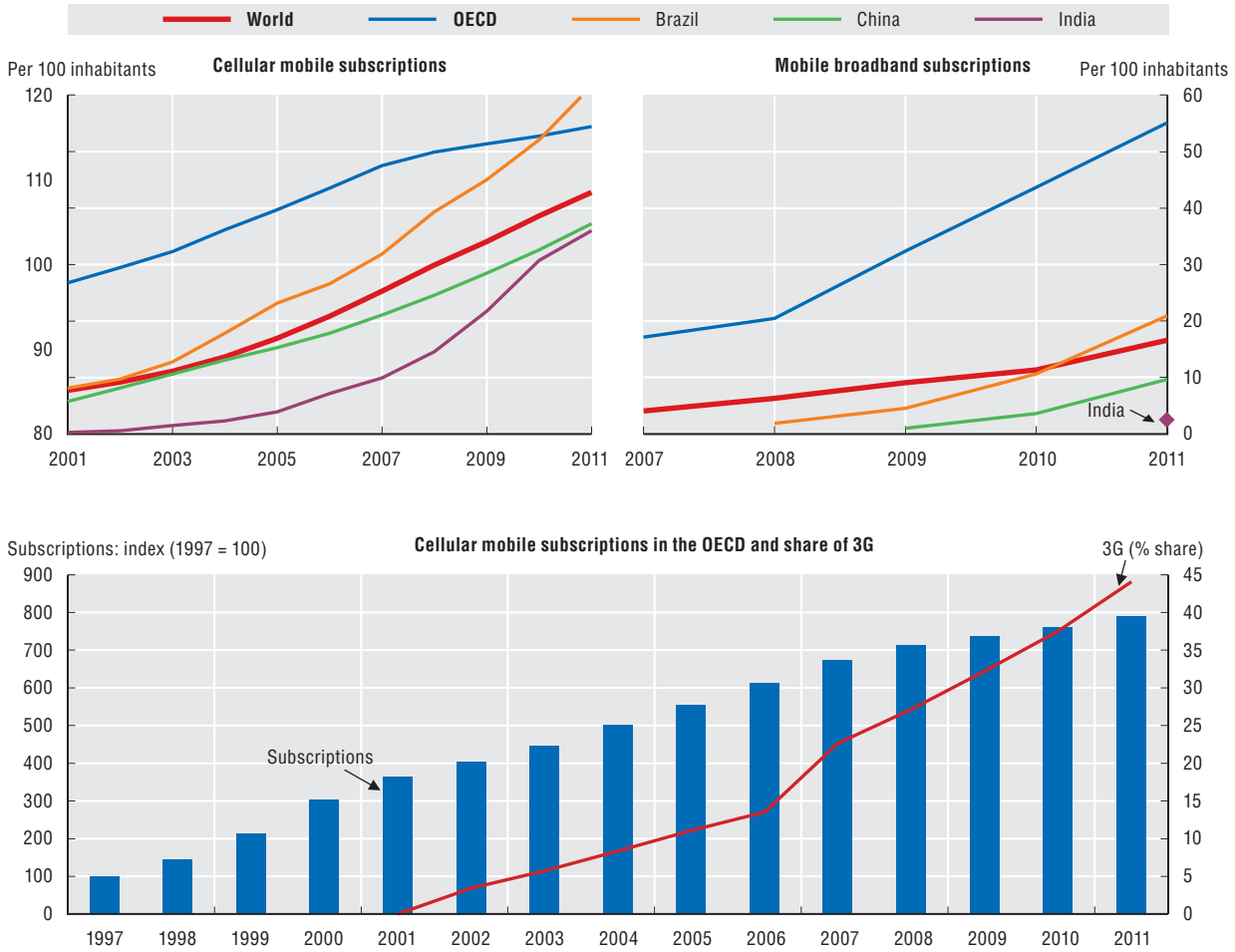
StatLink http://dx.doi.org/10.1787/888932890181

Towards near ubiquity

Around three-quarters of the world's inhabitants now have access to a mobile phone. The number of mobile subscriptions in use worldwide, both pre-paid and post-paid, has grown from fewer than 1 billion in 2000 to over 6 billion today, of which nearly 5 billion in developing countries. Mobile cellular penetration (per 100 inhabitants) in the OECD area passed 100% in 2008 and world subscriptions are estimated to approach this level in 2013. Emerging countries are now looking to replicate the success of the pre-paid model for mobile devices with Internet access capability. In 2011 Brazil overtook the OECD, with 123 subscriptions per 100 inhabitants, while China and India had about three subscriptions for every four inhabitants. Ownership of multiple subscriptions is increasingly common and their numbers may soon exceed that of the population. Convergence of mobile broadband penetration to OECD levels has yet to occur, but this service is recent and affordability and quality are improving fast. Subscriptions in the OECD area rose from 20% in 2008 to 55% in 2011 (less than 20% at world level). They are expected to reach 63% in the OECD area in 2012. In 2011, about 45% of OECD cellular mobile subscribers were 3G-enabled, and LTE (a more powerful version of 3G known as 4G) has reached most OECD countries. The story of mobile communications will now shift from the phone to how it is used. Near ubiquity brings new opportunities.

48. Mobile cellular and broadband penetration worldwide, 2001-11

Subscriptions per 100 inhabitants, indices and percentages



Source: OECD, Telecom Database and ITU, World Telecommunication/ ICT indicators Database, June 2013. StatLink contains more data. See chapter notes.

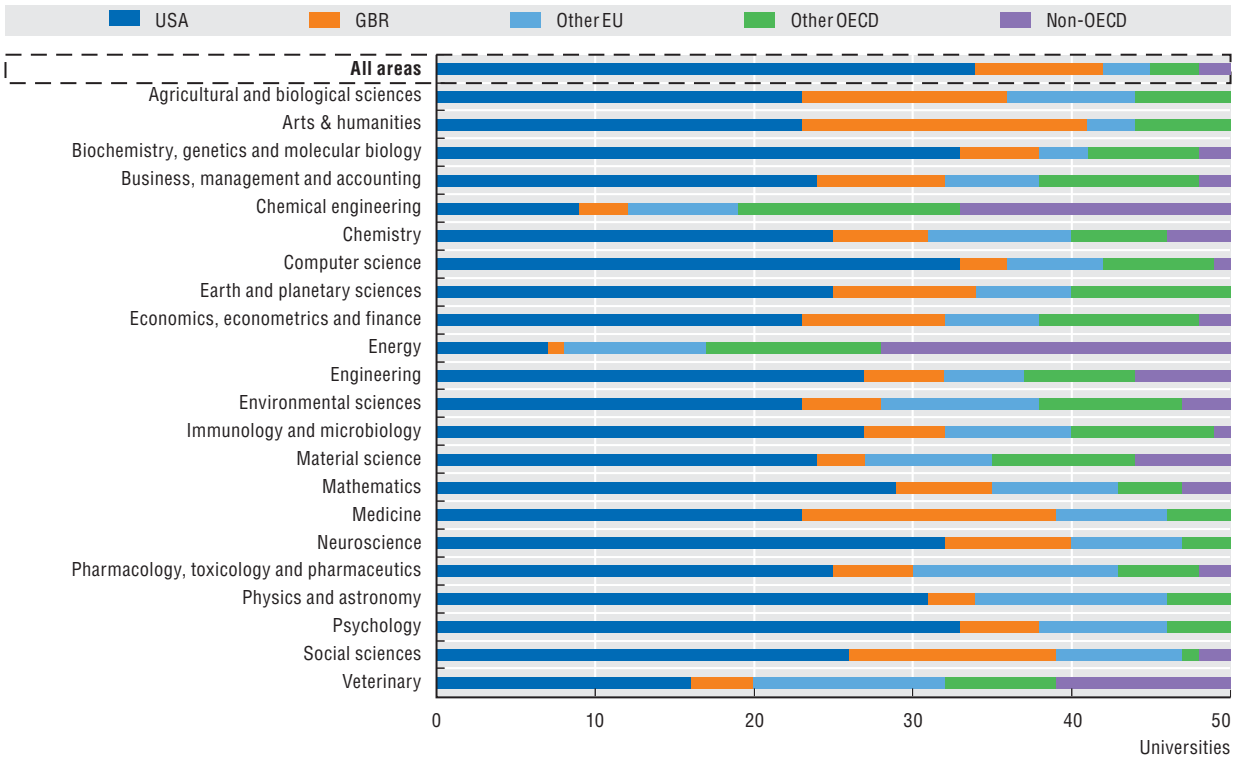
StatLink http://dx.doi.org/10.1787/888932890200

University hotspots

Worldwide, the top 50 universities with the highest relative impact in 2007-11 – in terms of normalised citations to academic publications across disciplines – are highly concentrated geographically but less so than in 2003-09. Overall, 34 of the top 50 are located in the United States. The rest are in Europe, and, for the first time, two are outside the OECD area, in Chinese Taipei. The United Kingdom is the second-ranked economy, with specific strengths in the medical and social sciences. There are interesting differences by subject, with US-based universities most likely to excel in biochemistry, computer science, neuroscience and psychology. Universities in non-OECD economies, especially in Asia, play a relatively prominent role in chemical engineering, energy and veterinary research. These results refer to measures of output quality per unit of production, not absolute values of high-quality publications. Economies also differ in the share of scientific output produced outside the higher education sector, for example in government research institutes.

49. University hotspots, geographical distribution of highest impact institutions, 2007-11

Location of top 50 universities by main subject areas



Source: OECD and SCImago Research Group (CSIC), *Compendium of Bibliometric Science Indicators 2014*, based on Scopus Custom Data, Elsevier, May 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890219

How to read this figure

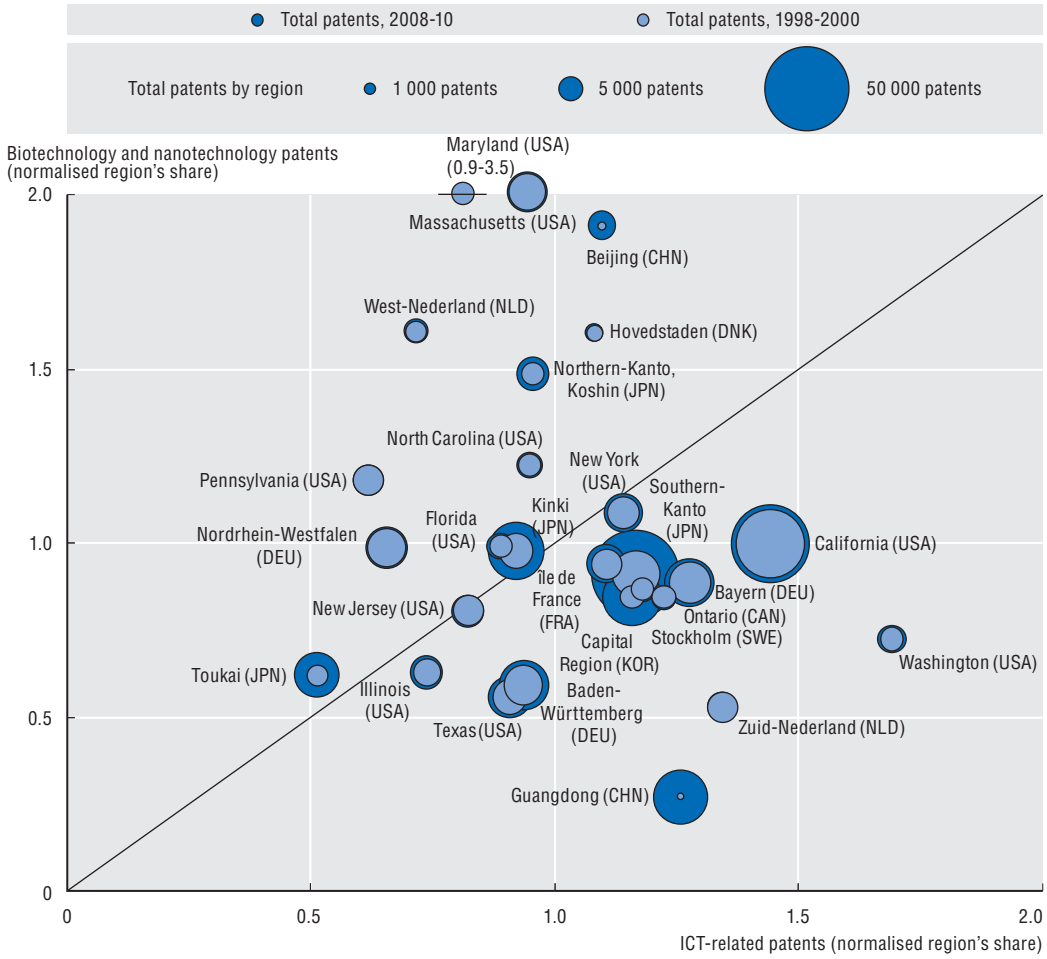
The X axis shows the geographic distribution of the top 50 universities in the main subject areas (Y axis) according to their normalised impact. The publication threshold set for the institutions was at least 100 documents in 2011, except for some disciplines for which the threshold was set at 50 documents. The normalised impact is the ratio between the average number of citations received by a specific unit and the world average of citations in the same time period, document type and subject area, i.e. the normalisation is done at the level of the individual article. If an article belongs to several subject areas a mean value of the areas is calculated. The normalised impact of these institutions is calculated for 2007-11 and only for the production in which the country is the main contributor (production in which the corresponding author belongs to the institution).

Regional innovation hotspots

Location seems to matter. Many of the leading firms in knowledge-intensive industries – such as information and communication technologies, biotechnology and nanotechnology – have emerged in a limited number of regions. The top 20 patenting regions in these enabling technologies are concentrated in a handful of countries, particularly the United States (34% of these regions' patent applications in 2008-10, down from about 50% ten years earlier) and Japan (29%, up from about 17% ten years earlier). China also has innovation hotspots, with the Beijing region relatively specialised in all three technologies but particularly in biotechnology and nanotechnology, and the Guangdong region relatively more specialised in ICT (a 90-fold increase in ICT applications over a ten-year period). Seven European regions are among the top innovation hotspots in enabling technologies, with a share in top patenting regions of about 21% (down from about 29% ten years earlier). Such regions appear to provide environments that are particularly conducive to business innovation. Much of the effort of policy makers in other regions goes to replicating or nurturing the conditions present in the best-performing regions.

50. Innovation hotspots in ICT, biotechnologies and nanotechnologies, 1998-2000 and 2008-10

Regional comparative advantage by technology field, top patenting regions



Source: OECD, REGPAT Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890238

How to read this figure

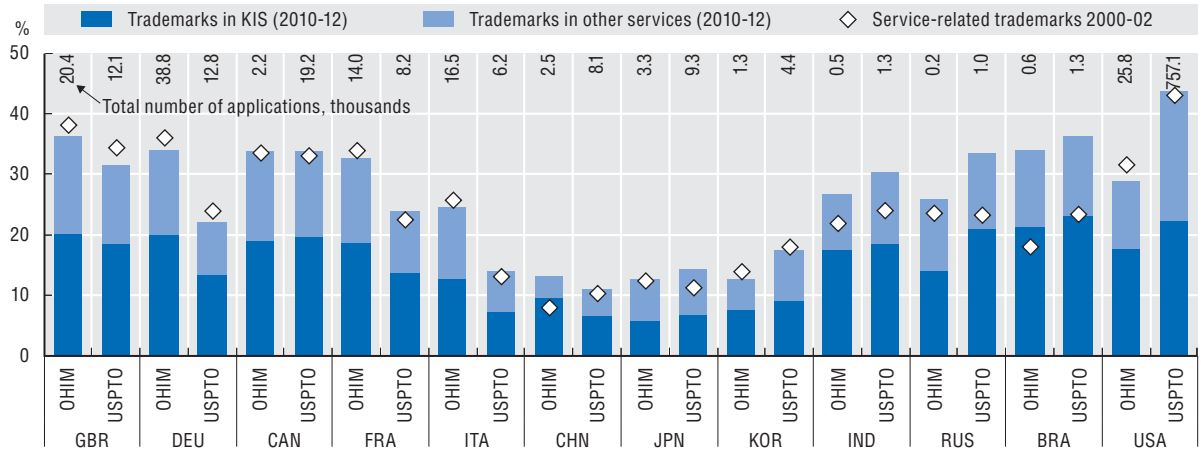
The world's top 20 patenting regions in ICT, biotechnology and nanotechnology are presented. The size of the bubble represents the volume of patent applications in all three fields in the two periods covered. Each region's share in the country's patents in the selected technology fields is normalised to the region's share in the country's patents for all technologies. This corrects for the average likelihood of some regions to patent more than others. Top patenting regions along the 45-degree line have an equal relative propensity to patent in ICT, on the one hand, and in biotechnology and nanotechnology, on the other. Top patenting regions to the right of the x value = 1 are relatively more specialised in these three technologies than in any other technology. For example, California is an innovation hotspot for ICT, biotechnology and nanotechnology, with ICT the dominant field of specialisation.

Innovation for new markets

Because trademark registrations often accompany the launch of new products and services, trademark-based indicators can point to the presence of incremental and marketing innovations. While trademark applications have increased over time, the share of trademark applications related to service classes has remained stable or declined slightly over the last decade in most OECD economies. In contrast, the share of service-related trademarks protected on both the European and US markets by the BRIICS economies has increased since 2000-02. Trademarks in knowledge-intensive business services account for the majority of service trademarks registered by all the economies considered, and especially in Brazil and the United States. A breakdown of trademarks in knowledge-intensive services (KIS) helps reveal firms' strategies in different markets. R&D-related trademarks applied for by the G7 and the BRIICS economies appear relatively more likely to be protected in the United States than in Europe, while the BRIICS have a relatively larger share of registrations of business-services-related trademarks on the European market.

51. Service-related trademark applications at USPTO and OHIM, selected OECD and non-OECD economies, 2000-02 and 2010-12

As a percentage of total trademark applications

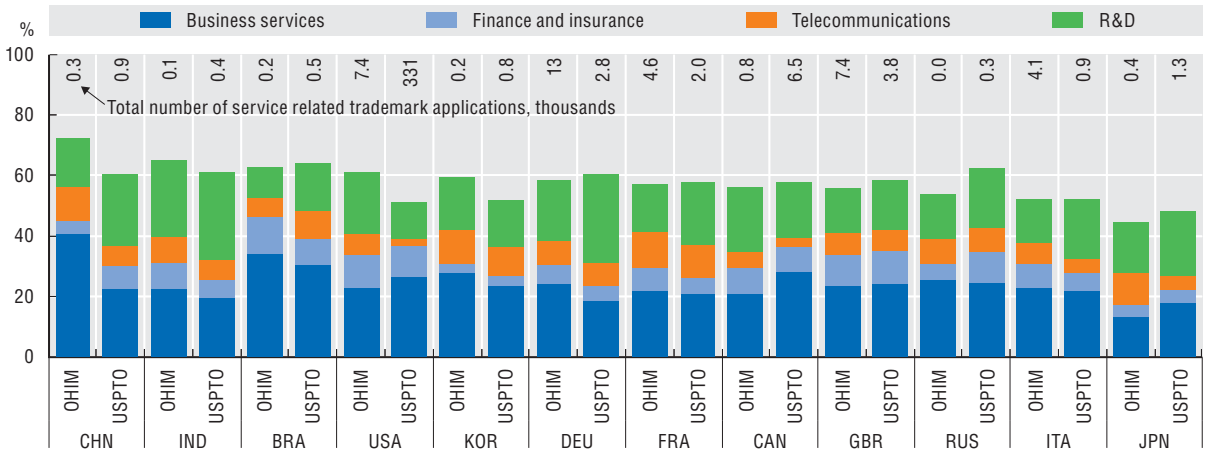


Source: US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google, May 2013; OHIM Community Trademark Database CTM Download, May 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890257

52. Trademarks in knowledge-intensive services, selected OECD and non-OECD economies, 2010-12

As a percentage of total service-related trademark applications



Source: US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google, May 2013; OHIM Community Trademark Database CTM Download, May 2013. StatLink contains more data. See chapter notes.

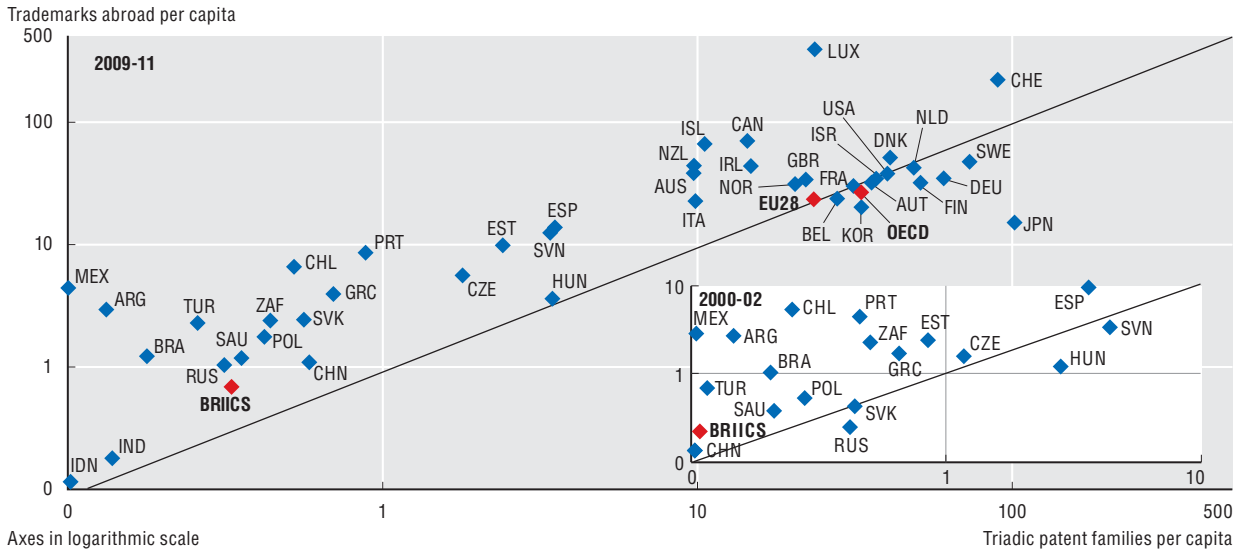
StatLink http://dx.doi.org/10.1787/888932890276

Innovation everywhere

Indicators of triadic patents and of trademarks abroad suggest the worldwide spread of innovative activities, in terms of both technological and non-R&D-based innovation. Economies featuring relatively large manufacturing sectors or specialisations in information and communication technologies have a greater propensity to patent than to "trademark". Economies with relatively larger services sectors tend instead to engage relatively more in trademark protection. Emerging economies, although they are generally less likely to seek protection for their innovations via patents or trademarks than OECD countries, increasingly rely on intellectual property protection to appropriate the results of their innovative activities.

53. Patents and trademarks per capita, 2000-02 and 2009-11

Average number per million population, OECD and G20 countries



Source: OECD, Patent Database, June 2013; US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google, May 2013; OHIM Community Trademark Database CTM Download, May 2013; JPO, *Annual Reports* 2001-12, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890295

What is a triadic patent?

Triadic patent families are defined as patents applied for at the European Patent Office (EPO), the Japan Patent Office (JPO) and the United States Patent and Trademark Office (USPTO) to protect a same invention. Triadic patents are typically of higher value and eliminate biases from home advantage and the influence of geographical location.

What is a trademark "abroad"?

Trademark counts are subject to home bias, as firms tend to file trademarks in their home country first. Trademarks abroad correspond to the number of applications filed at the USPTO, the Office for Harmonisation in the Internal Market (OHIM) and the JPO, by application date and country of residence of the applicant. For the United States, EU members and Japan, counts exclude applications in their domestic market (USPTO, OHIM and JPO respectively). Counts are rescaled, taking into account the relative average propensity of other countries to file in those three offices.

Why use trademarks as indicators of innovation?

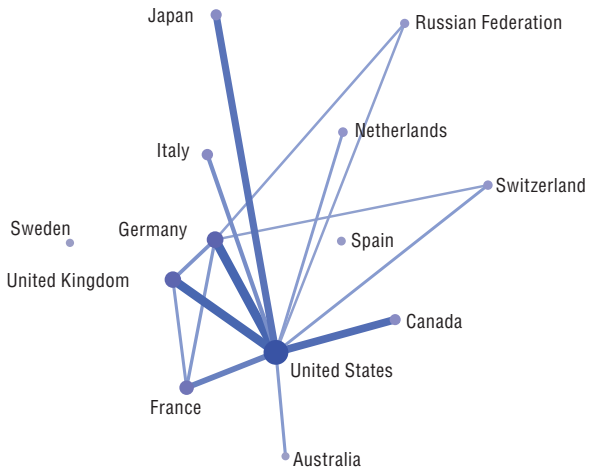
A trademark is a sign used to distinguish the goods and services of one undertaking from those of other undertakings. Firms use trademarks to signal novelty and to appropriate the benefits of their innovations when they launch new products on the market. The number of trademark applications is highly correlated with other innovation indicators. With their very broad perimeter of applications, they convey information on product innovations but also on marketing and services innovations. Because the data relating to trademark applications are publicly available immediately after filing, trademark-based indicators can provide very timely information on the level of certain types of innovative activities.

Collaboration in scientific research

In the global landscape of scientific research, scientific output has grown rapidly and collaboration between institutions in different countries has intensified. The emergence of new players has changed the structure of global collaboration networks.

54a. International collaboration networks in science, 1998

Whole counts of internationally co-authored documents



Source: OECD calculations based on Scopus Custom Data, Elsevier, version 5.2012, June 2013. See chapter notes.

How to read these figures

The position of selected economies (nodes) exceeding a minimum collaboration threshold of 10 000 documents is determined by the number of co-authored scientific documents published in 2011. A visualisation algorithm has been applied to the full international collaboration network to represent the linkages in a two-dimensional chart on which distances approximate the combined strength of collaboration forces. Bubble sizes are proportional to the number of scientific collaborations in a given year. The thickness of the lines (edges) between countries represents the intensity of collaboration (number of co-authored documents between each pair).

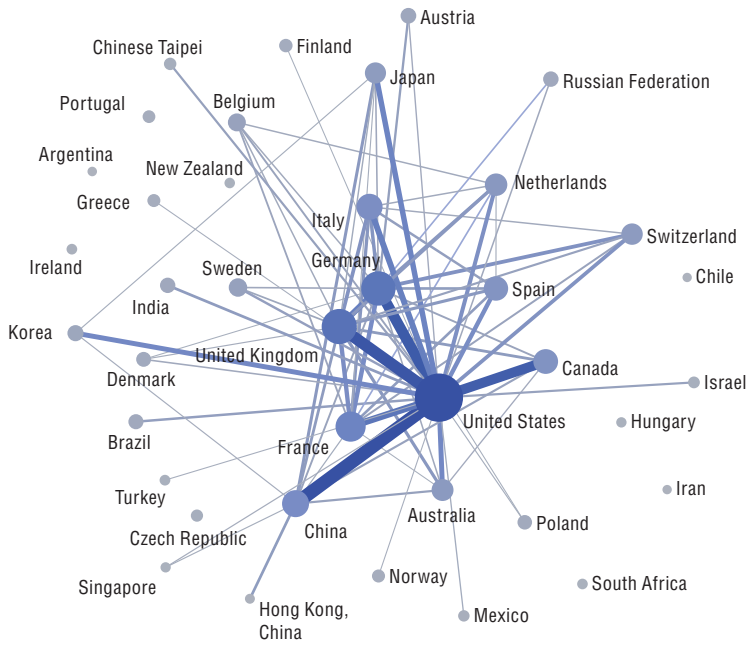
The positions derived for 2011 collaboration data have been applied to 1998 values. New nodes and edges appear in 2011 as they exceed the minimum thresholds.

Collaboration in scientific research

China and several other economies have become increasingly integrated in the global science system. China accounted for more than 74 000 collaborations in 2011 compared with only 9 000 in 1998. Over the period, its number of co-authored documents with US-based institutions increased from nearly 2 000 to more than 22 000. The United States continues to be at the centre of the international research network, accounting in 2011 for nearly 15% of all scientific collaborations documented in peer-reviewed scientific publications.

54b. International collaboration networks in science, 2011

Whole counts of internationally co-authored documents



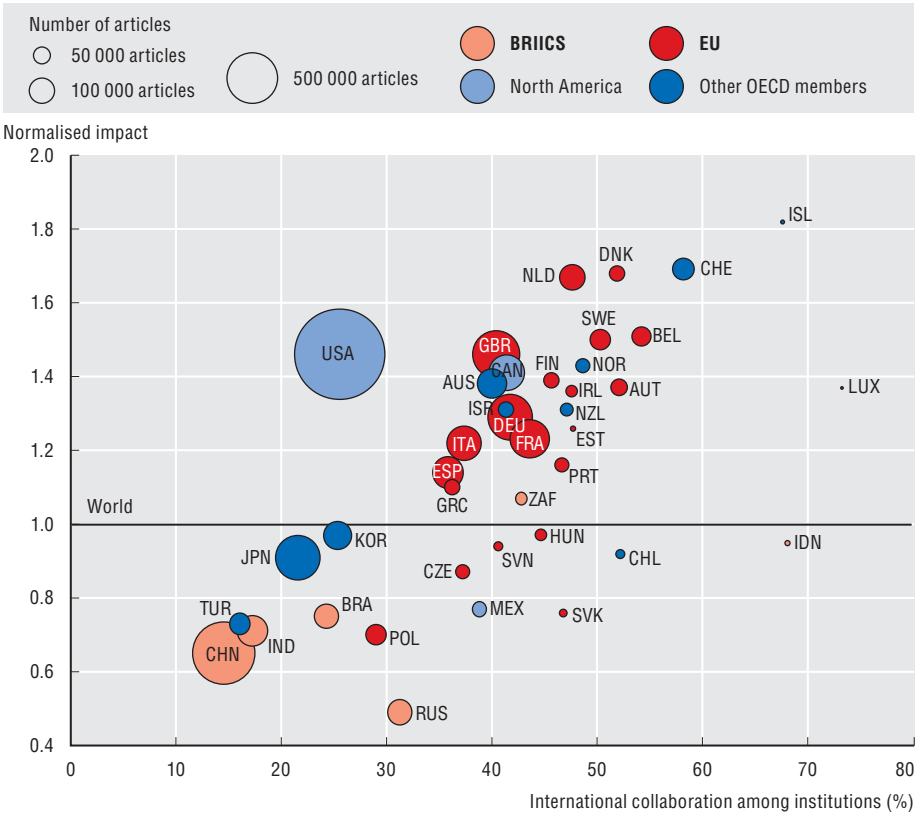
Source: OECD calculations based on Scopus Custom Data, Elsevier, version 5.2012, June 2013. See chapter notes.

The impact of scientific collaboration

The production of scientific research is progressively shifting from individuals to groups, from single to multiple institutions, and from national to international. Because they draw on larger pools of expertise, international research collaborations are more likely to have a bigger impact in terms of citations in subsequent scientific publications. Differences across countries suggest a positive relationship between measures of scientific research collaboration and impact, the latter proxied in this case by the average normalised citation index. The relationship appears to be stronger in economies with lower scientific production, suggesting the importance of scale, which smaller economies can overcome by participating in global networks.

55. The impact of scientific production and the extent of international scientific collaboration, 2003-11

Whole counts of internationally co-authored documents



Source: OECD and SCImago Research Group (CSIC), *Compendium of Bibliometric Science Indicators 2014*, based on Scopus Custom Data, Elsevier, May 2013.
See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890314

How to measure the impact of scientific collaboration

To measure the impact of scientific publications it is possible to either use the citations received by an article or to assess its quality on the basis of the level of citations relative to the record of the journal in which the article is published. Here, the focus is on publications and citations received during 2003-11. The normalised impact is the ratio between the average number of citations received by the documents published by a specific unit (country, institution and author) and the world average of citations of the same time period, 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 is cited 20% below average and 1.3 means the unit is cited 30% above average. Although article citation has the advantage of focusing directly on the impact of the articles examined, citing takes time, particularly in some disciplines. A trade-off exists between the length of time over which citations are accounted for and the timeliness of the indicator: the more time allowed to measure the impact, the less timely the indicator becomes.

How to read this figure

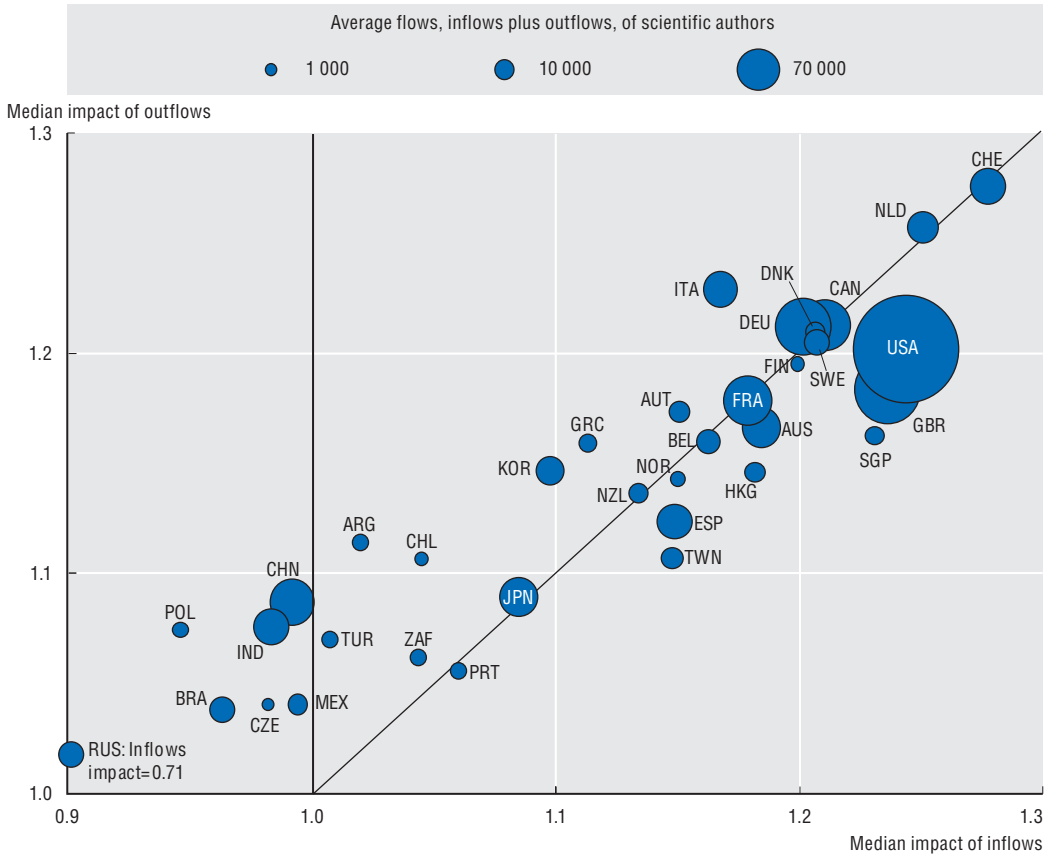
Bubbles plot a country's share of documents resulting from international collaboration – as implied by the share of domestic articles co-authored with individuals affiliated with foreign institutions – against the normalised impact of its publications. The size of the bubbles represents the volume of scientific production, with the United States and China the largest producers of scientific output. Switzerland has both a high share of international scientific collaboration and average impact, although its total output volume is smaller than that of countries such as France or the United Kingdom.

Researchers on the move and their impact

Scientists are known to be highly mobile and internationally mobile scientists tend to publish in higher-quality journals than their counterparts who stay in the same country throughout their research careers. New analysis of bibliometric data unveils the mobility patterns of scientific authors. For a majority of economies, the median impact of scientists whose affiliation shifts abroad tends to be higher than for new arrivals. The performance gap between inflows and outflows is largest for countries with relatively low average research performance. Causality could go both ways: high performers may be more enticed than others by better prospects elsewhere, while mobility can also enhance their performance, especially when moving to work in organisations with better resources and with leading experts.

56. The impact of internationally mobile scientists, inflows versus outflows, 1996-2011

Based on citation impact and changes in the affiliation of scientific authors



Source: OECD calculations based on Scopus Custom Data, Elsevier, version 5.2012, and SNIP2 Database, *www.journalmetrics.com*, Elsevier, Scimago and University of Leiden. May 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890333

How to read this figure

The scientific impact of researchers moving across countries is proxied by a measure of the quality of the journals they publish in. SNIP (source-normalised impact per paper) is the ratio of a journal's average citation count per paper and the citation potential of its subject field. The citation potential represents the likelihood of being cited for documents in a particular field. Impact is estimated by calculating, for each author and mobility profile, the median across the relevant journals' SNIP, over the entire period. An impact value higher than one means that the median-attributed SNIP for authors of that country/category is above average.

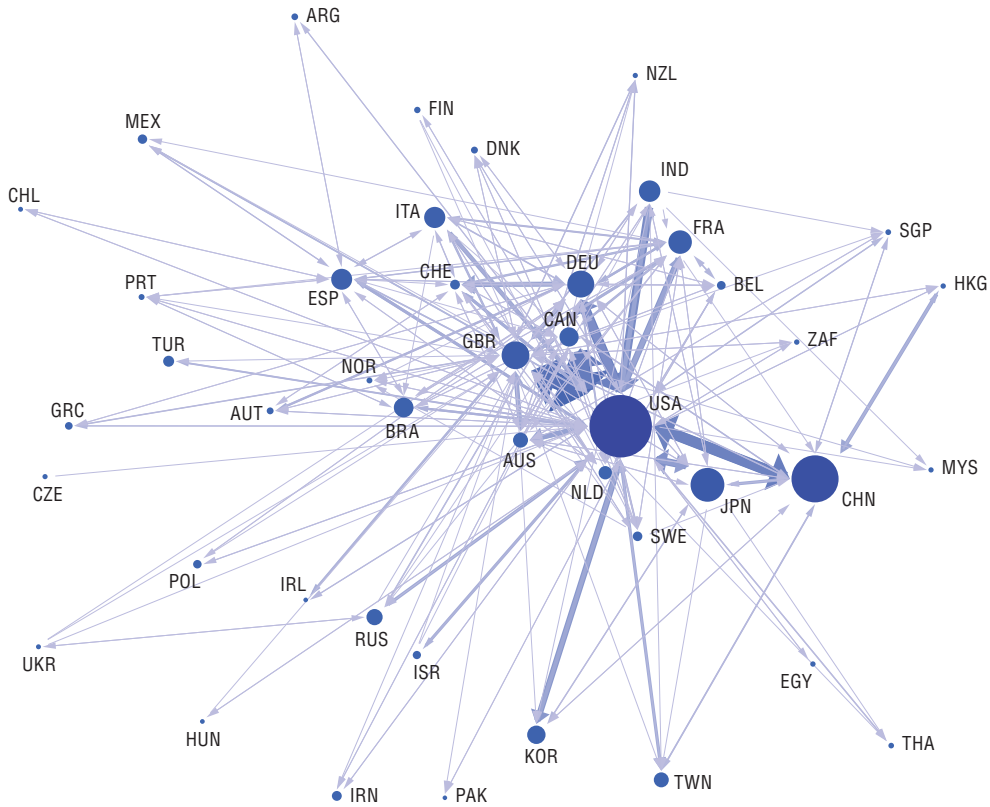
Switzerland has the highest impact factor of incoming (inflows) and outgoing (outflows) authors and these are nearly identical. In Korea, both types have higher impacts than the world average, but outflows have a higher citation impact than inflows (distant from the 45-degree line). For India, the impact of outgoing researchers is above average whereas it is below average for incoming ones. The size of bubbles is proportional to the degree of mobility among scientific authors in an economy, as reflected in the average of inflows and outflows over 1996-2011.

Knowledge networks

The mobility of researchers contributes to the diffusion of scientific and technological knowledge across institutions, at a national and international level. The trail of affiliation changes left by scientific authors in their scholarly publication records provides a partial means of identifying the international network of researcher flows. As expected, leading research countries tend to attract more scientific authors from abroad than they have authors who leave. Flows within each pair of countries tend to be of a similar order of magnitude in both directions, suggesting the existence of complex patterns of knowledge circulation representing the mobility of individuals at different stages of their careers, from students to established professors. The international mobility network also displays a number of interesting patterns that reveal affinities between different economies based on linguistic, historical as well as political and cultural linkages, such as the link between Spain and Latin America countries.

57. International mobility network, 1996-2011

Counts of bilateral flows, by first and last affiliation



Source: OECD calculations based on Scopus Custom Data, Elsevier, version 5.2012, June 2013.

How to read this figure

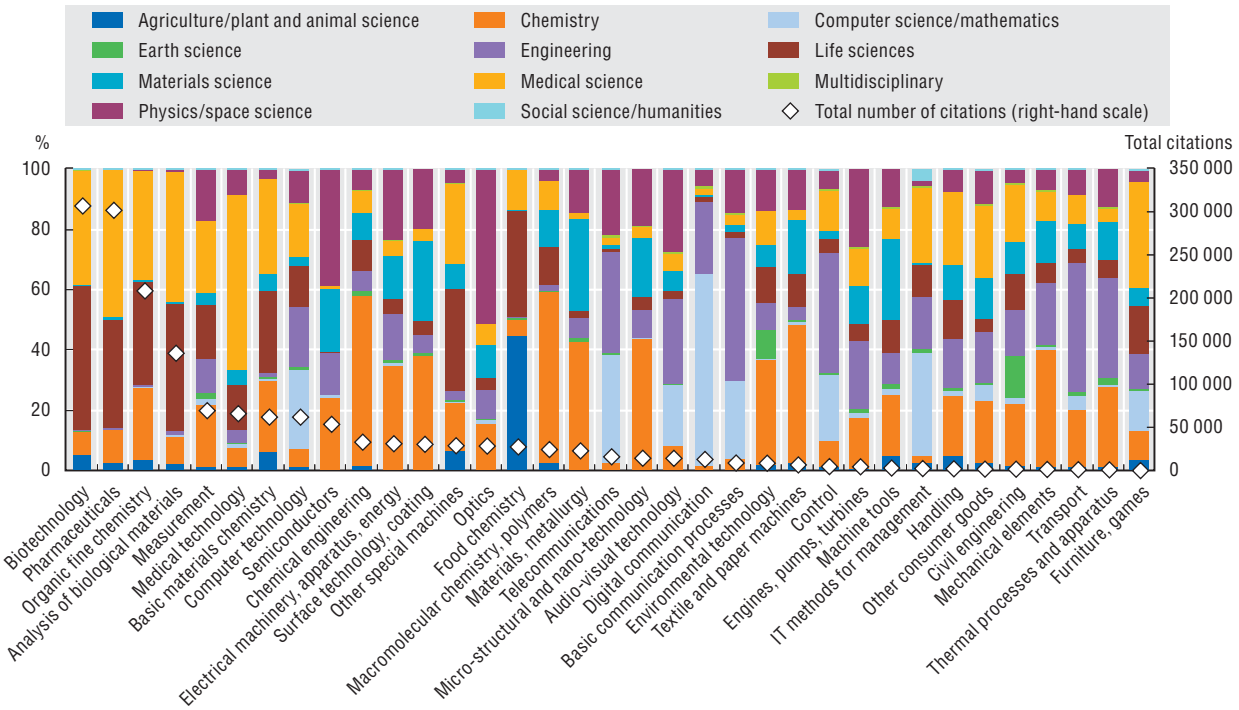
The position of selected economies (nodes) is determined by the number of bilateral flows of publishing scientific authors from 1996 to 2011. A visualisation algorithm has been applied to the international mobility network to represent the linkages in a two-dimensional layout where distances reflect the combined strength of mobility forces between economies. Bubble sizes are proportional to the number of scientific authors who stay in the economy. The thickness of the arrows joining the nodes represents the number of moves between each pair. A difference in the size of the arrow tip within each pair denotes a marked difference in the volume of flows in each direction.

Innovation on the shoulders of science

Much can be learned from citations to scientific publications by patents in different technology areas. This new indicator shows that patented inventions in biotechnology, pharmaceuticals, organic chemistry and analysis of biological materials account for the majority of citations to scientific literature in patent documents. The life sciences – biology and biochemistry, immunology, microbiology, molecular biology and genetics – and the medical sciences are the most frequently cited scientific fields. Micro-structural technology and nanotechnology rely particularly on chemistry, materials science, engineering and physics. Publications in the social sciences appear relevant to patents on IT methods for management, alongside computer science, engineering, life and medical sciences. The diversity of scientific sources shows the impossibility of identifying a single major scientific field for an invention in any area. It also reveals the fundamental interdisciplinarity and reliance on basic science for important advances in innovation.

58. The innovation-science link by technology area, 2001-11

Share of scientific fields in non-patent literature cited in patents



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 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890352

What is a patent-science link?

The link between patents and scientific literature is based on the non-patent literature (NPL) listed as relevant references in patent documents in the Thomson Reuters Derwent World Patents Index and Derwent Patents Citation Index databases. It is applied to patents in selected technology areas, based on the International Patent Classification (IPC) codes in the patent document, which define technology areas according to the classification presented in Schmoch (WIPO, 2008 revised in 2013). To identify whether NPL corresponds to a scientific document, NPL references were matched to Thomson Reuters Web of Science Database, an index of scientific literature. For successfully matched references, it is possible to extract bibliographical information, including on the field(s) of science.

How to read this figure

36% of citations to scientific literature in telecommunication patents are to articles in computer science and mathematics, 34% to engineering science articles and 22% to physics-related articles.

Openness in science and innovation

Collaboration among institutions is a pervasive feature of research in, and increasingly between, countries. This is confirmed by an analysis of the affiliations and geographic locations of co-authors and co-inventors in scientific publications and patent documents. International co-authorship appears more widespread for scientific publications than for patented inventions, except in India and Poland. The positive correlation between international scientific collaboration and cross-border patent applications may signal the existence of common underlying factors. Smaller countries tend to have higher rates of international collaboration. This may be partly due to the need to overcome limited domestic opportunities for collaboration and, in some cases, to the possible proximity (not only geographical) to centres of knowledge located abroad.

59. International collaboration in science and innovation, 2007-11

Co-authorship and co-invention as a percentage of scientific publications and PCT patent applications

Source: OECD, Patent Database, June 2013; OECD and SCImago Research Group (CSIC), *Compendium of Bibliometric Science Indicators 2014*, based on Scopus Custom Data, Elsevier, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890371

How to read this figure

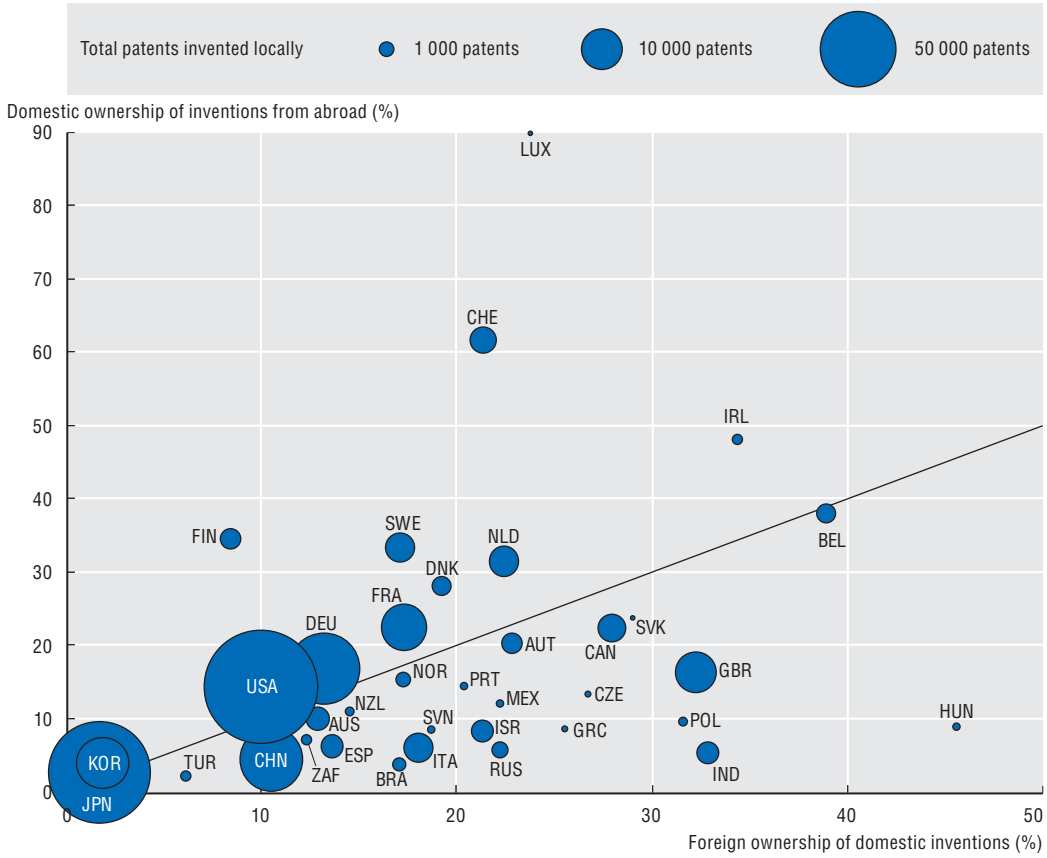
International co-authorship of scientific publications is based on the share of articles featuring authors affiliated with foreign institutions in total articles produced by domestic institutions. Co-inventions are measured as the share of patent applications with at least one co-inventor located abroad in total patents invented domestically. For Switzerland, 60% of publications featuring Swiss institutions involve co-authorship with institutions based abroad. For Japan, scientific co-authorship just exceeds 20% but this is still more than its level of international patent co-invention, which stands at less than 5%. Most countries fall below the 45-degree line; this indicates that they have more international scientific co-authorships than patent co-inventions.

Domestic and foreign ownership of inventions

Companies worldwide look at home and abroad for the knowledge and innovative capacity they need to become and remain competitive. As a result, knowledge is increasingly owned and used in a different country from the one in which it was developed. To use the knowledge and inventions of others, companies acquire the legal rights associated with intellectual property (IP) rights, including patents. Differences in the owner's and the inventor's country of residence are often due to the activities of multinationals: the owner is an international conglomerate and the invention is that of a foreign subsidiary. The propensity to create knowledge and appropriate the returns to knowledge through IP varies across economies. Italy and Sweden applied for a similar number of patents over 2009-11 and have a similar share of patents controlled by foreign firms (about 21%), but they exhibit very different shares of inventions generated abroad, around 31% in Sweden and 8% in Italy. In general, small open economies with a strong presence of multinationals are more likely to appropriate returns from knowledge created elsewhere. Companies resident in Luxembourg, Switzerland and Ireland own a substantial proportion of inventions generated abroad, but only up to a third of their patented inventions are owned by foreign firms. The reverse is true in Poland, Hungary and India.

60. Cross-border ownership of patents, 2009-11

As a percentage of total patents by countries



Source: OECD, Patent Database, June 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890390

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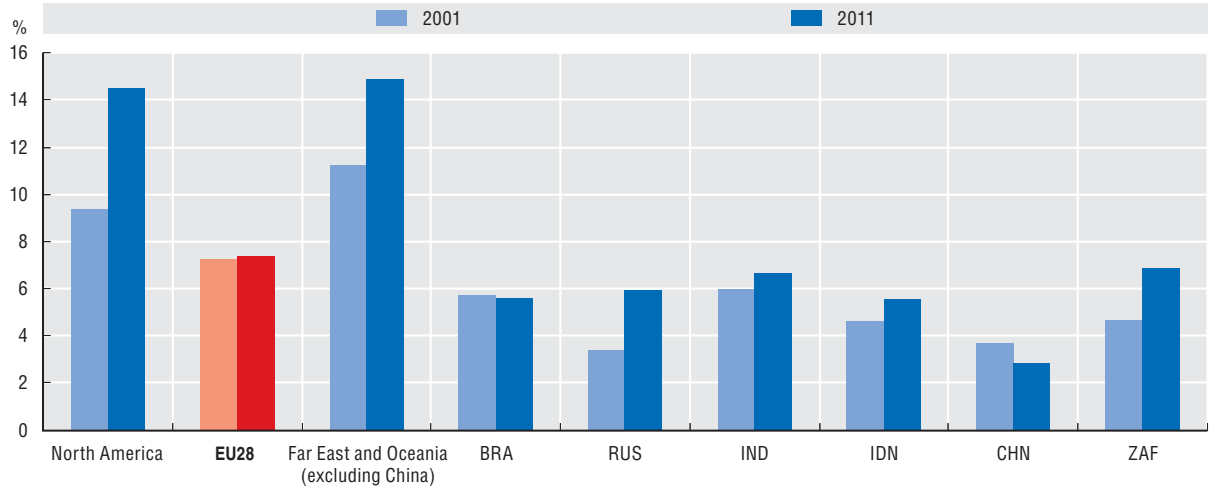
Foreign ownership of domestic inventions is measured as the share of patents invented in one country that is owned by residents in another country in total patents invented domestically. Domestic ownership of inventions from abroad is measured as the share of patents owned by country residents with at least one foreign inventor in total patents owned by country residents. In Belgium the two measures are almost identical. Some 38% of Belgian patents filed over 2009-11 are owned by foreign companies or individuals and about 38% of the patents in the hands of Belgian residents were invented or co-invented by foreigners.

Collaboration with new players

Geographical and cultural proximity influences international scientific collaboration. The widespread use of English and information and communication technologies has helped to extend the scope of international research collaboration. While Europe increases scientific collaboration in the European research area, the rest of the world reaches out to emerging economies. Co-inventions are an indicator of formal R&D co-operation and knowledge exchange among inventors located in different countries. International co-inventorship is affected by countries' skills endowment and conditions of appropriability, especially their IP regimes. International co-invention typically involves multinational corporations with units in several countries and joint research ventures between firms and institutions of various types (e.g. universities, public research organisations). While co-invention with the BRIICS continues to increase, it remains limited as only about 1.7% of European patents and around 2.5% of US patents are co-invented with partners in BRIICS economies.

61. Scientific collaboration with BRIICS countries, 2001 and 2011

As a percentage of total international co-authored articles

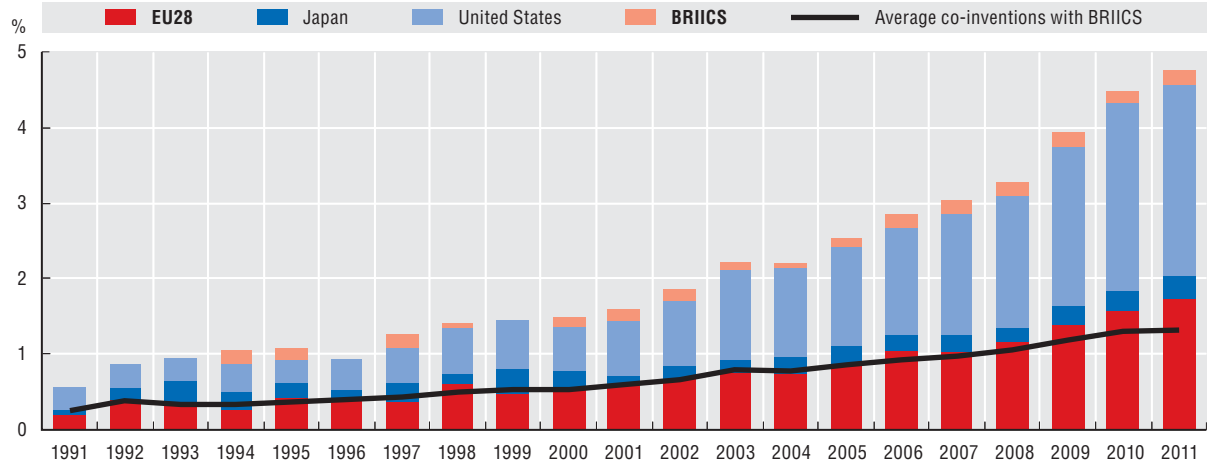


Source: OECD calculations based on Scopus Custom Data, Elsevier, version 5.2012, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890409

62. Co-inventions with the BRIICS countries, 1991-2011

As a percentage of patents in each country or aggregate



Source: OECD, Patent Database, June 2013. See chapter notes.

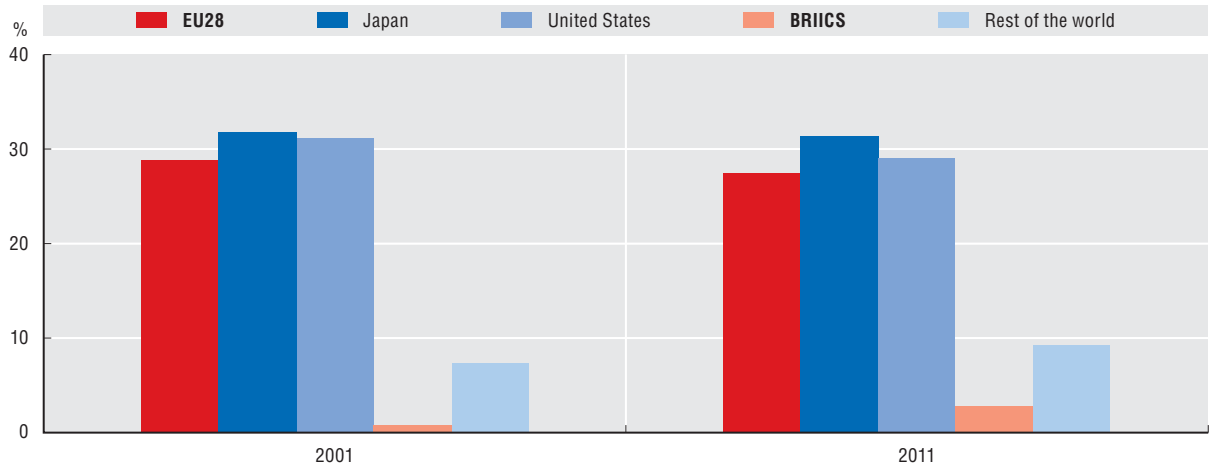
StatLink http://dx.doi.org/10.1787/888932890428

Technology flows

The ownership of "higher-value" patents, i.e. triadic patent families, in non-OECD economies is increasing as competition becomes global and the capacity of non-OECD countries to generate innovations and penetrate key OECD markets increases. As they have developed, emerging economies have benefited to varying degrees from technologies and innovations generated elsewhere. Patented technologies that were invented in Europe, Japan, Korea and the United States and that are filed at patent offices of BRIICS economies bear witness to this. On average 40% of world inventions and over 45% of Japanese inventions are protected in China; the technology flows are predominantly in the field of electrical and mechanical engineering. The strategic behaviour of firms, the location of both subsidiaries and competitors, and the attractiveness of emerging markets may help to explain the patterns observed.

63. Triadic patent families by blocs, 2001 and 2011

Share in total triadic patent families

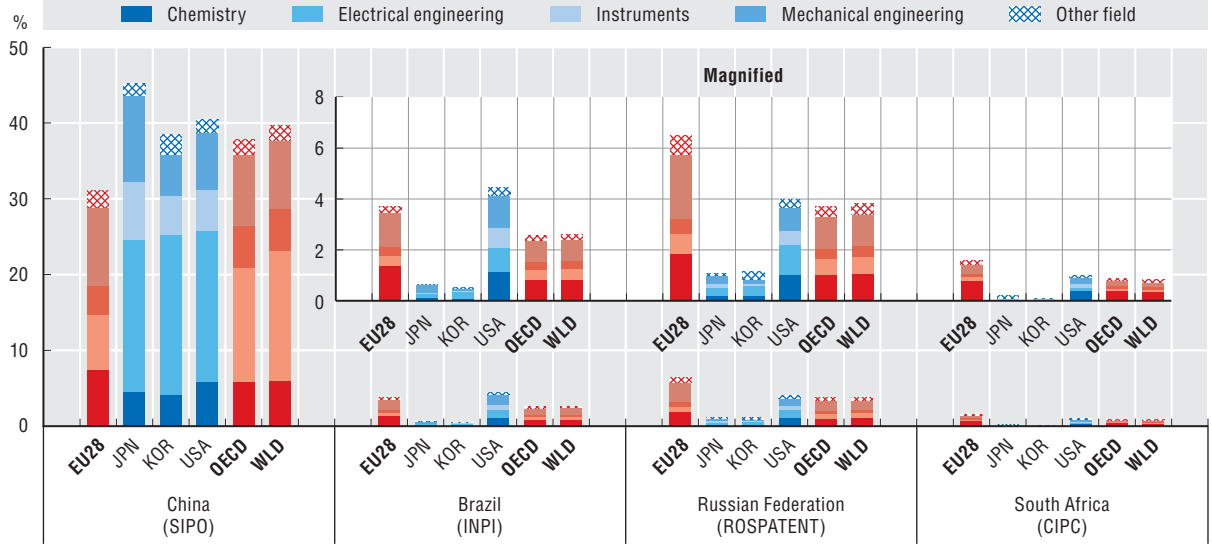


Source: OECD, Patent Database, June 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890447

64. Technology transfers to selected BRIICS, 2005-09

Share of patent families by origin of inventor and patent office of destination in total patent families



Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013. StatLink contains more data. See chapter notes.

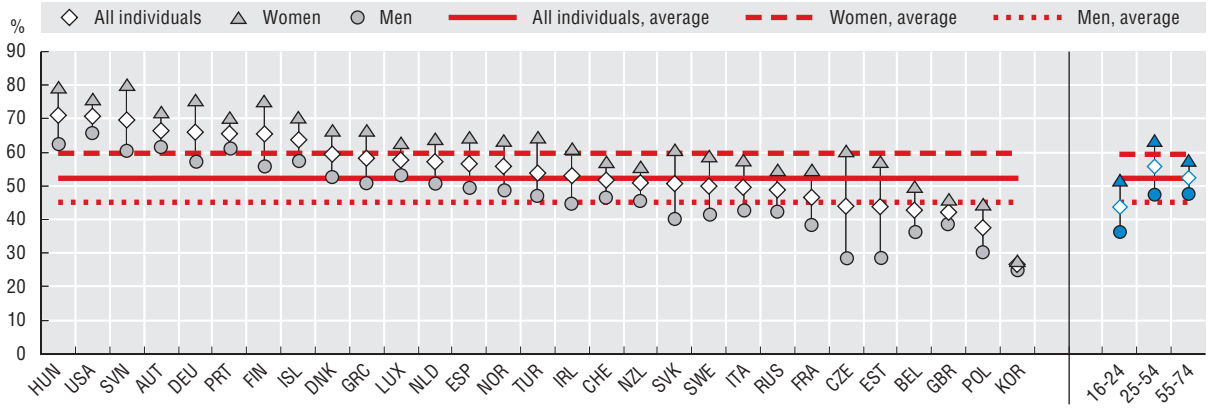
StatLink http://dx.doi.org/10.1787/888932890466

Internet and society

One of the primary uses of the Internet in everyday life is to find information. The search for health-related information ranks among the top activities, with over 50% of users doing so. While cross-country differences are important, the data suggest that in all countries and across all age cohorts women search more actively for such information, with a gender gap of about 15 percentage points. The Internet is also increasingly used to search for employment: on average, almost one-quarter of working-age Internet users seek job-related information on the Internet, with cross-country differences likely to reflect labour market conditions and the opportunities offered by this channel. The diffusion of this activity is higher among younger users, especially in the Nordic countries.

65. Gender differences in seeking health-related information on the Internet, 2011

Percentages of 16-74 year-old Internet users and of users by age group

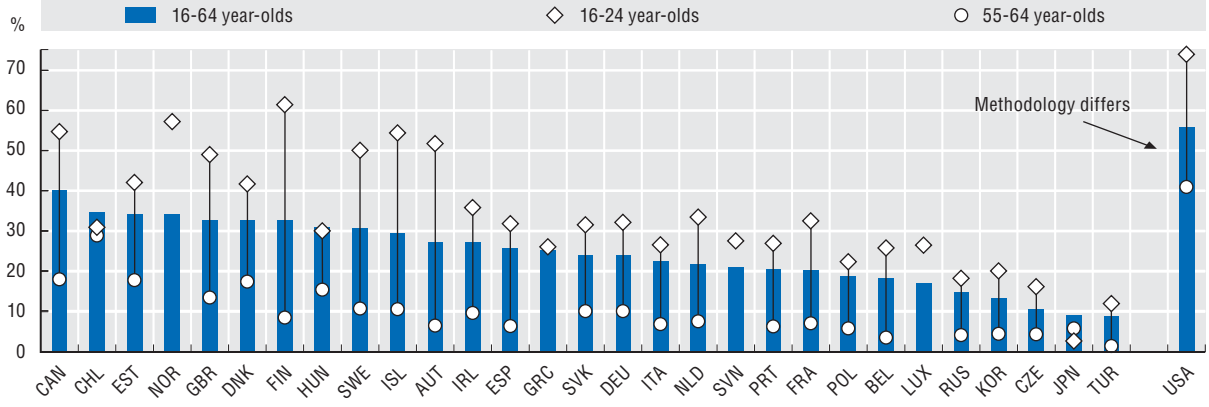


Source: OECD, ICT Database, June 2013; Eurostat; and national sources, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890485

66. Age differences in seeking employment-related information on the Internet, 2011

Percentage of Internet users in working age population, by age group



Source: OECD, ICT Database, June 2013; Eurostat; and national sources, May 2013. See chapter notes.

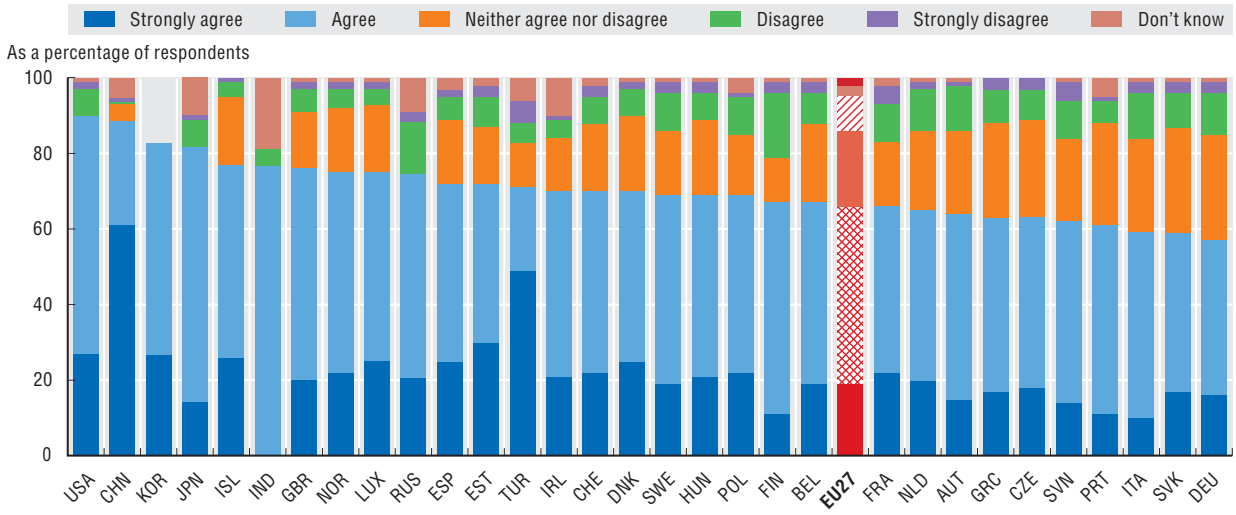
StatLink http://dx.doi.org/10.1787/888932890504

Science and technology and society

Developments in science and technology have visible impacts on people's lives. Surveys carried out across a large number of countries indicate that the public has a mainly positive view of the impact of science and technology on their personal well-being. However, the surveys do find that a significant fraction of the population has mixed or critical opinions as regards the balance of the beneficial and harmful effects of scientific research. They also suggest that non-European countries tend to have more positive views of science and technology.

67. Public perception of the impact of science and technology on personal well-being, 2010

"Science and technology are making our lives healthier, easier and more comfortable"

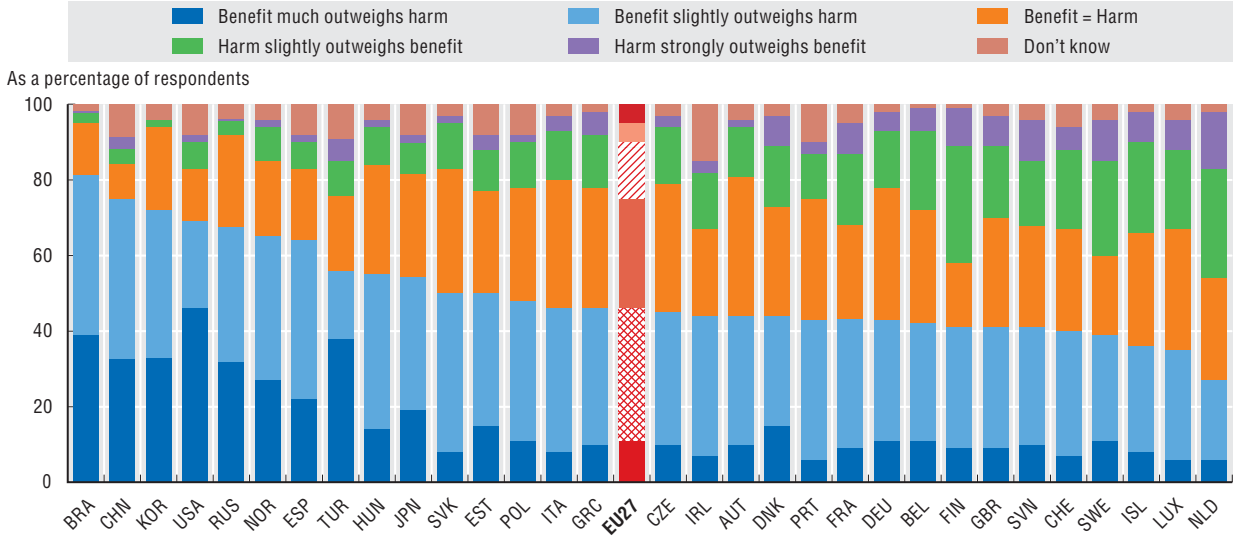


Source: OECD, based on European Commission, US National Science Foundation and other national data sources. June 2013. See chapter note.

StatLink http://dx.doi.org/10.1787/888932890523

68. Public perception of scientific research benefits, 2010

"Have the benefits of scientific research outweighed the harmful results?"



Source: OECD, based on European Commission, US National Science Foundation and other national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890542

Measuring public perceptions and engagement in science and technology

Surveys on the public perception and awareness of, and engagement in science and technology have been carried out in several countries. A new OECD project is reviewing the methodological challenges faced by such surveys and their international comparability. Given the methodological differences and potential biases that affect responses, results should be interpreted with caution.

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 recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'."

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

"The Republic of Cyprus is 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, 2001-12

Euro area here excludes Cyprus and Malta.

2. Growth in GDP per capita and GDP per person employed in the BRIICS and the OECD, 2007-09 and 2009-12

Calculations are based on GDP at constant prices, converted to USD using 2005 purchasing power parities. GDP for Brazil, Indonesia and South Africa are from OECD, Quarterly National Accounts, April 2013. GDP for India is from OECD, Annual National Accounts, April 2013; the series was extended after 2009 using OECD, Quarterly National Accounts, April 2013.

Employment estimates for Brazil, China, India and Indonesia are based on GGDC, Total Economy Database, January 2013.

Employment data for South Africa are from OECD, Annual National Accounts, April 2013; the series was extended after 2010 using GGDC, Total Economy Database, January 2013.

3. Job recovery across socio-economic groups, 2008 Q1-2012 Q4

The skill dimension is based on ISCED97 as follows: low-skilled (ISCED97 0/1/2), less than upper secondary education; medium-skilled (IECD97 3/4), upper secondary education; high-skilled (ISCED97 5/6); tertiary education.

4. Harmonised unemployment rates, OECD, Euro area, United States and Japan, July 2008-April 2013

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 who, in the reference period: are without work; are available for work; and have taken specific steps to find work.

Rates are seasonally adjusted.

Euro area here excludes Cyprus and Malta.

5. Net job growth, younger versus older firms, 2001-11

Establishments and firms that appear only for one year are excluded.

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

The shares are calculated as shares of total employment, job destruction and job creation.

Small firms have between 1 and 49 employees, medium firms have between 50 and 249 employees, and large firms have more than 250 employees.

For Austria, data are at the establishment level.

For Japan, data are at the establishment level and refer to the manufacturing sector only.

For Austria, Italy, Luxembourg and Sweden, data refer to 2001-10.

For Brazil, data refer to 2002-10.

For France, data refer to 2002-07.

For Japan and New Zealand, data refer to 2001-09.

For Spain, data refer to 2003-09.

6. Employment, job creation and job destruction, by firm age and size, 2001-11

See notes under 5.

7. Employment, job creation and job destruction, manufacturing and services 2001-11

See notes under 5.

8. Where people lost their jobs, 2008-11

General note:

The aggregate activity groups are defined according to ISIC Rev.4 Divisions 01-03 (Section A), 05-39 (B-E), 41-43 (F), 45-56 G-I), 58-63 (J), 64-68 (K-L), 69-82 (M-N) and 84-99 (O-U).

Additional notes:

For Australia, calendar year averages from the Quarterly Labour Force Survey (QLFS), June 2013. Finance, insurance and real estate activities includes renting and hiring of machinery and equipment (77).

For Iceland, Annual Labour Force Survey (LFS) data by industry are used in the absence of employment by activity statistics published in an SNA context.

For Israel, estimates based on SNA employment data provided to OECD according to ISIC Rev.3. Professional, scientific, technical and other business services (69-82) includes Information and communication (58-63) and Finance, insurance and real estate activities (64-68).

For Japan, public administration, education, health and other services (84-99) includes Professional, scientific, technical and other business services (69-82).

For New Zealand, data are based on employment estimates for fiscal years 2008/09 and 2011/12. Agriculture, forestry and fishing (01-03) includes Mining and quarrying (05-09).

The OECD aggregate does not include Chile and Turkey.

9. Where people lost their jobs in Europe, 2011-12

See general note under 8.

10. Job creation and destruction in the information industries, 2008-11

To assess the effects of the economic crisis on employment across information industries, sectoral changes in levels of employment can be "normalised" in order to highlight their relative contributions, within each country, to the total change in information industry employment between 2008 and 2011. This is achieved, for each country, by expressing the sectoral changes as a percentage of the sum of the absolute changes.

The four activity groups comprising "information industries" are defined according to ISIC Rev.4 Divisions 26 (CI), 58-60 (JA), 61 (JB) and 62-63 (JC) respectively.

The gains and losses, in thousands, represent the sum of the aggregate sectors with positive changes and the sum of the aggregate sectors with negative changes, respectively. With a finer activity breakdown (such as 3-digit ISIC Rev.4), the estimates for total gains and losses could differ. For example, within the losses noted for Manufacture of computer, electronic and optical products (26), certain (3- or 4-digit) activities may have experienced gains in employment.

The employment data are measured in terms of persons except for Canada and the United States where number of jobs is the unit of measurement.

For Spain, IT and other information services (JC) includes Telecommunications (JB).

11. Change in the skill mix in Europe, services and manufacturing, 2011-12

Occupations are defined according to International Standard Classification of Occupations 2008 (ISCO-08). The following major groups are used 1) Managers, 2) Professionals, 3) Technicians and associate professionals, 4) Clerical support workers, 5) Service and sales workers, 7) Craft and related trades workers, 8) Plant and machine operators and assemblers, and 9) Elementary occupations.

Craft and related trades workers includes ISCO-08 major group 6, Skilled agricultural, forestry and fishery workers, which are reported by a few countries under manufacturing and business-sector services.

Manufacturing corresponds to ISIC Rev.4 (NACE Rev.2) Divisions 10-33 (Section C) while business-sector services cover Divisions 45-82 (G-N).

12. R&D growth over the business cycle by source of financing, OECD area, 1982-2012

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.

Estimates for government R&D budgets are based on GBAORD (government budget appropriations or outlays for R&D) data for OECD countries with information available for 2012 (Denmark, Estonia, Finland, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, the Slovak Republic, Slovenia and the United States). Rates of growth for this series only from 2008. 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.

13. US GDP and trademark applications at the US Patent and Trademark Office, 2003-13

US GDP is based on the series of seasonally adjusted GDP, expenditure approach, in volume (chained volume estimates) contained in the OECD Quarterly National Accounts Database, June 2013.

The following aggregated fields based on the Nice Classification are used: Health, pharma and cosmetics: classes 3, 5, 10 and 44; Leisure and education: classes 13, 15, 16, 28 and 41; Advertising and business services: classes 35, 36 and 45; ICT and audiovisual: classes 9 and 38.

Raw GDP and trademark applications series were treated using the OECD's Composite Leading Indicators methodology. Monthly data were used for trademark applications and quarterly data for GDP, converted to a monthly frequency via linear interpolation and aligned with the mid-quarter month. This treatment removes seasonal patterns and trends (using the Hodrick-Prescott filter) in order to extract the cyclical pattern. The cyclical pattern presented on the graph is expressed as a percentage deviation from the long-term trend. Considering the filters applied, the remaining cycles are those with a period of between 18 months and 10 years. The analysis was performed on series from January 1990 to February 2013 for trademark applications and to March 2013 for GDP. For more information on the methodology, see OECD (2012), "OECD System of Composite Leading Indicators", *www.oecd.org/std/leading-indicators/41629509.pdf*.

The figure shows a peak around 2004 for the trademark series that does not correspond to economic activity. It corresponds to the accession of the United States to the Madrid Agreement in November 2003, which facilitated the filing procedure for foreign applications.

15. New enterprise creations, selected OECD countries, 2007-13

The trend cycle reflects the combined long-term (trend) and medium-to-long-term (cycle) movements in the original series.

For Australia, data exclude non-incorporated companies.

For Spain, data exclude natural persons and sole proprietors.

For the United States, data only refer to establishments with employees.

16. Trends in bankruptcies, 2007-11

For France, Norway and Spain, data refers to SMEs only.

17. Venture capital investment in the United States, 1995-2012 and in Europe, 1995-2010

Data for the United States refer to market statistics, data for Europe refer to industry statistics.

Europe includes Austria, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Former Yugoslav Republic of Macedonia, Montenegro, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Ukraine and the United Kingdom.

18. Venture capital exits in the United States and Europe, 2007-12

Trade sale refers to the sale of company shares to industrial investors.

Initial public offering refers to the sale or distribution of a company's shares to the public for the first time.

Europe includes Austria, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Former Yugoslav Republic of Macedonia, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Ukraine and United Kingdom.

19. Patents by technology fields, 1999-2011

The data refer to counts of patent applications filed under the Patent Cooperation Treaty (PCT), at international phase, by priority date. Data for 2011 are estimates.

Patents in biotechnologies, nanotechnologies health- and ICT-related technologies are based on a selection of International Patent Classification (IPC) classes.

Patents in environment-related technologies are defined using combinations of IPC classes and codes Y02 of the European Classification (ECLA).

20. The dynamics of merchandise exports in OECD and non-OECD economies, 2000-11

Underlying values are in current USD. Data refer to manufactured goods and goods stemming from primary activities (i.e. agriculture, fishing, forestry, mining and quarrying); a few utilities, such as electricity and some community services, are also covered.

22. Worldwide collapse in exports, in gross value added terms between 2008 and 2009

Gross exports of goods and services are estimated from the underlying inter-country input-output (ICIO) system used to produce the OECD-WTO Trade in Value Added (TiVA) indicators. Of necessity, the system requires consistent bilateral trade matrices in which exports of products X from country A to B are equal to imports of products X by B from A. Efforts are made to ensure consistency with aggregate exports and imports as reported in countries' National Accounts or Balance of Payments statistics. However, because of the required balancing of global bilateral trade matrices, certain results may not match countries' perceptions of their trading patterns.

23. Trends in world foreign direct investment flows, 1995-2011

From 2005, data refer to the definition of FDI 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.

24. Decomposition of growth in GDP per capita, 2007-09 and 2009-12

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.

25. Gap in GDP per capita and GDP per person employed in the BRIICS, with respect to the United States, 1997-2012

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

26. Labour productivity growth in non-agricultural business sector before the crisis, 2001-07

General notes:

The contribution of each sector to aggregate labour productivity growth is computed as the difference between the growth rate of real value added and that of hours worked, weighted by the sector's share in total nominal value added and total hours worked, respectively.

The aggregate activity groups are defined according to ISIC Rev.4 Divisions 05-39 (Sections B-E), 41-43 (F), 45-56 (G-I), 58-63 (J), 64-66 (K) and 69-82 (M-N) respectively. Total non-agriculture business sector thus includes all activities except ISIC Rev.4 Sections A: Agriculture, forestry and fishing (Divisions 01-03), L: Real estate (68), and O-U: Public administration, education, health and other services (84-99).

Additional note:

Korean hours worked for 2001 are a Secretariat estimate which applies the 2004 industry distribution of hours worked to a 2001 total economy figure.

27. Labour productivity growth in non-agricultural business sector after the crisis, 2007-11

See general notes under 26.

28. Investment in fixed and knowledge-based capital, 2010

For Canada, Japan and Korea estimates refer to 2008.

Estimates refer to the business sector for all countries except Korea, for which estimates refer to the total economy. Value added in the business sector is adjusted to include knowledge-based investments.

Data on knowledge-based capital (KBC) for Australia provided by L. Talbott; all data for Canada provided by J. Baldwin, W. Gu and R. Macdonald; data on KBC and physical assets for members of the European Union, Norway and the United States provided by the INTAN-Invest consortium led by C. Corrado, J. Haskel, C. Jona-Lasinio and M. Iommi; all data for Japan provided by K. Fukao and T. Miyagawa; data on KBC for Korea provided by H. Chun. Data on tangible investment for Australia, Austria, Denmark, Finland, France, Ireland, Italy, Korea, Luxembourg, the Netherlands, Spain and Sweden and data on adjusted value added for Australia, Korea, Luxembourg and Portugal are OECD calculations based on OECD and Annual National Accounts Databases, May 2013.

29. Change in business investment intensity between 2008 and 2010

Estimates refer to the business sector for all countries.

Data on knowledge-based capital (KBC) for Australia provided by L. Talbott; data on KBC and physical assets for members of the European Union, Norway and the United States provided by the INTAN-Invest consortium led by C. Corrado, J. Haskel, C. Jona-Lasinio and M. Iommi. Data on tangible investment for Australia, Austria, Denmark, Finland, France, Ireland, Italy, Luxembourg, Netherlands, Spain and Sweden and data on adjusted value added for Australia, Luxembourg and Portugal are OECD calculations based on OECD and Annual National Accounts Databases, May 2013.

30. Foreign value added content of exports, 1995

Regional aggregations are as follows:

ASEAN: Brunei Darussalam, Cambodia, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam. The aggregate does not include Laos and Myanmar.

EU15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

Other EU: Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Iceland, Latvia, Lithuania, Malta, Norway, Poland, Romania, the Slovak Republic, Slovenia and Switzerland.

Rest of the world (world excluding TiVA countries, see *www.oecd.org/sti/ind/TiVA_Guide_to_Country_Notes.pdf*).

For the regions ASEAN, EU15 and Other Europe, intra-regional trade is included. For example, the arrow from USA to EU15 includes USA value added embodied in EU15 countries' exports to other EU15 countries.

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

31. Foreign value added content of exports, 2009

See notes under 30.

32. Foreign value added content of exports, non-OECD economies, 2009

OECD calculated as a weighted average of OECD countries.

33 Service value added in manufacturing exports by industry, 1995 and 2009

The manufacturing activities covered are based on the following ISIC Rev.3 industries: 15-16 (Food products, beverages and tobacco); 17-19 (Textiles, wearing apparel, leather and related products); 20-22 (Wood, paper products, printing and publishing); 23-26 (Chemicals, pharmaceuticals, plastics and other non-metallic mineral products); 27-28 (Basic metals and fabricated metal products); 29 (Machinery and equipment); 30-33 (Electrical and optical equipment); 34-35 (Transport equipment); 36-37 (Other manufacturing and recycling).

Outliers were excluded from the computation of indices.

34. Foreign direct investment inflows, 1995-2000, 2001-06 and 2007-11

Data from 2005 to 2011 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, Russian Federation and South Africa.

Southeast Asia includes: Cambodia, Chinese Taipei, Hong Kong (China), Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam.

35. Outward foreign direct investment flows from BRIICS, 2001-04, 2005-07 and 2008-11

For Indonesia, the 2001-04 average is not available.

The IMF (2009), Balance of Payments and International Investment Position Manual, 6th edition definition of FDI is used for 2005-07 and 2008-11, IMF (1993), Balance of Payments and International Investment Position Manual, 5th edition definition for 2001-04.

36. Outward foreign direct investment flows from China, yearly average 2007-11

Offshore financial centres include Antigua & Barbuda, the Bahamas, the British Virgin Islands, the Cayman Islands, St Vincent & the Grenadines, and Bermuda.

Southeast Asia includes Brunei Darussalam, Cambodia, Chinese Taipei, Indonesia, Laos, Macau, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam.

37. Top 20 countries, total stock of foreign direct investment, 2012

Top 20 countries by the sum of inward and outward positions.

Countries are ranked by their inward position.

38. Composition of GDP in OECD and BRIICS economies, 2011

The major activity groups defined according to ISIC Rev.4 are: Market services: ISIC Divisions 45-82 (G-N); Non-market services: 84-99 (O-U); Industry: 05-39 (B-E), i.e. Mining (05-09), Manufacturing (10-33) and Utilities (35-39); Construction: 41-43 (F); and Agriculture: 01-03 (A).

Value added is measured in basic prices except for Indonesia and Japan (market prices) and India and the United States (factor costs).

For Australia data refer to the fiscal year ending June 2012.

For Brazil and Canada data refer to 2009.

For India data refer to the fiscal year ending March 2012.

For New Zealand data refer to the fiscal year ending March 2010.

39. Top 20 OECD and BRIICS economies reliant on natural resources, 2011

For Estonia, previous year data refer to 1995.

Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents. Rents are estimated as the difference between the value of production at world prices and total costs of production, including depreciation of fixed capital and return on capital.

40. Top manufacturers, 1990, 2000 and 2011

For Canada the 2011 share is based on a Secretariat extrapolation from official current price value added statistics available up to 2009.

For China the 2011 share is based on an estimate calculated by the United Nations Statistics Division and derived by applying the average 2008-10 share of manufacturing value added to total industry value added published for 2011.

42. Exports from energy-intensive manufacturing industries, 2011

The five industries considered are those included in ISIC Rev.4 Divisions 17, 19, 20, 23 and 24.

43. Biggest net CO_2 importers and net CO_2 exporters, 2009

Countries are listed by production-based CO_2 emissions, in descending order on the left-hand side, in ascending order on the right-hand side.

44. R&D in OECD and key partner countries, 2011

Figures for researchers are in full-time equivalent units.

For Brazil, Chile and the Netherlands, data refer to 2010.

For Iceland, Indonesia and South Africa data refer to 2009.

For Switzerland, data refer to 2008.

For Greece, data refer to 2007.

For Australia, data refer to 2010 for R&D expenditures and 2008 for researchers.

For India, data refer to 2007 for R&D expenditures and 2005 for researchers.

For Canada, France and Germany, data for researchers refer to 2010.

For United States, data for researchers refer to 2007.

Data for Brazil are provided by Brazil's Ministry of Science, Technology and Innovation. Data for India and Indonesia from the Science & Technology Statistics collected and published by the UNESCO Institute for Statistics. Owing to methodological differences, data for these countries may not be fully comparable with those for other countries.

45. Business R&D intensity and government support to business R&D, 2011

This is an experimental indicator. International comparability may be limited. For more information, see *www.oecd.org/sti/rd-tax-stats.htm*.

For Australia, Belgium, Brazil, Chile, Ireland, Israel and Spain, figures refer to 2010. For China, Luxembourg and South Africa, figures refer to 2009 and for Switzerland to 2008.

Estimates of direct funding for Belgium, 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 2009 share is used for 2011. For Brazil, the 2008 share, based on national sources, is used for 2010.

In Austria, Poland 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.

Estonia, Finland, Germany, Luxembourg, Mexico, New Zealand, Sweden and Switzerland did not provide information on expenditure-based R&D tax incentives for 2011. For Israel the R&D component of incentives cannot be separately identified at present.

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 costs 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*.

46. Global Internet Protocol (IP) traffic, 2005-13

VoD: video on demand. WAN: wide area network.

2013: estimates.

47. IPv6 deployment by country, November 2012

Data collected on 19 November 2012.

48. Mobile cellular and broadband penetration worldwide, 2001-11

OECD series are computed with OECD data.

For Brazil, China, India and World, data are from ITU for mobile subscriptions and from the United Nations for population.

49. University hotspots, geographical distribution of highest impact institutions, 2007-11

Other OECD includes Australia, Canada, Israel, Japan, Korea, Mexico, New Zealand, Norway and Switzerland.

Other EU (and OECD) includes Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Poland, Portugal, Spain and Sweden.

Non-OECD includes Brazil, China, Chinese Taipei, Hong Kong (China), India, Iran, Lithuania, Malaysia, Singapore, South Africa and Thailand.

50. Innovation hotspots in ICT, biotechnology and nanotechnology, 1998-2000 and 2008-10

Data relate to patent applications filed under the Patent Cooperation Treaty (PCT) in ICT, biotechnology and nanotechnology. Patent counts are based on the priority date, the inventor's region of residence and fractional counts. The regional breakdown used is the OECD's Territorial Level 2.

51. Service-related trademark applications at USPTO and OHIM, selected OECD and non-OECD economies, 2000-02 and 2010-12

Shares of service trademarks are calculated using fractional counts of the classes designated in the trademark application. Classes 1 to 34 relate to goods; classes 35 to 45 relate to services.

Trademarks in knowledge-intensive services refer to applications in classes 35, 36, 38 and 42 of the Nice Classification. Trademarks in other services refer to applications in classes 37, 39, 40, 41, 43, 44 and 45 of the Nice Classification.

52. Trademarks in knowledge-intensive services, selected OECD and non-OECD economies, 2010-12

Shares of knowledge-intensive service trademarks are calculated using fractional counts of the classes designated in the trademark application. The following classes of the 10th edition of the Nice Classification are covered: class 35, business services; class 36, finance and insurance; class 38, telecommunications; and class 42, R&D.

53. Patents and trademarks per capita, 2000-02 and 2009-11

Patent families are counted using fractional counts and according to the earliest priority date (first patent application worldwide) and the inventor's country of residence.

Trademarks abroad are counted according to the application date and the address of the applicant.

55. The impact of scientific production and the extent of international scientific collaboration, 2003-11

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.

56. The impact of internationally mobile scientists, inflows versus outflows, 1996-2011

International mobility of scientific researchers is inferred from authors listed in the Scopus Custom database of peer-reviewed scientific publications with at least two documents during the reference period, based on changes in the location of their institutional affiliation. Outflows are defined on the basis of their first affiliation. Inflows are defined on the basis of the final affiliation and exclude individual authors who "return" to their original country of affiliation.

A proxy measure of scientific impact for researchers with different mobility patterns is estimated by calculating, for each author and mobility profile, the median across the relevant journals' Source-Normalized Impact per Paper (SNIP) over the entire period. A SNIP impact value that is higher than one means that the median-attributed SNIP for authors of that country/category is above average.

58. The innovation-science link by technology area, 2001-11

To identify whether NPL corresponds to a scientific document, NPL references were matched to Thomson Reuters Web of Science database, an index of scientific literature. For matched references, scientific domains correspond to Thomson Reuters Essential Science Indicators 22-field classification (*http://archive.sciencewatch.com/about/met/fielddef/*). For presentational purposes, the fields are combined into a reduced set of 11 categories. Medical sciences encompasses clinical medicine, neuroscience, psychiatry and psychology. Life sciences covers biology and biochemistry, immunology, microbiology, molecular biology and genetics. Earth science includes geosciences and environment/ecology. Economics is included in social sciences. Other items are as indicated.

59. International collaboration in science and innovation, 2007-11

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

International co-inventions are measured as the share of patent applications filed under the Patent Cooperation Treaty (PCT) with at least one co-inventor located in a different country in total patents invented domestically. Patent counts are based on the priority date, the inventor's country of residence and whole counts.

60. Cross-border ownership of patents, 2009-11

The data refer to counts of patent applications filed under the Patent Cooperation Treaty (PCT), at international phase, by priority date, country and fractional counts.

61. Scientific collaboration with the BRIICS countries, 2001 and 2011

Numbers are based on whole counts.

North America includes the United States, Canada and Mexico.

Far East and Oceania includes Australia, Japan, Korea, Malaysia, New Zealand, Singapore and Thailand.

62. Co-inventions with the BRIICS countries, 1991-2011

Co-inventions are measured as the share of patent applications with at least one co-inventor located in a BRIICS country in total patents invented domestically.

Data refer to counts of patent applications filed under the Patent Cooperation Treaty (PCT), at international phase, by priority date, inventor's country of residence and whole counts.

63. Triadic patent families by blocs, 2001 and 2011

"Triadic" patent families refer to patents filed at the European Patent Office (EPO), the Japan Patent Office (JPO) and the United States Patent and Trademark Office (USPTO) that protect the same invention. Patent counts are based on the priority date, the inventor's country of residence and fractional counts.

Data for 2011 are estimates.

64. Technology transfers to selected BRIICS, 2005-09

Data refer to patent families, i.e. patents applied for at more than one patent office, one of which is among the following: Canadian Intellectual Property Office (CIPO, Canada); Companies and Intellectual Property Commission (CIPC, South Africa); Deutsches Patent- und Markenamt (DPMA, Germany); European Patent Office (EPO); Federal Service for Intellectual Property (ROSPATENT, Russian Federation); Institut National de la Propriété Industrielle (INPI, France); Instituto Nacional de Propriedade Industrial (INPI, Brazil); Japan Patent Office (JPO, Japan); Korean Intellectual Property Office (KIPO, Korea); State Intellectual Property Office of the People's Republic of China (SIPO, China); UK Intellectual Patent Office (UKIPO, United Kingdom); and the United States Patent and Trademark Office (USPTO, United States).

Patents are allocated to technology fields using the International Patent Classification (IPC) codes and the classification presented in Schmoch (2008, revised in 2013). Patent counts are based on the earliest priority date, the inventor's country of residence and fractional counts.

65. Gender differences in seeking health-related information on the Internet, 2011

Except where otherwise stated, the recall period is three months.

Averages are calculated using data from available OECD countries for which data are strictly comparable.

The national source for the Russian Federation is the Institute for Statistical Studies and Economics of Knowledge, Higher School of Economics (HSE) of the National Research University, May 2013.

For Canada, individuals aged 16 and over. Internet users are defined for a recall period of 12 months.

For Korea and New Zealand, data refer to 2012. Internet users are defined for a recall period of 12 months.

For Switzerland, data refer to 2010. Internet users are defined for a recall period of 6 months.

For the United States, data refer to May 2011 and are from the Pew Research Center. Percentages refer to adult Internet users (aged 18 or more) who have ever looked on line for health or medical information. There is no recall period.

66. Age differences in seeking employment-related information on the Internet, 2011

The recall period is three months, except for Canada, Chile, Japan and Korea (12 months), and the United States, which has no recall period (see note below).

The national source for the Russian Federation is the Institute for Statistical Studies and Economics of Knowledge, Higher School of Economics (HSE) of the National Research University, May 2013.

For Canada, data refer to 2010 and to search for employment only. The recall period is 12 months.

For Chile, data refer to 2012. Calculations for 16-64 year-olds are based on population figures for the group of individuals 15-64 years old.

For Japan, data refer to 2012 with different age groups: 15-59 year-olds, 15-19 year-olds and 50-59 year-olds.

For Korea data refer to 2012.

For the United States, data refer to May 2011 and are from the Pew Research Center. Percentages refer to adult Internet users (aged 18 or more) who have ever looked on line for information about a job. Internet users aged 18 or more instead of 16-64, 18-29 instead of 16-24 and 50-64 instead of 55-64.

67. Public perception of the impact of science and technology on personal well-being, 2010

For Japan and the Russian Federation, data refer to 2011.

For Korea, data refer to 2012.

For the United States, data refer to 2004.

For India, data refer to 2004.

Based on surveys conducted by means of face-to-face interviews. Results for Japan are based on web-based questionnaire.

Respondents in Japan, the Russian Federation and the United States were offered the following options (Strongly agree, Agree, Disagree, Strongly disagree, Don't know). Respondents in India were presented with three options (Agree, Disagree, Don't know). For Korea, only results for Strongly agree and Agree to some extent are available.

National sources within the following publications:

China: Ministry of Science and Technology of the People's Republic of China (2010). EU countries: European Commission (2010). Japan: National Institute of Science and Technology Policy (2011). Korea: Korea Foundation for the Advancement of Science and Creativity (2012). Russian Federation: National Research University – Higher School of Economics (2012). United States: National Science Board (2012). India: National Science Board (2012).

68. Public perception of scientific research benefits, 2010

For Japan and the Russian Federation, data refer to 2011.

For Korea, data refer to 2006.

Based on surveys conducted by means of face-to-face interviews.

For Japan, Korea, the Russian Federation and the United States, respondents were invited to choose 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.

For Brazil, respondents are asked to choose among the following options: Only benefits, More benefits than harm, Both benefit and harm, More harm than benefits, Only harm, and Don't know.

For EU countries and China, 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", by choosing among the following: Totally agree, Tend to agree, Neither agree nor disagree, Tend to disagree, Totally disagree, Don't know.

National sources within the following publications:

Brazil: Ministry of Science and Technology of Brazil (2010). China: Ministry of Science and Technology of the People's Republic of China (2010). EU countries: European Commission (2010). Japan: National Institute of Science and Technology Policy (2011). Korea: National Science Board (2012). The Russian Federation: National Research University – Higher School of Economics (2012). United States: National Science Board (2012).

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2. BUILDING KNOWLEDGE

1. Investment in knowledge
2. Human resources and knowledge-based capital
3. Learning for innovation
4. Skills for innovation
5. New doctorates
6. Doctorate holders
7. Researchers
8. R&D
9. Higher education and basic research
10. Business R&D
11. R&D tax incentives
12. International funding of R&D

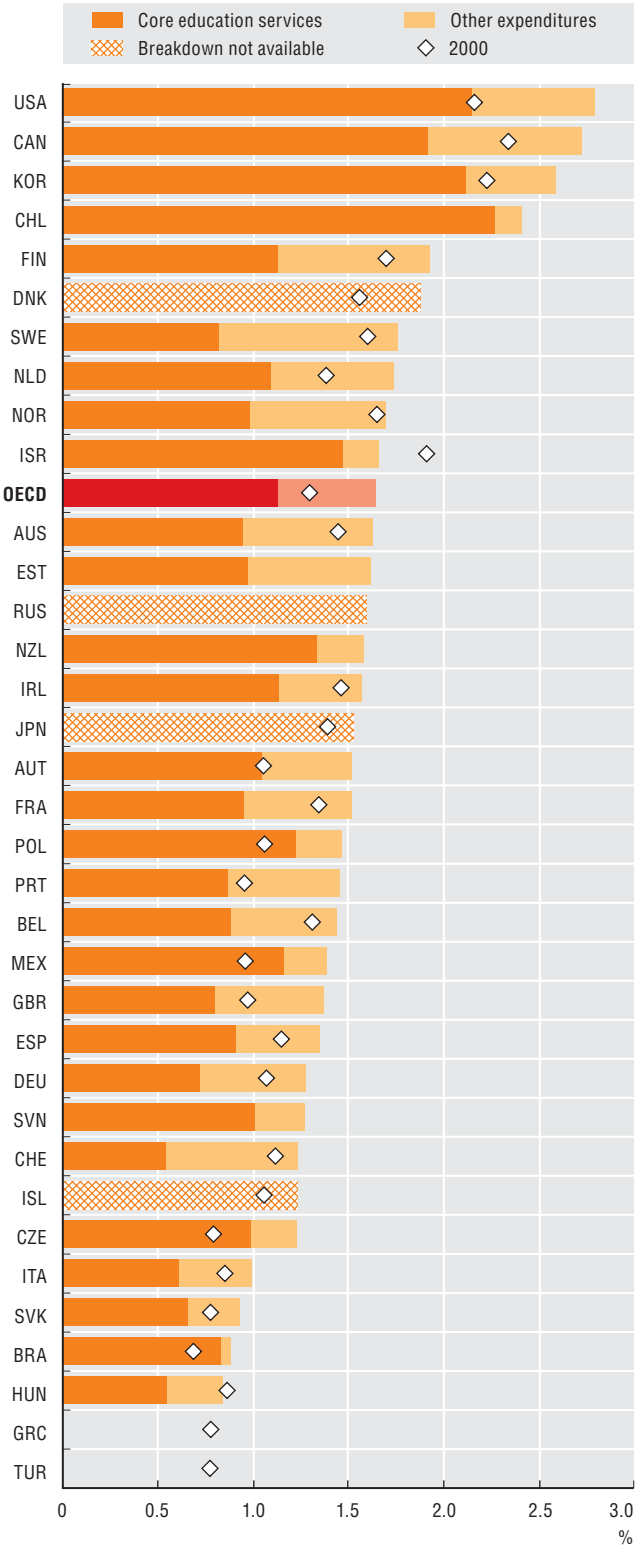
Notes and References

Investment in education, research and innovation generates the knowledge-based capital that makes a key contribution to the productivity and competitiveness of nations. A new experimental indicator identifies the occupations and employment of workers who add to knowledge-based capital. A second set of indicators focuses on the role of education systems in building competencies for innovation and positions countries with respect to the performance of students from a young age and throughout the educational system. There is a special focus on scientific skills, science and engineering degrees and doctorate holders, who are specifically trained for research. Other indicators look beyond the educational system to labour market outcomes, in particular for human resources in science and technology and researchers. Still another set of indicators looks at investment in R&D performed by the business sector, government and higher education. Experimental indicators of public funding "modes" (e.g. institutional versus project funding) are also included. Finally, new estimates of R&D tax incentives are combined with direct funding of R&D to provide a more complete picture of the efforts made by governments to promote business R&D.

1. Investment in knowledge

Spending on higher education, 2000 and 2010

As a percentage of GDP



Source: OECD (2013), *Education at a Glance 2013: OECD Indicators*, OECD Publishing. See chapter notes.

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Education and research, along with innovation, are at the heart of knowledge economies and drive long-term growth. Investments in higher education (HE), R&D and new information and communication technologies (ICT) complement each other, empower human capital and provide the infrastructure needed to address the many challenges that societies face.

The proportion of GDP invested in HE varies substantially across economies, as does the proportion spent on core education services. In 2010 the United States, Canada and Korea invested more than 2.5% of GDP in HE, but most OECD economies invested less than 1.5%. Compared to 2000, almost all economies have seen the share of HE expenditures increase.

From 2001 to 2011, the R&D intensity of the OECD area increased slightly from 2.2% to 2.4% of GDP. This aggregate reflects a highly heterogeneous performance in the years before and after the economic and financial crisis of 2008. Economies as Korea, Portugal and Slovenia experienced an increase in R&D intensity comparable to China's, but R&D intensity declined in Sweden and Canada.

In 2011 the share of ICT investment remained below its top level of 2000 in nearly all OECD economies, confirming the strong pro-cyclical behaviour of these expenditures. In relative terms investment in ICT decreased even more, owing to the drop in spending on equipment, although the software component maintained or slightly increased its weight in GDP. This pattern largely reflects the overall decrease in unit prices for ICT goods, and particularly for products with higher local-service content, such as business software.

Definitions

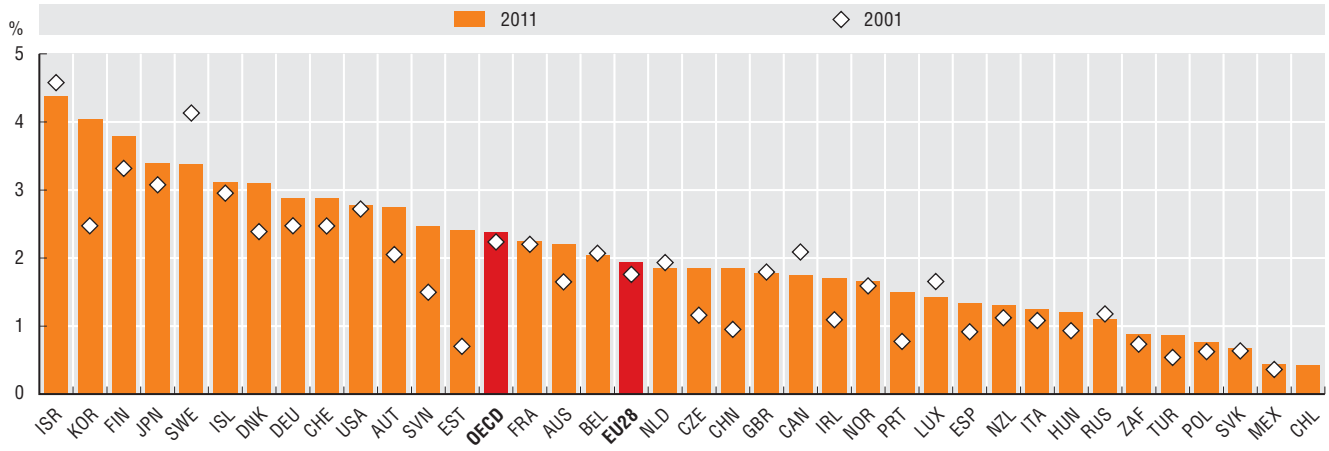
Expenditure on higher education measures spending on educational institutions by governments, enterprises and private individuals. Higher education is the combination of tertiary-type A education (ISCED 5A), tertiary-type B education (ISCED 5B) and advanced research qualifications (ISCED 6). *Core education 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, with R&D defined according to the *Frascati Manual* (OECD, 2002). When reported as a percentage of GDP, GERD denotes the R&D intensity of an economy.

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, 2001 and 2011

As a percentage of GDP



Source: OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

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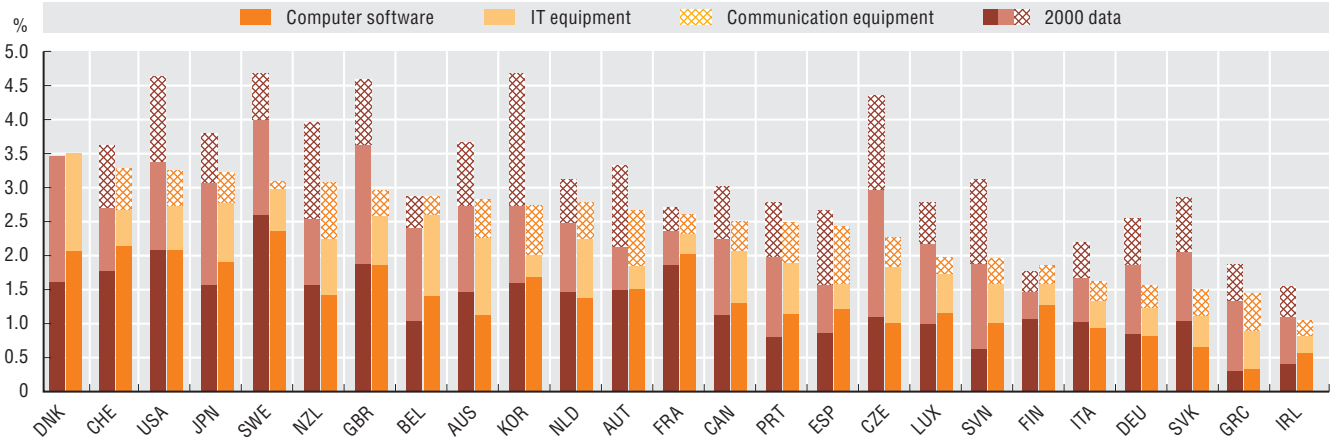
ICT investment by asset, 2000 and 2011

As a percentage of GDP



Source: OECD, based on OECD Annual National Accounts (SNA) Database; Eurostat, EU-KLEMS Database and national sources, July 2013. StatLink contains more data. See chapter notes.

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Measurability

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

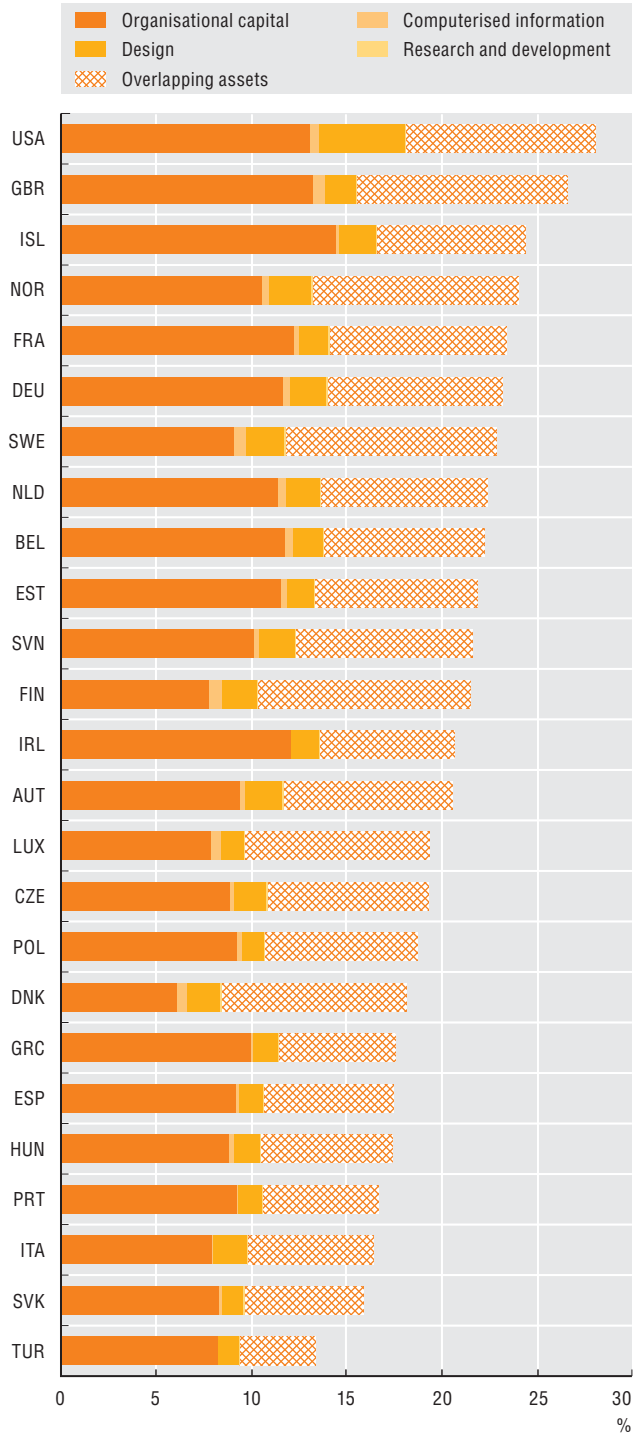
Data on R&D expenditures are collected through surveys of R&D-performing institutions and firms, often complemented by administrative sources. R&D intensities reflect differences in economic structures, as industries vary in their propensity to carry out R&D. Despite common guidelines, national R&D surveys follow different sampling and estimation methods. In small economies, changes in R&D intensity can be overstated by one-off investments in R&D.

Expenditure on ICT products is considered investment in SNA only if these can be physically isolated. This may understate the importance of ICT investment. Measuring investment in software is problematic, as its capitalisation in SNA is recent, methodologies vary, and there are difficulties linked to its acquisition (e.g. rental and licence, embedded in hardware, or developed on own account). Differences in the computation of data on telecom equipment can also affect comparability.

2. Human resources and knowledge-based capital

Knowledge-based capital related workers, 2012

As a percentage of total employed persons



Note: Workers contributing to R&D, design, software and database activities and to firms' organisational knowhow account for between 13% and 28% of total employment in many OECD economies (total length of the bar). Of these workers, between 30% and 54% contribute to more than one type of KBC asset (bar "overlapping assets").

Source: OECD, based on United States Occupational Information Network Database, US Current Population Survey and European Union Labour Force Survey, June 2013. See chapter notes.

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Knowledge-based capital (KBC) is considered extremely important for firms and countries as it relates positively to value added, productivity and competitiveness. It consists of assets lacking physical substance the value of which stems from their knowledge content and lasting nature. Because people are the main source and means to embody such knowledge, human capital plays a key role in generating and accumulating KBC.

The OECD has developed an experimental methodology to identify occupations that contribute to the formation of KBC, in particular organisational capital (OC), computerised information (CI), design, and research and development (R&D). The occupations are selected on the basis of the tasks workers perform on the job, the skills they apply, and the level of knowledge of the subject area they rely on. Several categories of workers are involved in more than one type of KBC; this shows the need to look at KBC in its entirety and to address the relationships (e.g. complementarities) among the different KBC assets.

KBC-related workers account for between 13% and 28% of total employment in many OECD economies. Of these workers, between 30% and 54% contribute to more than one type of KBC asset, and, of these, between 30% to 50% are involved in tasks related to the combination of R&D and CI. In particular, workers involved in CI, i.e. those dealing with software and databases, are to various extents involved in tasks related to all other KBC types considered. OC-related occupations that do not overlap with other assets conversely account for the single largest group of employed persons (6% to 14% of total employment).

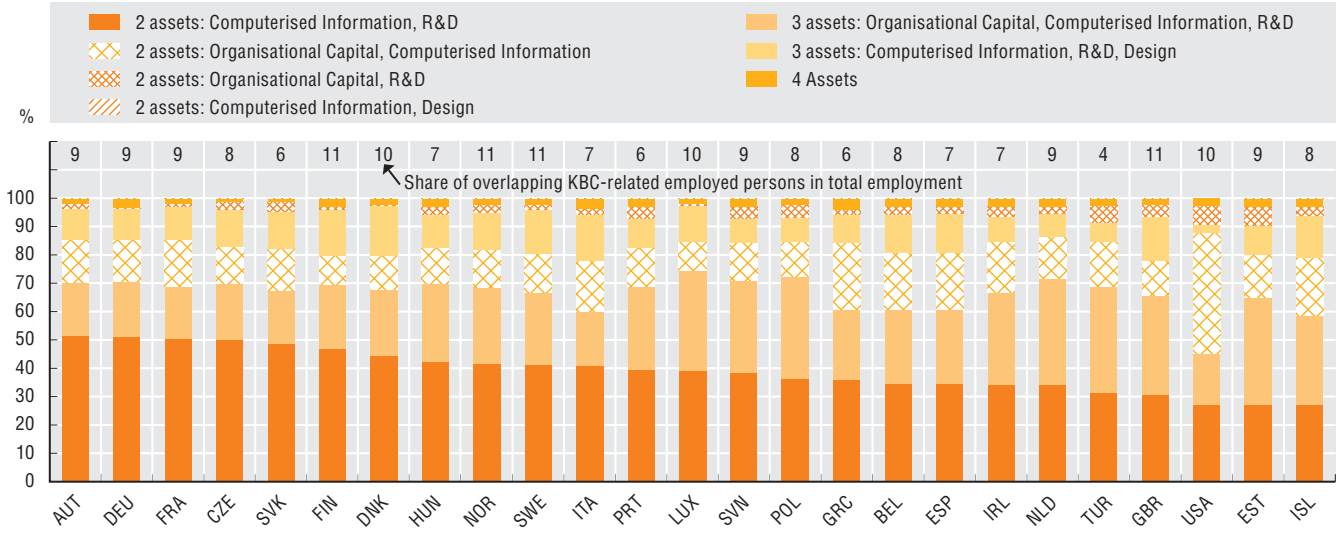
The proportion of KBC-related employment varies more widely in manufacturing (between 12% and 37%) than in services industries (21%-34%). The United States has the most KBC-intensive manufacturing and the Nordic economies have among the most KBC-intensive services. There are differences of up to 11 percentage points between the two industry aggregates. Composition effects, technology intensity, industrial specialisation and differences in the content of occupations may explain these patterns.

Definitions

Four of the 12 assets identified in Corrado et al. (2009) are considered here: CI, R&D, design and OC. *Overlapping assets* refers to occupations contributing to more than one KBC type. Occupations related to KBC are defined on the basis of tasks performed, skills and knowledge areas, using the United States Occupational Information Network (O*NET) Database. Occupations are defined according to the Standard Occupational Classification (SOC, 2010) for the United States and to the latest International Standard Classification of Occupations (ISCO, 2008) for Europe. Figures for *employed persons* refer to employees and self-employed workers for the total economy in 2012.

Workers contributing to more than one activity related to knowledge-based capital, 2012

As a percentage of employed persons related to more than one asset type



Source: OECD, based on United States Occupational Information Network Database, US Current Population Survey and European Union Labour Force Survey, June 2013. See chapter notes.

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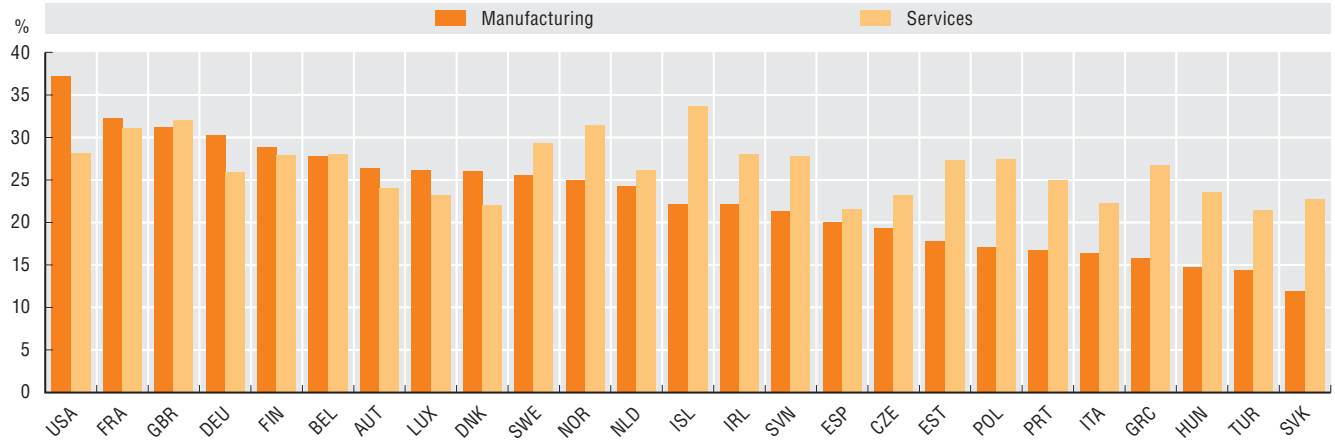
Employment contributing to knowledge-based capital by industry, 2012

As a percentage of all employed persons in the industry



Source: OECD, based on United States Occupational Information Network Database, US Current Population Survey and European Union Labour Force Survey, June 2013. See chapter notes.

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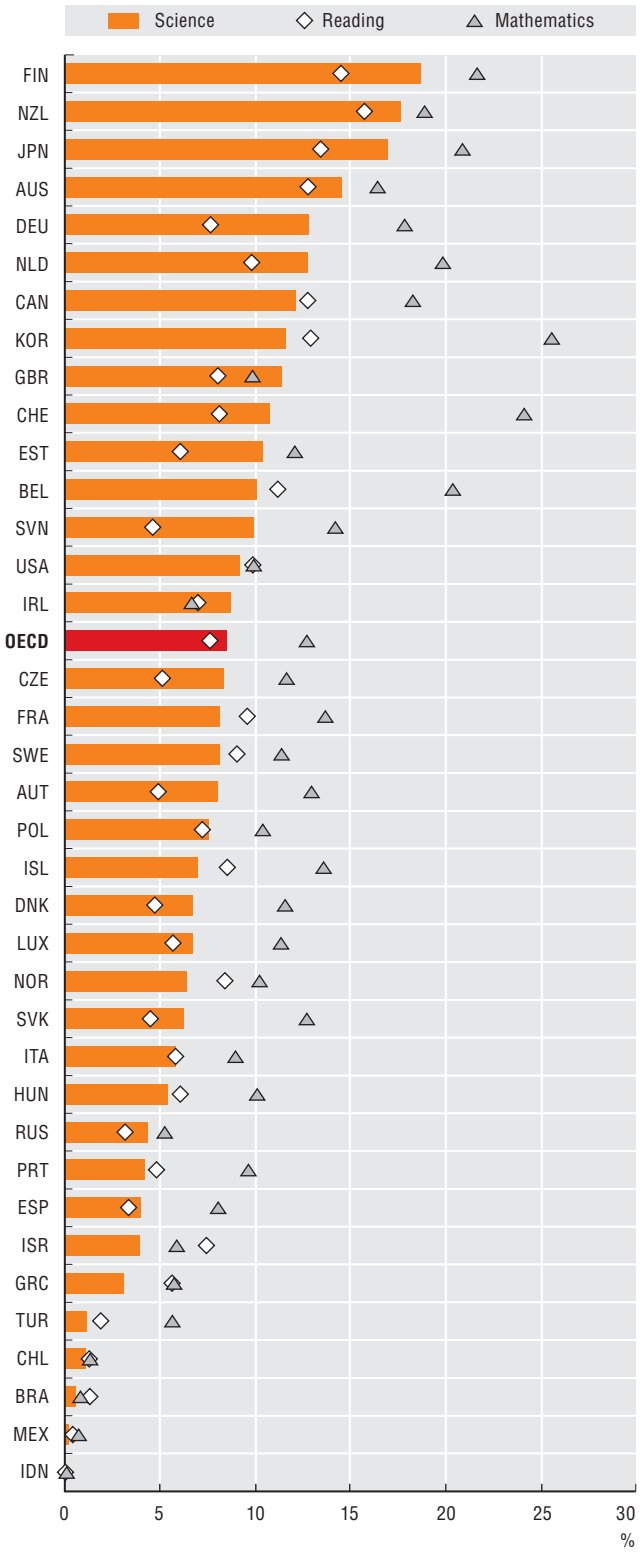
Measurability

KBC-related occupations are identified via cluster analysis and a distribution-based approach (Squicciarini and Le Mouel, 2012) using pooled O*NET data on the importance and level of tasks, skills and knowledge areas of workers. The cross-sectional nature of O*NET does not allow for addressing changes in occupational profiles. The absence of O*NET-type surveys for other countries hinders analysis of country-specific data. Here it is assumed that employees with corresponding occupational titles perform identical tasks in the EU and the United States. The OECD is trying to develop country-specific analysis by using data from the Programme for the International Assessment of Adult Competencies (PIAAC). SOC (2010) occupations are translated into ISCO (2008) 4-digit classes to identify KBC-related occupations for the EU. Small differences in the selection of KBC-related occupations are due to differences in the two classifications. Employment figures for the United States are calculated on Current Population Survey (CPS) data. Employment figures for the EU are based on 3-digit Labour Force Survey (LFS) data and rely on proportions drawn from CPS data.

3. Learning for innovation

Science, reading and mathematics proficiency at age 15, 2009

Percentage of top performers



Source: OECD (2010), *PISA 2009 Results: What Students Know and Can Do: Student Performance in Reading, Mathematics and Science*, Vol. 1, OECD Publishing. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890675

The rapidly growing demand for highly skilled workers has led to global competition for talent. High-level skills are critical for creating new knowledge, technologies and innovation and, as such, are key to economic growth and social development, and top-performing students in reading, mathematics and science are likely to contribute to a country's future talent pool. Results from the 2009 OECD PISA study show that, in the OECD area, 8.5% of students were top performers in science, 7.6% in mathematics and 12.7% in reading. Economies with better performance in mathematics and science often also invest more in R&D. However, Israel has low PISA scores and a high R&D-to-GDP ratio.

The difference between entry rates into university and graduation rates at the qualifying secondary level may be due to factors such as students coming to study from abroad. High tuition fees may discourage qualified candidates from remaining in education while limited employment opportunities may reduce the opportunity cost of higher education. Graduation rates at tertiary level may be low relative to entry rates in countries with longer degrees.

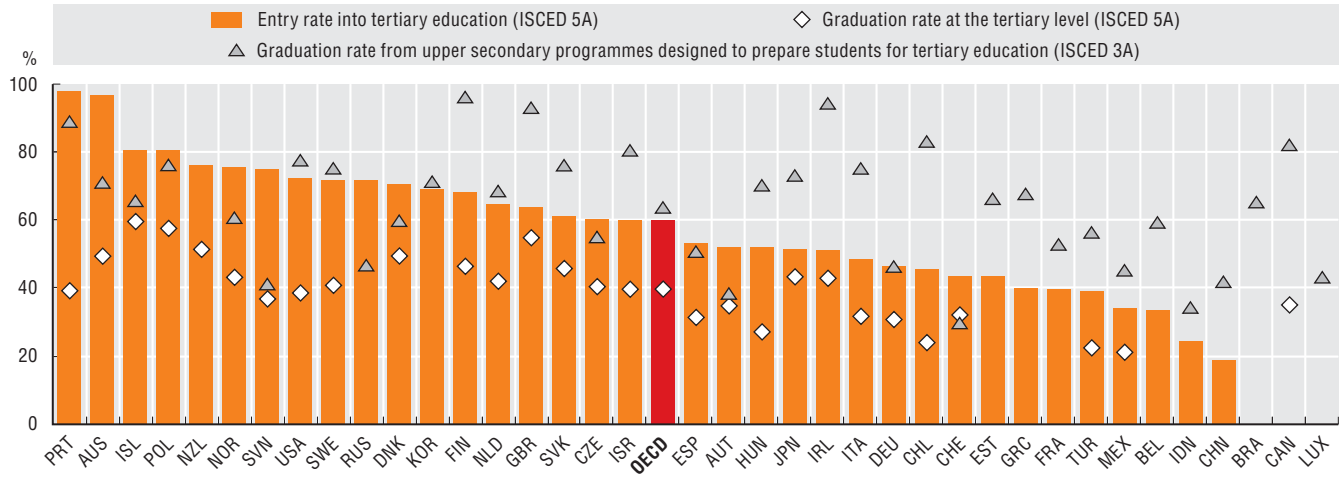
Once in the workforce, individuals often engage in formal adult education or training, sometimes sponsored by their employers. A new indicator from the OECD PIAAC survey shows a consistently positive relation between job-related training and education and the level of workers' skills, in this case proficiency in problem solving in technology-rich (e.g. computer-based) environments. This may reflect decisions by employers to train employees with high potential since much knowledge work is facilitated by the use of ICT.

Definitions

Top performers are students proficient at level 5 or 6 of the PISA assessment in the relevant subject. To attain that level, students need more than 626, 607 or 633 points in reading, mathematics and science, respectively. *University education* denotes tertiary-type A education. *Graduation rates* are the estimated share of an age cohort that will complete the relevant level of education during their lifetime. *Entry rates* represent the proportion of an age cohort that will enter a university programme for the first time in their lifetime. *Job-related education and training* refers to organised, systematic education and training activities to obtain knowledge and/or learn new skills for a current or a future job, and generally to improve opportunities for advancement and promotion. *Problem solving in technology-rich environments* in the PIAAC survey involves testing the ability to use digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks (OECD, 2009).

Transition from upper secondary to graduation at university level, 2011

Graduation and entry rates

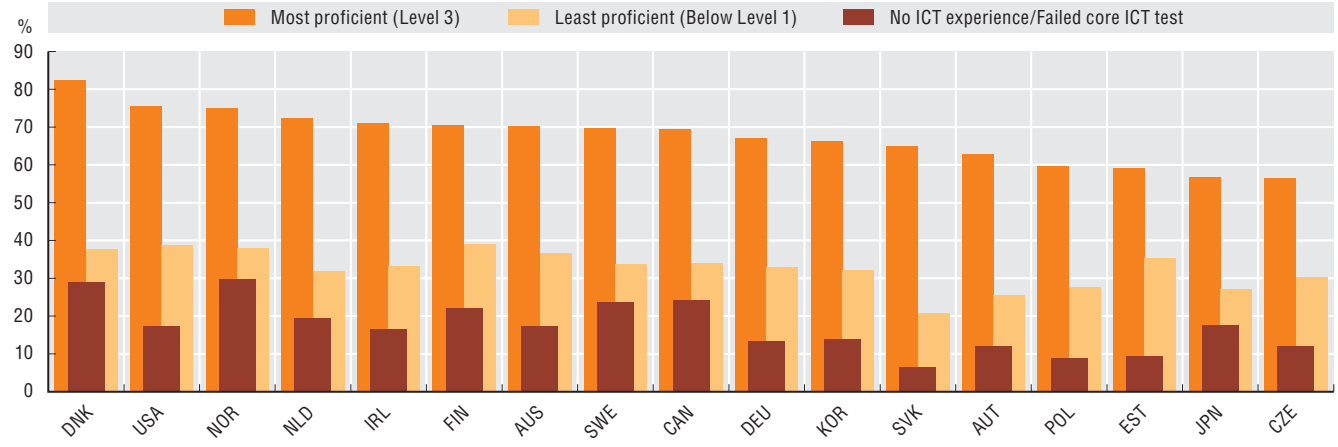


Source: OECD (2013), *Education at a Glance 2013: OECD Indicators*, OECD Publishing. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890694

Participation in job-related education and training by level of problem solving in technology-rich environments, 2012

As a percentage of the adult population at the relevant proficiency level



Source: OECD, Survey of Adult Skills Database, Programme for the International Assessment of Adult Competencies (PIAAC), April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890713

Measurability

The OECD Programme for International Student Assessment (PISA) assesses the extent to which students near the end of compulsory education have acquired key knowledge and skills, with a focus on reading, mathematics and science. The 2009 survey was conducted in 34 OECD and 31 partner economies; 470 000 students aged 15 to 16 participated (OECD, 2010).

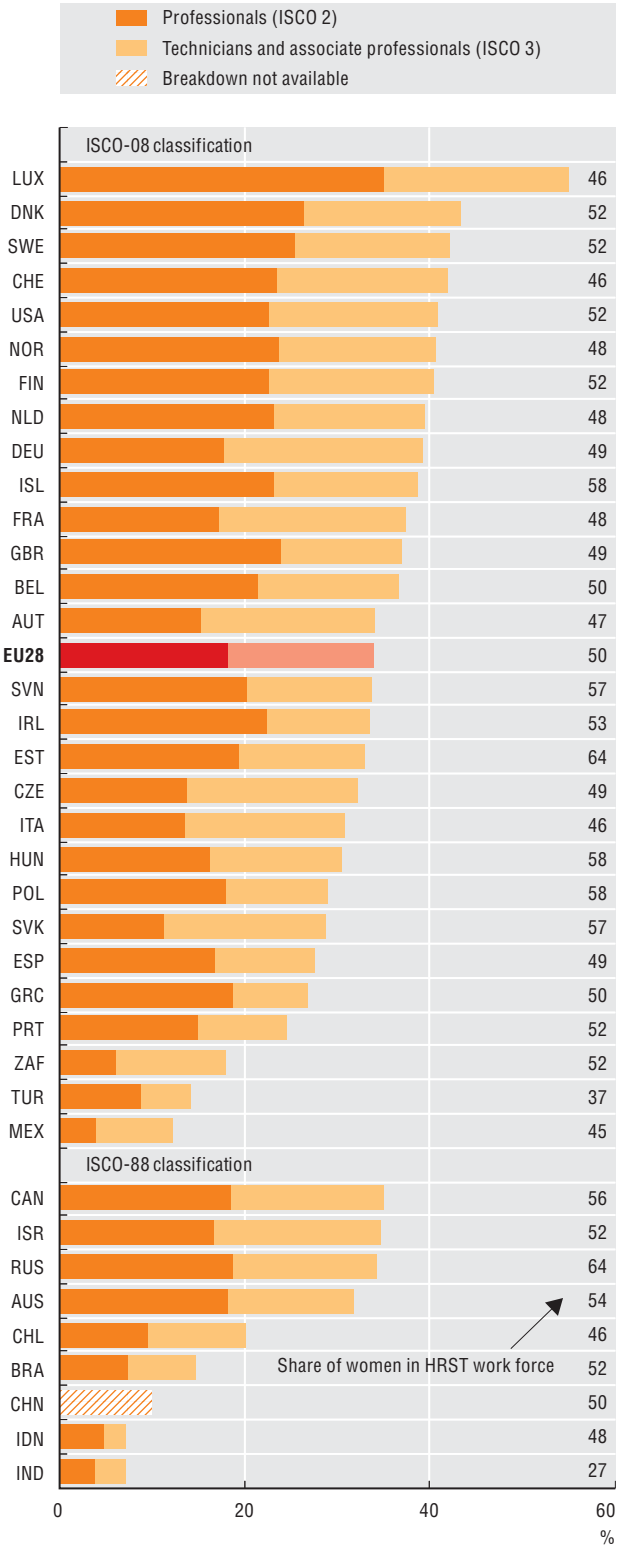
The calculation of graduation and entry rates on a net basis requires information that is not always available. In this case, gross rates, which divide the total number of entrants or graduates by the population at the typical entry or graduation age, are used. In Europe, the Bologna process for harmonising higher education systems may result in limited comparability of education statistics during the transition.

Education and training participation rates are calculated on an adjusted adult population that excludes students who have not completed their first formal cycle of education. Individuals aged 16 to 19 who recently completed or are engaged in short-duration education or training at level ISCED 3C or below, as well as those aged 20 to 24 for ISCED 3A,B,C, are included.

4. Skills for innovation

Professionals and technicians, 2012

HRST as a percentage of total employment



Note: HRST refers to human resources in science and technology.
Source: OECD, based on European Labour Force Surveys, Eurostat, July 2013; ILO Laborsta Database, July 2013; and national sources. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890732

Human resources in science and technology (HRST) play a key role in innovation. In most OECD countries, professionals, associates and technicians – an occupation-based proxy for HRST – represented more than a quarter of total employment in 2010, with an EU average above 30%. In Luxembourg, Denmark, Sweden and Switzerland, over 40% of all employed individuals are in these occupations. The split between professionals and technicians differs across countries.

The industry structure of employment shows that HRST are, in general, a little more prevalent in business sector services than in manufacturing - with differences of about 4 and 7 percentage points in the EU and the United States respectively. In France and Germany, however, shares of these HRST workers are higher in manufacturing than in business sector services while for a few other EU countries, HRST shares in manufacturing are only slightly lower. This partly reflects the skill intensity of manufacturing in these countries, as well as in business sector services which are highly diverse in terms of skills use.

Innovation requires a broad range of capabilities that include but go beyond science and technology. Business surveys can help to identify skills and competencies used by firms and their relation to innovation. New innovation survey data show significant differences in the use of internal or external skills between innovative and non-innovative firms. Innovative firms are more likely to draw not only on skills in engineering and applied science, but also on skills in product design, graphics, advertising, market research, software development and data management.

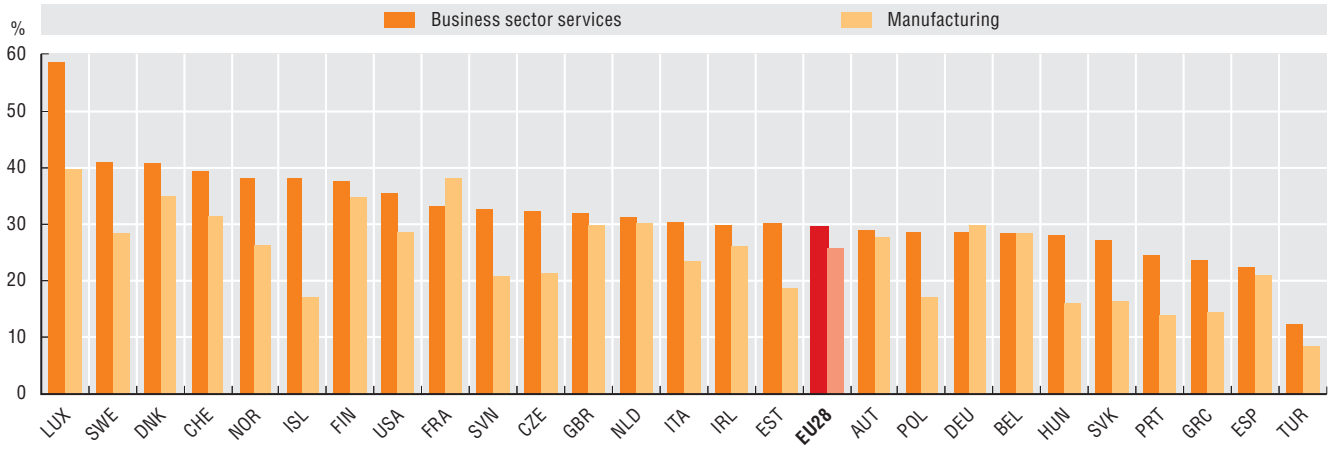
Definitions

Human resources in science and technology (HRST) are defined in the *Canberra Manual* (OECD and Eurostat, 1995) as persons graduated at the tertiary level of education or employed in a science and technology occupation for which a high qualification is normally required and innovation potential is high. In terms of occupational data, HRST comprises *Professionals* (ISCO Group 2) and *Technicians and associate professionals* (ISCO Group 3) in physical and engineering science; life sciences and health; teaching; and other areas.

In line with the *Oslo Manual* definition of innovation (OECD and Eurostat, 2005), *innovative enterprises* engaged during 2008-10 in activities related to the introduction of new products, processes, organisational or marketing methods. Enterprises with ongoing and abandoned activities for product and process innovation are included. *Companies using innovation-relevant skills* are defined as having employed individuals with skills in areas such as product design, software development, database management, or having secured such skills from external sources, such as consultants.

Professionals and technicians in business sector services and manufacturing, 2012

As a percentage of total employment in each industry group

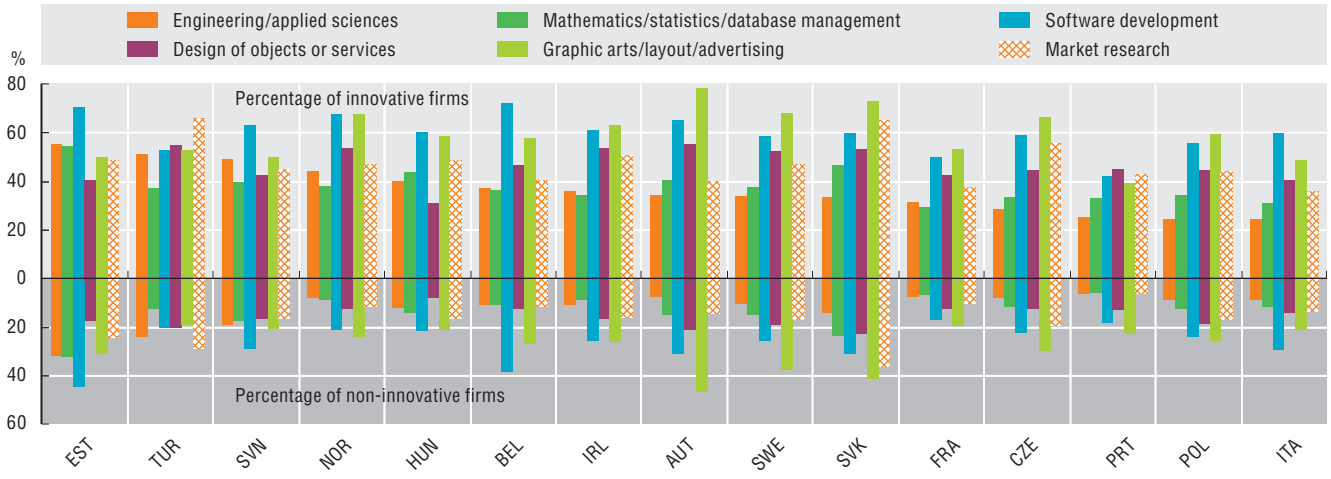


Source: OECD, based on European Labour Force Surveys, Eurostat, June 2013; and US Current Population Survey, March 2012. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890751

Firms using innovation-relevant skills, 2008-10

As a proportion of innovative and non-innovative firms



Source: Eurostat, Community Innovation Survey Database, July 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890770

Measurability

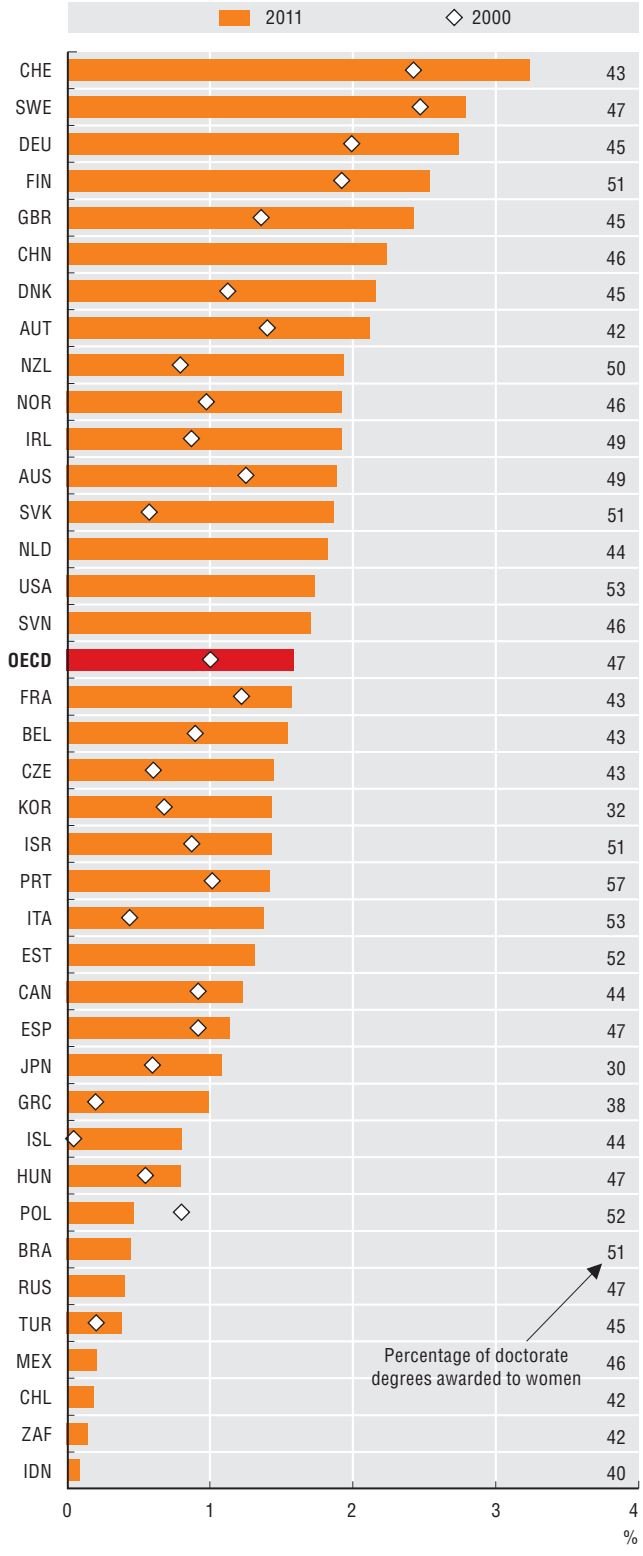
ISCO-08 (International Standard Classification of Occupations 2008) is an international classification designed to produce comparative official statistics. Adopted late in 2007, it replaced ISCO-88 (*www.ilo.org/public/english/bureau/stat/isco/index.htm*). Many countries maintain national classifications that are more detailed and may have different criteria for defining occupations. Converting national classifications to ISCO for comparative purposes may lead to a loss or distortion of information. As the process of adopting the new classification and developing appropriate conversion tables is still under way, the scope for cross-country and longitudinal comparisons is currently reduced.

The primary focus of business innovation surveys is to identify the innovation outcomes and activities of firms, but there is increasing interest in questions concerning firms' innovation capabilities, and innovation-related skills in particular. A voluntary module was introduced in the EU Community Innovation Survey 2010 on firms' internal and external skills and methods used to stimulate new ideas and creativity.

5. New doctorates

Graduation rates at doctoral level, 2000 and 2011

As a percentage of population in the reference age cohort



Source: OECD, based on OECD (2013), *Education at a Glance 2013: OECD Indicators*, and OECD Education Database, July 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890789

Doctoral graduates are key players in research and innovation. They are specifically trained to conduct research and are considered best qualified to create and diffuse scientific knowledge.

While only a small proportion of students obtained advanced research degrees in 2011, doctoral graduation rates increased over the last decade in all countries except Poland. In Switzerland, Sweden, Germany and Finland, they were at least 2.5% of all population in the relevant age cohorts. The increase was proportionally largest in the Slovak Republic and New Zealand.

The growing presence of women in doctoral programmes partly explains the overall increase in doctorates over the past decade. In 2011, women received 47% of the OECD average of doctoral degrees, up from 43% in 2006.

The largest share of new doctorates is in science (25%), followed by health and welfare (20%). Science and engineering degrees combined account for 40% of new doctorates and social sciences and humanities for 36%. There are significant variations among countries in the share of new science and engineering degrees. Science accounts for more than 40% of new doctoral degrees in Iceland, Chile and France. Engineering represents up to one-quarter of new doctoral degrees in Korea and Denmark. Women are under-represented among new science and engineering doctorates but outnumber men in health degrees.

On average over 2007-11, in the United States, China and Germany, some 67 000, 48 000 and 26 000 individuals, respectively, received doctoral degrees. Science and engineering degrees represent more than 50% of the total flow of new doctorates in Chile, France, China, Canada, Ireland, Estonia and Israel.

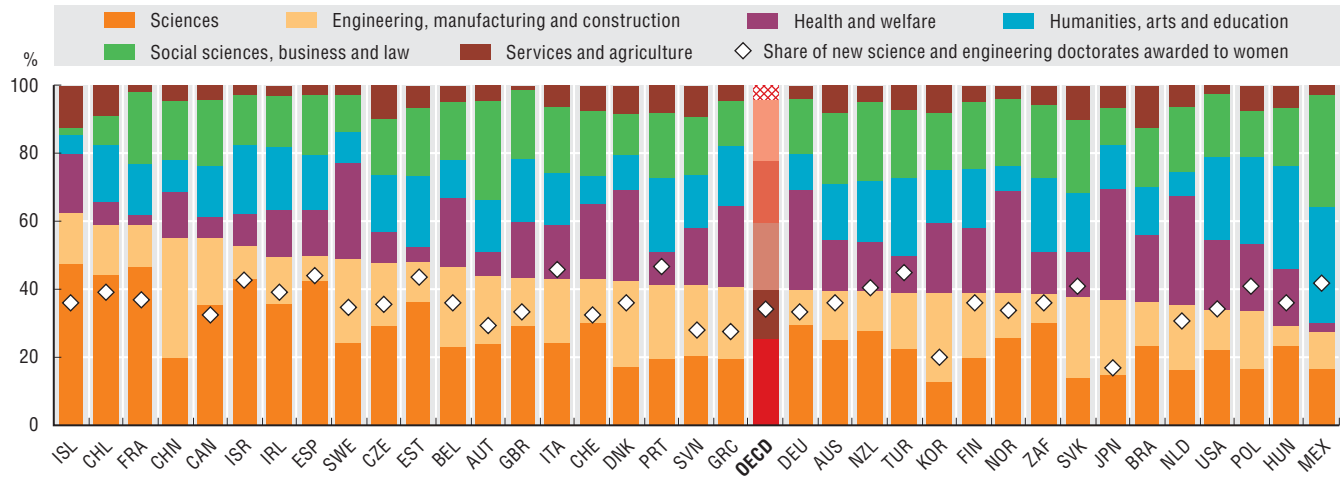
Definitions

Doctoral graduates have attained the second stage of university education and obtained a degree at ISCED-97 Level 6. They have successfully completed an advanced research programme and gained an advanced research qualification, e.g. a Ph.D. or equivalent. The fields of education correspond to those defined in the ISCED-97 classification.

Graduation rates represent the estimated percentage of an age cohort that will complete a given level of education during their lifetime. These are calculated as net graduation rates (i.e. as the sum of age-specific graduation rates). Gross graduation rates are used for countries that are unable to provide more detailed data. The number of graduates, regardless of their age, is divided by the population at the typical age of graduation.

Graduates at doctorate level, 2011

By field of education

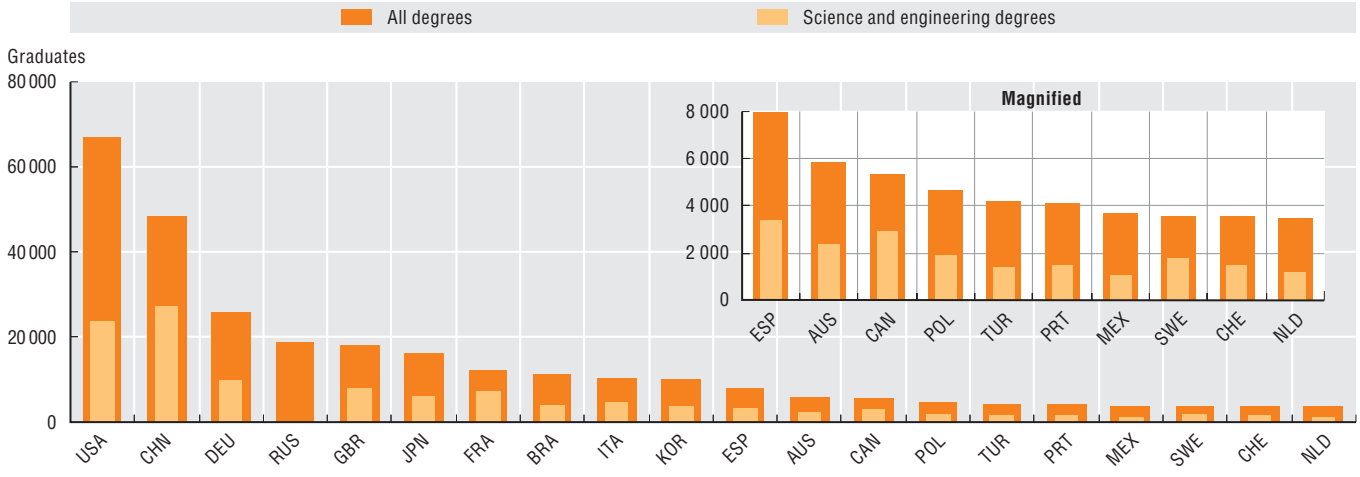


Source: OECD, based on OECD Education Database and national sources, July 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890808

New doctorates in science and engineering, 2007-11

Countries with largest average annual counts



Source: OECD, based on OECD Education Database and national sources, July 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890827

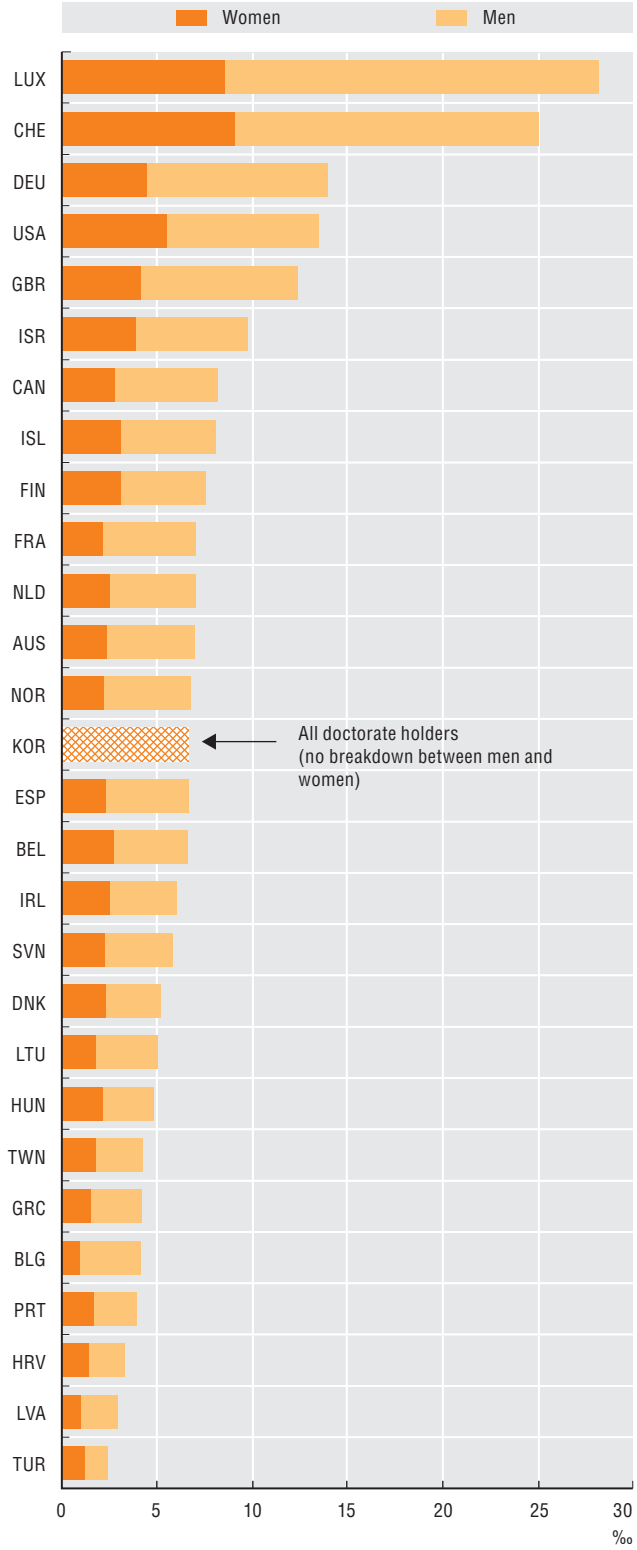
Measurability

Graduation rates 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, and specifically on participation and completion rates for education programmes in more than 60 countries worldwide. A graduate of a programme is defined as a student who has successfully completed all requirements of that programme. Because of national differences regarding what is understood as graduation, the international comparability of "successful graduation" is a major issue. Avoiding double-counting of individuals graduating from several programmes in the same year, or remaining at the same educational level over time, are other measurement challenges.

6. Doctorate holders

Doctorate holders in the working age population, 2009

Per thousand population aged 25-64



Source: OECD, based on OECD/UNESCO Institute for Statistics/Eurostat data collection on Careers of Doctorate Holders 2010; OECD Main Science and Technology Indicators and OECD Education Attainment Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890846

An economy's ability to encourage research affects its capacity to create new knowledge and stimulate innovation. Increasing specialisation and rapid growth in scientific production have made research professionals with advanced research degrees a cornerstone of modern science and innovation systems worldwide. There are marked differences among countries in the share of individuals with doctorates. Luxembourg and Switzerland have the largest shares in the working age population, partly owing to a relatively large share of foreign doctoral graduates. Germany, the United States and the United Kingdom also have high shares of doctoral graduates. The quality of doctoral training and the possibility of rewarding research careers are key factors in explaining these differences. In most countries, women account for less than 40% of the doctoral population, but there are significant differences by field of science.

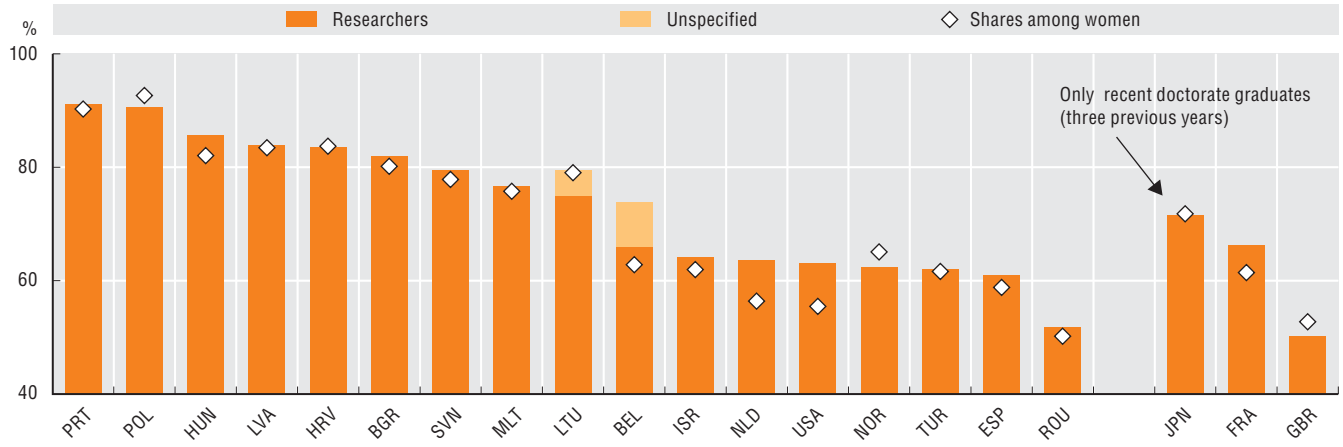
A majority of doctorate holders follow academic careers in higher education. In countries for which data are available, at least 50% work as researchers. While higher education is the main institutional sector of employment for individuals with a doctorate, they are becoming more prevalent in other sectors, particularly in countries with high R&D intensity. Higher education accounts for a variable share of doctorates, from around one-third in the Netherlands, Denmark and Belgium, to nearly four-fifths in Poland and Portugal. The government and business sectors alternate as the second most important share. In Belgium, Denmark and the United States, more than one out of three employed doctorate holders works in the business sector.

Definitions

Doctorate holders are all residents of a country who have completed the second stage of tertiary education (ISCED-97 level 6) leading to an advanced research qualification. *Researchers* are defined as in the OECD *Frascati Manual* (OECD, 2002) as professionals engaged in the conception and creation of new knowledge, products, processes, methods and systems and directly involved in the management of the projects concerned. Employed doctorate holders are allocated to the institutional sectors defined in the *Frascati Manual*. *The higher education sector* may include private and public corporations, as well as private not-for-profit organisations. Similarly, *the business enterprise sector* includes both public and private corporations. In some countries, a considerable fraction of staff in hospitals is included in the *government sector*.

Doctorate holders working as researchers, 2009

As a percentage of employed doctorate holders

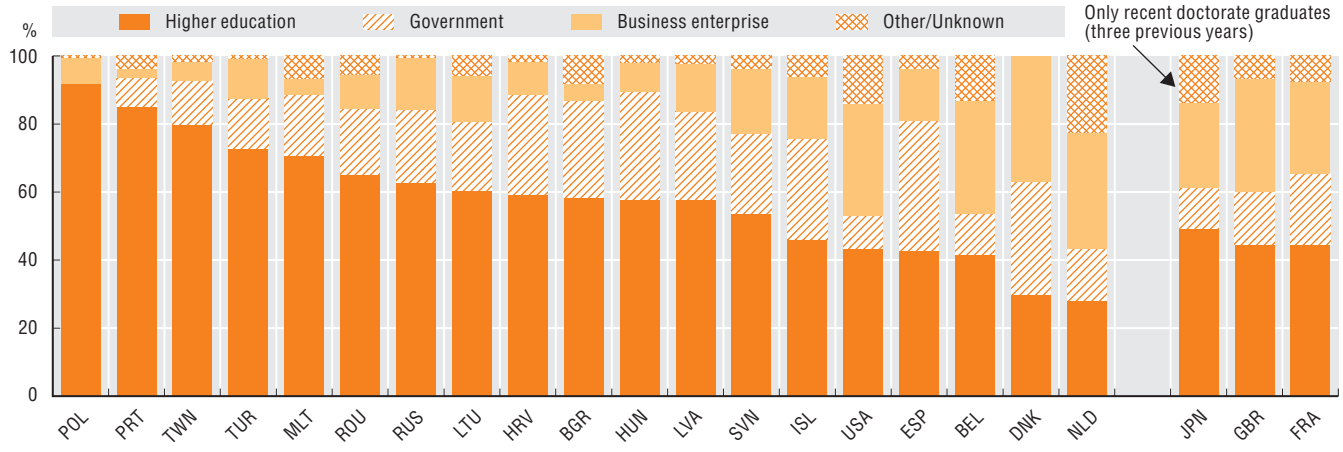


Source: OECD, based on OECD/UNESCO Institute for Statistics/Eurostat data collection on careers of doctorate holders 2010, *www.oecd.org/sti/cdh*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890865

Doctorate holders by sector of employment, 2009

As a percentage of employed doctorate holders



Source: OECD, based on OECD/UNESCO Institute for Statistics/Eurostat data collection on careers of doctorate holders 2010, *www.oecd.org/sti/cdh*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890884

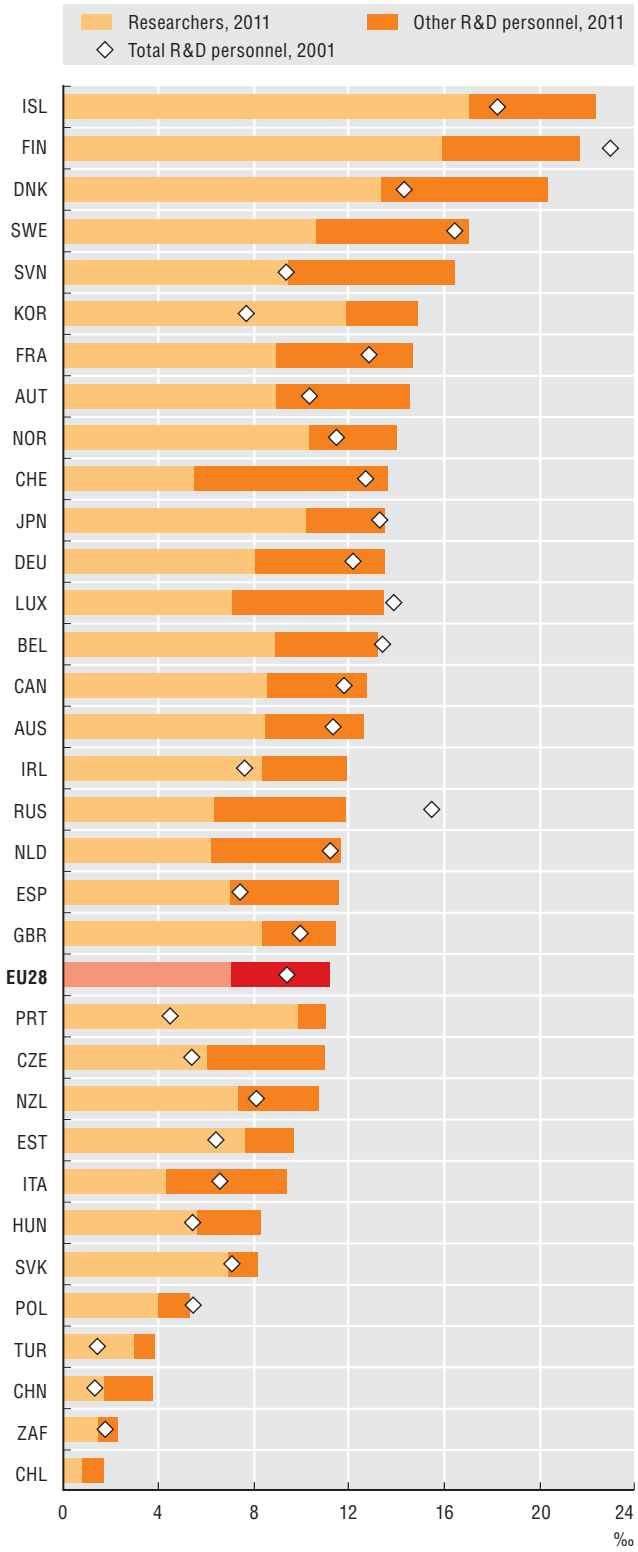
Measurability

The Careers of Doctorate Holders (CDH) project is a joint initiative of the OECD, UNESCO Institute for Statistics and Eurostat to provide empirical evidence on the career path and performance of a population that plays a key role in generating and diffusing new knowledge. The project has developed, with the help of an international expert group, a set of methodological guidelines, a model survey questionnaire and templates for output tables. Owing to the need for comprehensive national registers of doctorate holders, some countries use alternative data sources such as censuses, registers or labour force surveys as the main source. The use of different methodologies may affect the coverage of the target population, the availability of certain variables or the international comparability of the data. For example, data for France, Japan and the United Kingdom are shown for recent doctoral graduates only. The project has used published tables and micro-data to address some of these challenges and to investigate structural issues concerning the careers, mobility, competencies and labour market performance of doctorate holders. For more information see *www.oecd.org/sti/cdh*.

7. Researchers

R&D personnel, 2001 and 2011

Per thousand employment



Source: OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890903

R&D efforts in OECD and key partner economies rely on personnel engaged in R&D activities. The share of R&D personnel in total employment, measured on a full-time equivalent (FTE) basis, exceeds 2% in Iceland, Finland and Denmark, about twice the EU average of 1.1%. 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 share of researchers in total R&D personnel varies widely, from 90% in Portugal to 40% in Switzerland.

The business enterprise and the higher education sectors are the main employers of researchers. The former leads the latter in more than half of countries reporting estimates, and its share is above 60% in Korea, Japan, Austria, China, Denmark and Sweden. The sectoral distribution of researchers and R&D expenditures reveals that higher education is more researcher-intensive, owing to sectoral differences in the relative importance of non-labour costs such as investment in R&D equipment. Higher education institutions account for more than a third of researchers in a majority of countries.

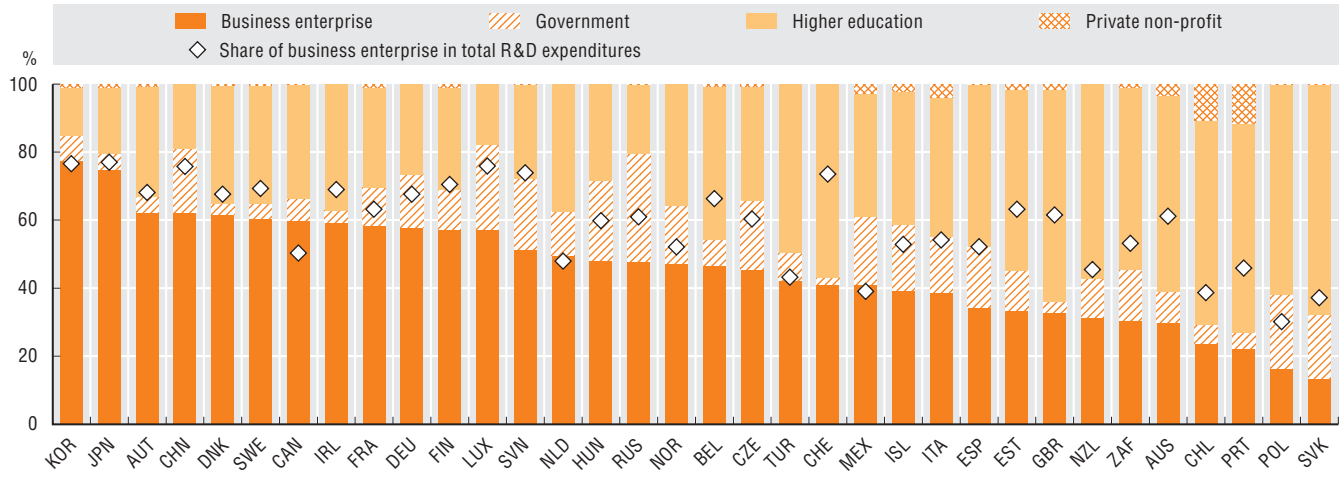
Among countries for which data are available, the share of women in the researcher population ranges from nearly 45% in Portugal, the Slovak Republic and Estonia to less than 20% in Luxembourg and Germany. Higher education is the main employer of female researchers, except in Denmark and Sweden, where a majority work in the business sector.

Definitions

Research and development personnel includes all persons employed directly in R&D activities and therefore covers 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 0.5 person year in 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 the OECD National Accounts.

Researchers by sector of employment, 2011

As a percentage of total researchers, full-time equivalent

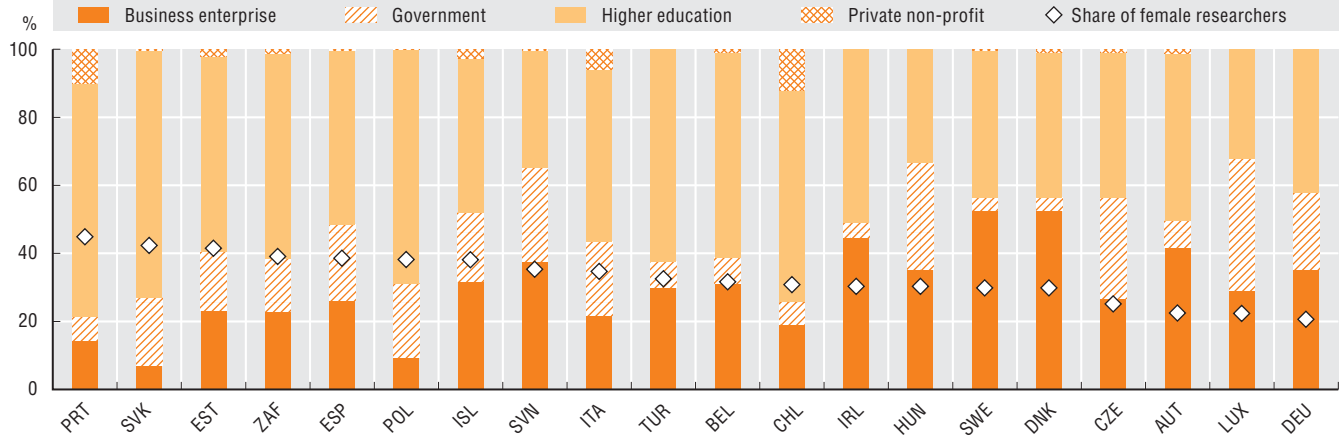


Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890922

Female researchers by sector of employment, 2011

As a percentage of female researchers, full-time equivalent



Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890941

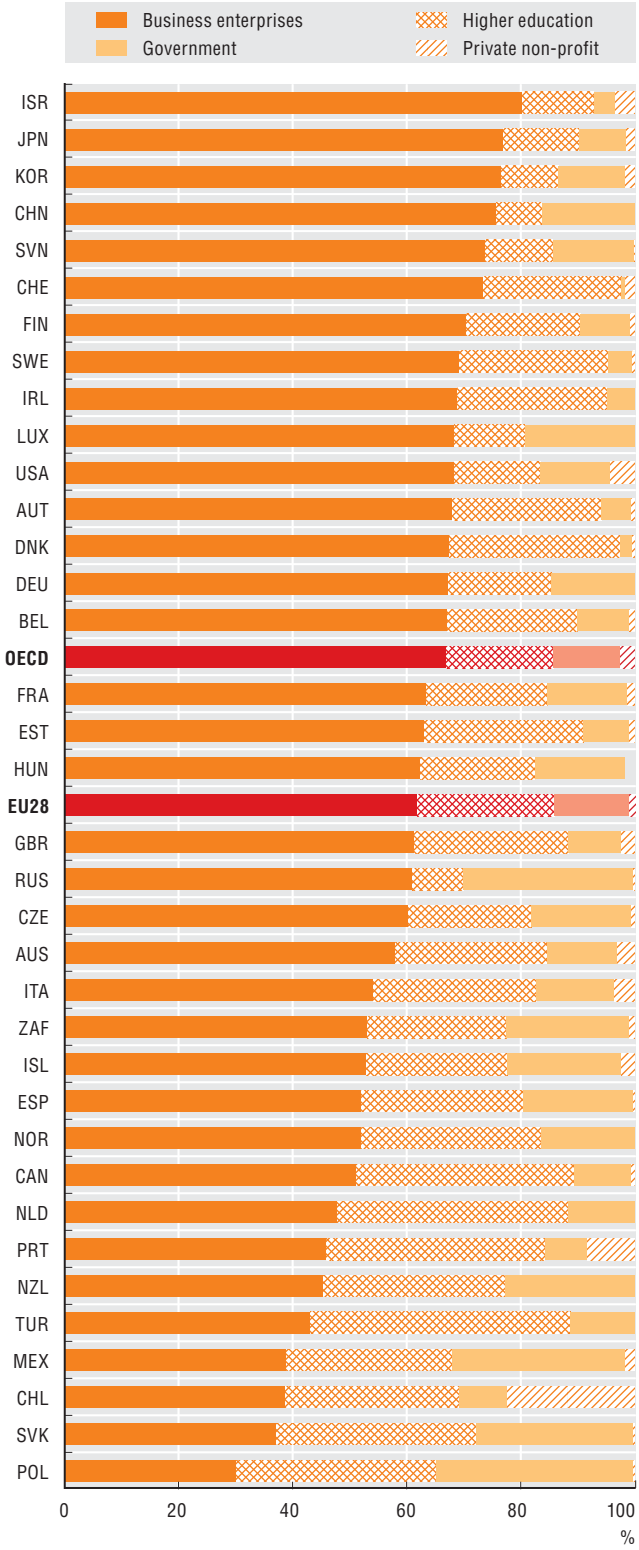
Measurability

Production of internationally comparable estimates of R&D personnel is fraught with difficulties. These are a focus of attention for the current revision of the *Frascati Manual* (OECD, 2002). 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 the higher education sector, as many researchers typically engage in other activities, such as teaching or administrative tasks, some of which are at the boundary of R&D. In the business sector, staff providing information on financial resources have difficulty answering questions on R&D personnel, so that questionnaires need to be shared with human resource departments with limited information on the nature of R&D projects. At present, no reliable up-to-date estimates on R&D personnel and its components are available for a number of OECD countries.

8. R&D

R&D expenditure, by performing sectors, 2011

As a percentage of gross domestic expenditures on R&D



Source: OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932890960

Expenditure on research and development (GERD) is one of the most widely used measures of innovation input. The sectoral structure of the R&D performed in a country can be particularly revealing of the relative strengths and weakness of its innovation system. The business sector accounts for the largest share of R&D performed in most economies and for 67% in the OECD area. Israel's business sector makes the largest contribution to GERD, with nearly 80% of total R&D; it is closely followed by Japan and Korea. Higher education R&D accounts for nearly 17% of total OECD GERD.

At nearly 12%, government plays a relatively minor role as performer of R&D. However, it is a major funder of R&D performed in the higher education and business sectors. Direct government funding of R&D performed in the business sector includes grants and payments for R&D contracts for public procurement. Government funds nearly 9% of R&D performed by business in the OECD area, up from 7% in 2001.

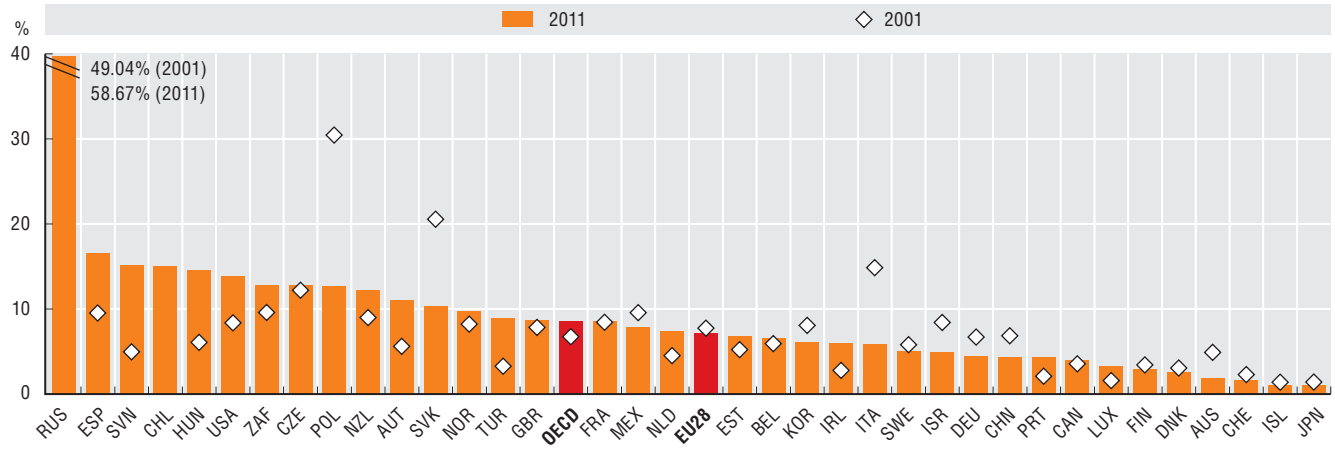
Sectoral differences in R&D performance tend to be reflected in the type of R&D conducted. In China and Israel, for example, most R&D efforts are directed to experimental development, while Chile, Slovenia and Italy give relatively more weight to basic and applied research. With relatively few exceptions, the balance between research and development has not markedly changed over the 2001-11 period.

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). R&D covers three *types of activities*: *Basic research* is experimental or theoretical work undertaken to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application in view. *Applied research* is directed towards a specific practical aim or objective. *Experimental development* is systematic work, drawing on research and/or experience, which is directed to producing new goods or services or improving substantially those that exist. *Government-funded business R&D* is the component of R&D performed by business enterprises which they attribute 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.

Direct government funding of business R&D, 2001 and 2011

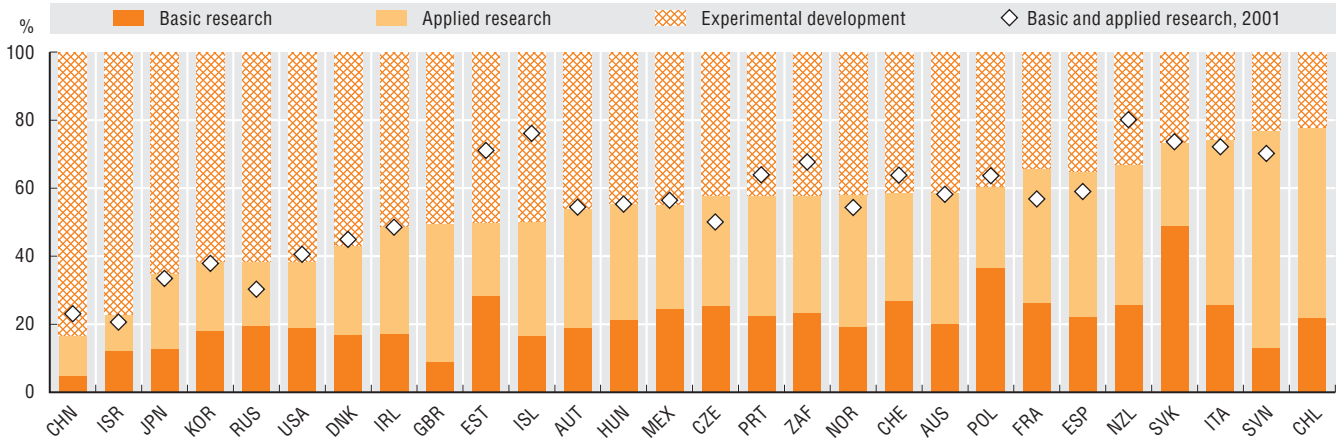
As a percentage of R&D performed in the business sector



Source: OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932890979*

Gross expenditures on research and development, by type of R&D, 2001 and 2011



Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932890998*

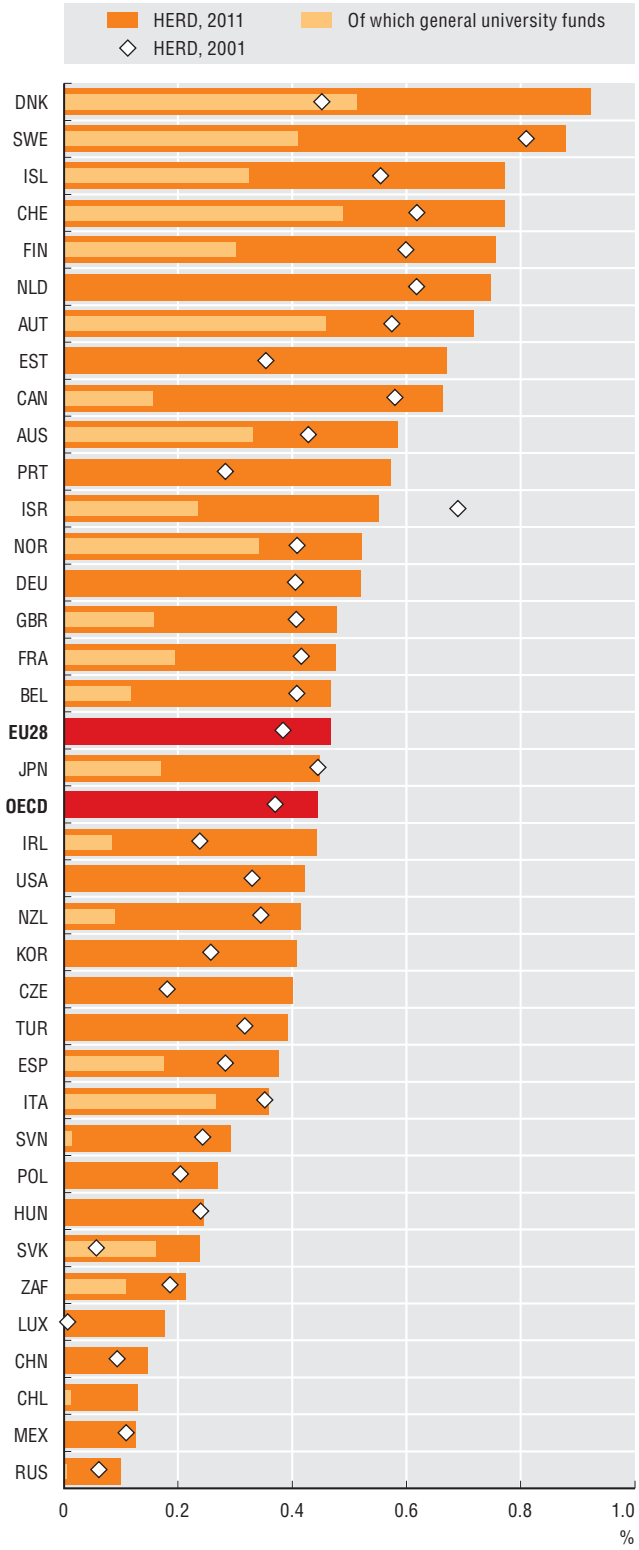
Measurability

Institutions that perform R&D are often located at the boundaries of categories within traditional classification systems. For example, university hospitals or research institutes that cannot be unequivocally assigned to government, higher education or business require judgement by national authorities that collect and report national R&D data. The OECD *Frascati Manual* provides a decision tree to minimise the likelihood of classifying institutions with similar functions in different sectors. It also provides guidance on separating R&D activities (basic and applied research and experimental development) from other innovation or S&T-related activities. For some countries, data by type or character of R&D are available for current as opposed to total expenditures, or are only available for some institutional sectors. The identification of flows of funds requires a direct transfer of resources for the performance of R&D by a given unit. The existence of subcontracting and intermediaries challenges the identification of the ultimate source of funds. The guidance contained in the *Frascati Manual* is currently being revised by the OECD; see *www.oecd.org/sti/frascatimanual*.

9. Higher education and basic research

Higher education expenditure on R&D, 2001 and 2011

As a percentage of GDP



Source: OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932906293

Most basic research is performed in universities and in public research organisations. Total higher education spending on R&D (HERD) accounts for 0.4% of GDP in the OECD area and has increased in most countries over the last decade. Denmark and Sweden have the highest research intensities in the higher education sector at close to 0.9% of GDP. HERD intensity in Denmark, Estonia, the Czech Republic, the Slovak Republic and Portugal has nearly doubled over the last decade.

Governments rely on two main modes of direct R&D funding: institutional and project-based. Institutional funding can help ensure stable long-run research funding, while project-based funding can promote competition and target strategic areas. This distinction is addressed by an experimental indicator on modes of public funding for the higher education sector. Results differ widely and reflect the institutional settings of countries' research systems. In Denmark, Israel, New Zealand, Austria and Germany, institutional funding is the principal mode, while Belgium and Korea rely mainly on project funding.

On average, units in the government and higher education sector perform more than three-quarters of all OECD basic research. The higher education sector's contribution to basic research ranges from 80% in Denmark to approximately 20% in Korea, the United Kingdom and the Russian Federation. The government sector's contribution to basic research is largest in the Russian Federation, followed by the Czech Republic, the Slovak Republic, Hungary and China.

Definitions

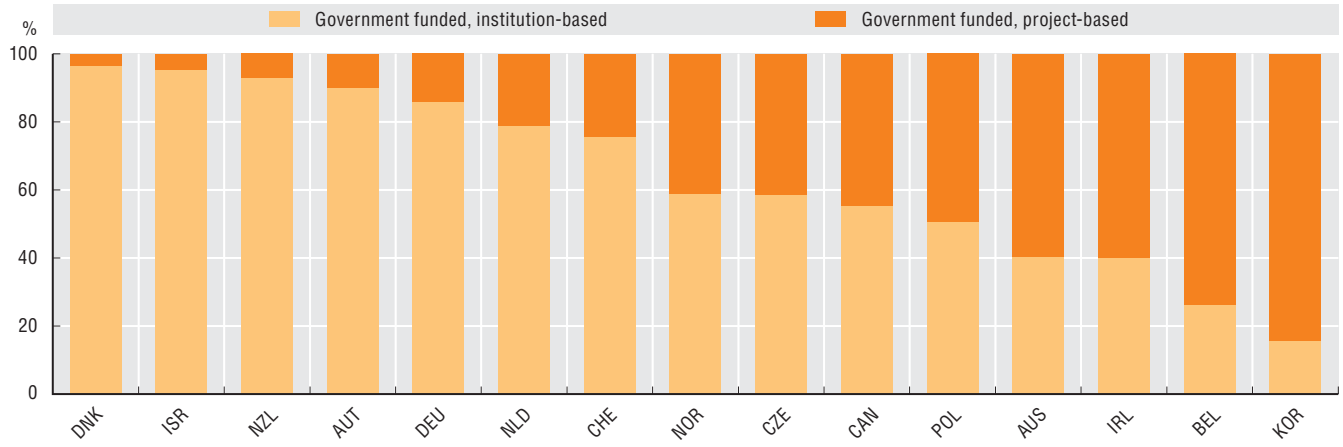
The *higher education sector* comprises universities and other tertiary education institutions, independently of their sources of finance or legal status. It also includes research institutes, experimental stations and clinics operating under the direct control or in association with higher education institutions.

Project R&D funding is defined as funding attributed on the basis of a project submission by a group or individuals for an R&D activity that is limited in scope, budget and time. *Institutional R&D funding* is defined as the general funding of institutions with no direct selection of R&D projects or programmes.

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.

Government funding of R&D in higher education, by type of funding, 2010

As a percentage of national funding of domestic R&D

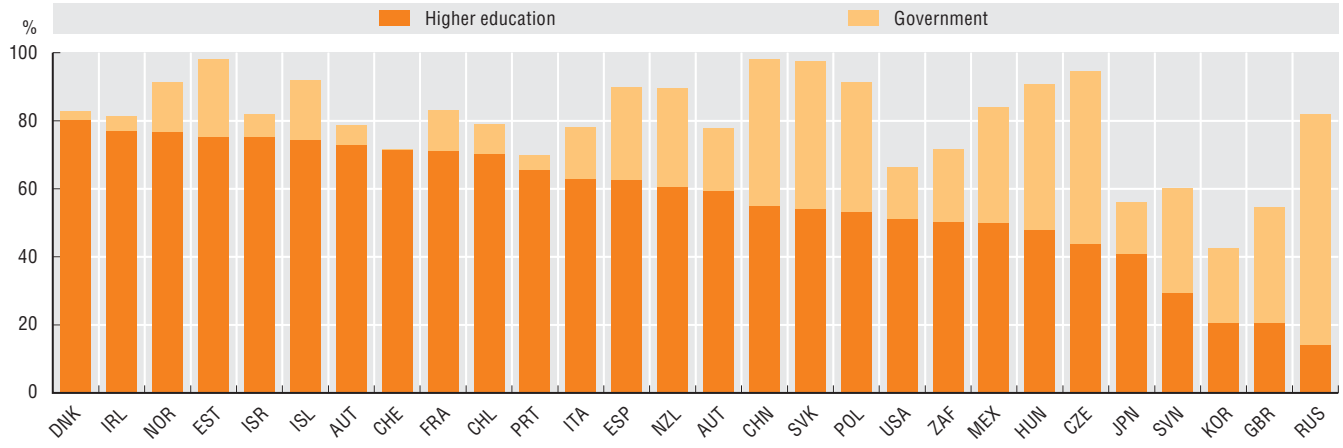


Note: This is an experimental indicator. International comparability is currently limited.
Source: OECD, based on data collected from national authorities in 2010 and 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891017

Basic research performed in the higher education and government sectors, 2011

As a percentage of domestic expenditures on basic research



Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891036

Measurability

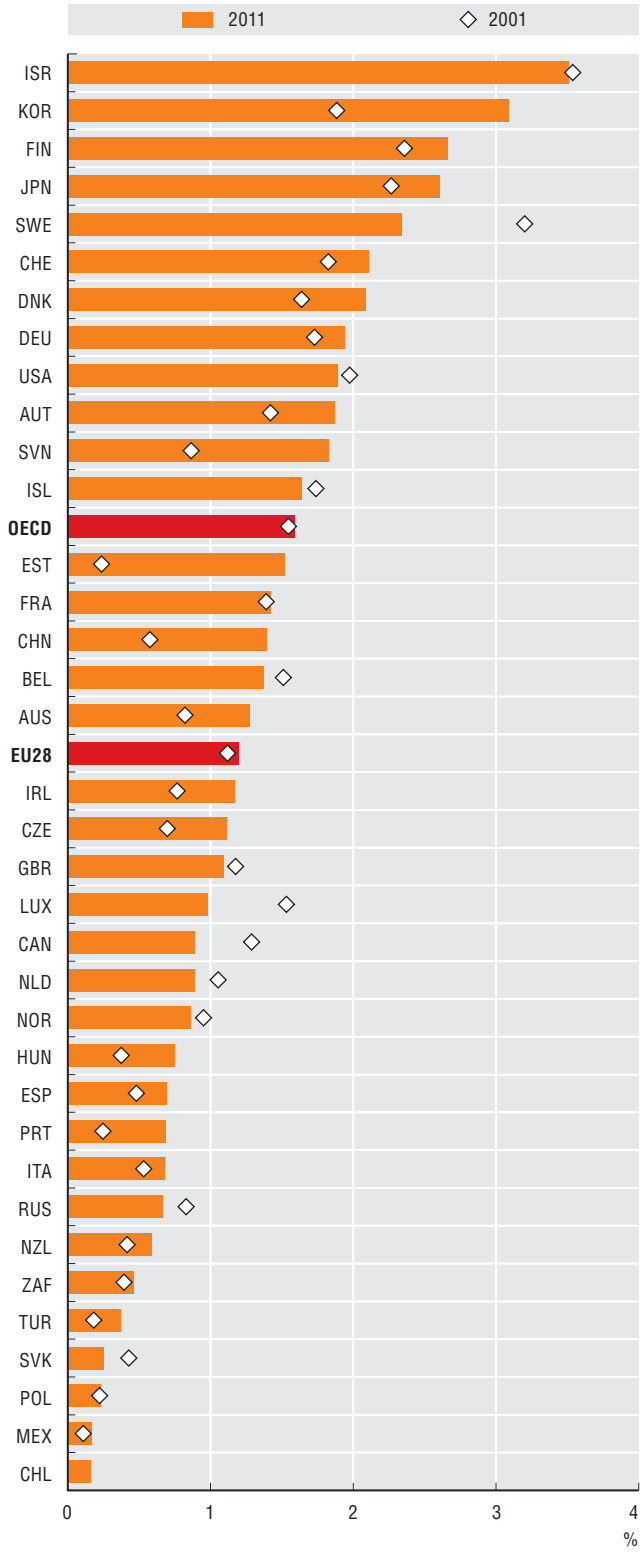
The *higher education sector* is not a formal sector in the System of National Accounts (SNA). It is separately identified by the OECD and other organisations because of the important and specific role played by universities and related institutions in the performance of R&D and the training of researchers (doctorates and other research degrees). Measurement of higher education R&D (HERD) relies on dedicated institutional surveys in most OECD countries, and it is particularly sensitive to institutional differences that influence the data that universities and departments are able to provide.

Project-based funding to higher education includes national R&D contracts, while *institutional funding* to higher education includes general university funds (GUF) and other institutional funds. The OECD project on modes of public funding of R&D has been developing new indicators by exploiting existing budget data. As part of the ongoing revision of the *Frascati Manual*, a number of options for updating recommendations are being considered in order to improve the measurement of higher education R&D and government funding of R&D across the whole economy.

10. Business R&D

Business enterprise expenditure on R&D, 2001 and 2011

As a percentage of GDP



Source: OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891055

Business enterprise expenditure on research and development (BERD) is an important driver of innovation and economic growth. During the last decade, business R&D in the OECD area grew steadily from 1.55% of GDP in 2001 to a peak of 1.63% in 2008 and declined slightly to 1.59% in 2011. BERD intensity rose significantly in Estonia, Korea, Slovenia and China, but declined in Canada, Luxembourg, the Slovak Republic and Sweden.

A country's R&D is generally concentrated in a limited number of large firms. In some countries, however, small and medium-sized firms (SMEs) account for a significant share of the total business R&D effort. This may be due to a relatively large body of SMEs or to SMEs that perform a large amount of R&D (such as specialised R&D units that are part of a larger group). The share of SMEs in total BERD ranges from more than two-thirds in Estonia and New Zealand, to around 10-15% in the United States and Germany, to less than 5% in Japan.

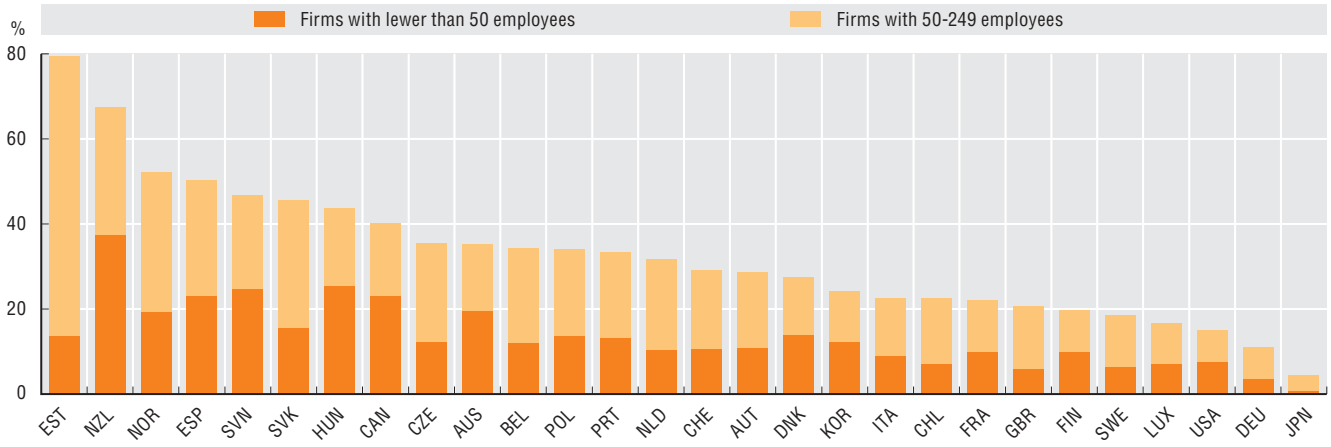
Foreign-controlled affiliates also play an important role in domestic R&D. In 2009-10 they accounted for more than one-fifth of total business R&D in most OECD countries for which data are available, and in some smaller open economies, their share exceeded half of BERD, reaching 62% in Israel and almost 70% in Ireland. However, for the two OECD economies with the largest volume of BERD, the share of foreign affiliates is relatively low: 14.8% in the United States and 6.3% in Japan.

Definitions

Business enterprise expenditure on R&D (BERD) covers R&D activities carried out in the business sector by performing firms and institutes, regardless of the origin of funding and is arguably most closely linked to the creation of new products and production techniques. According to the *Frascati Manual* (OECD, 2002), the business enterprise sector includes "all firms, organisations and institutions 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". The term "foreign affiliate" refers to affiliates under foreign control; the geographical origin of a foreign affiliate is the country of residence of the ultimate controller. An investor (company or individual) is considered to be the investor of ultimate control if it is at the head of a chain of companies and controls directly or indirectly all the enterprises in the chain without itself being controlled by any other company or individual. The notion of control implies the ability to appoint a majority of administrators empowered to direct an enterprise, to guide its activities and determine its strategy.

Business R&D by size class of firms, 2011

As a percentage of R&D performed in the business sector

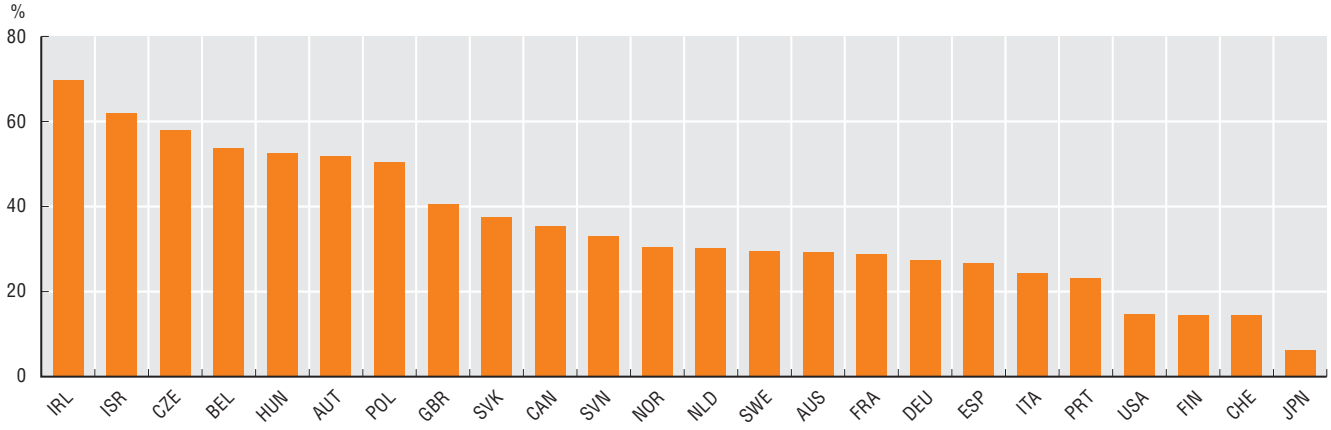


Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932891074*

R&D expenditures incurred by foreign-controlled affiliates, 2009

As a percentage of R&D performed in the business sector



Source: OECD, Activity of Multinational Enterprises Database, *www.oecd.org/sti/ind/amne.htm* and Eurostat Inward FATS Database, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932891093*

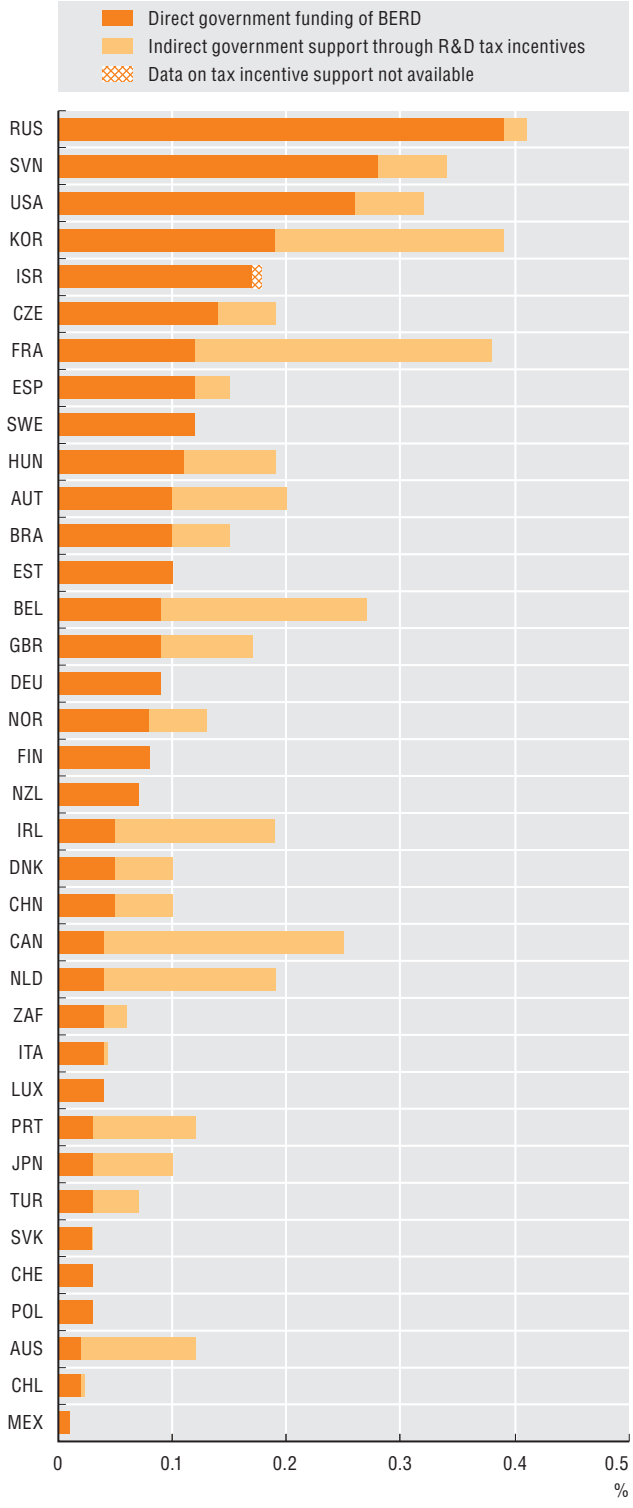
Measurability

The comparability of BERD data over time may be affected by a number of factors, including changes in survey methods, notably the sectoral extension of survey coverage and the reclassification of units to/from the business sector. In order to identify new and occasional R&D performers, countries generally construct a register of known performers which is updated regularly with the use of different sources. These vary among countries and include official business registers, other business surveys (e.g. innovation), administrative information (e.g. data on grants or tax credits, patents), or publicly available sources (e.g. media announcements, company databases). There are some concerns regarding the comparability of BERD data, as firms face growing challenges for reporting their intramural R&D expenditures adequately in BERD surveys owing to differences in their internal accounting systems and other frameworks (e.g. R&D tax credits) and the complexity of their R&D sourcing strategies (e.g. joint projects, outsourcing, on/off-site consultants, intra-firm transfers). These issues are being addressed as part of the ongoing revision of the *Frascati Manual*.

11. R&D tax incentives

Direct government funding of business R&D and tax incentives for R&D, 2011

As a percentage of GDP



Note: This is an experimental indicator. International comparability may be limited. For more information, see *www.oecd.org/sti/rd-tax-stats.htm*.
Source: OECD, based on OECD R&D tax incentives questionnaire, publicly available sources, and OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891112

In addition to providing grants, contracts and loans, many governments contribute to business R&D through tax incentives. In 2013, 27 OECD countries gave preferential tax treatment to business R&D expenditures. In 2011, the Russian Federation, Korea, France and Slovenia provided the most combined support for business R&D as a percentage of GDP. R&D tax credits were worth USD 8.3 billion in the United States, followed by France and China.

Over 2006-11, the importance of tax incentives *vis-à-vis* direct support increased in 11 out of 23 countries for which complete data are available. Their share of support fell in many countries owing to the crisis-driven decline in business R&D. Mexico and New Zealand abolished their tax incentives but Finland introduced them in 2013. Falling profits at the outset of the economic crisis also reduced firms' ability to claim incentives.

National differences in the cost of R&D tax incentives reflect eligibility rules and their use by firms, which depends not only on R&D spending but also on profitability. Effective tax subsidy rates are influenced by business characteristics. Australia, Canada, France, Japan, Korea, the Netherlands, Norway and Portugal give more generous treatment to SMEs relative to large firms. Some countries allow firms to benefit from tax incentives when they are not profitable enough to use them in the current period, but few do so to a significant extent. In Austria and Norway, refunds by authorities effectively allow such firms to benefit from incentives as if they were profitable. Refunds and carry-forward provisions are sometimes used to promote R&D in firms that could not otherwise use their credits or allowances. Such provisions tend to be more generous for SMEs and younger firms, as in Australia, France and the United Kingdom.

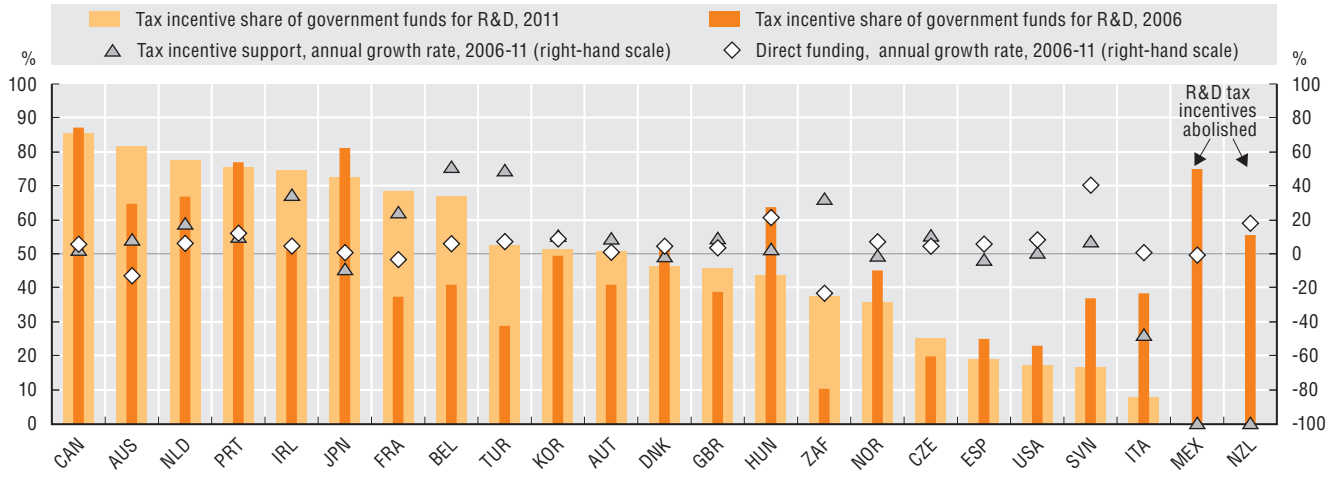
Definitions

Tax incentives for business R&D expenditures include allowances and credits, as well as other forms of advantageous tax treatment such as allowing for the accelerated depreciation of R&D capital expenditures. Estimates here exclude income-based incentives – preferential treatment of incomes from licensing or asset disposal attributable to R&D or patents – and incentives to taxpayers other than companies. Figures refer to incentives applied at a national level through corporate income taxes, employer social security contributions and withholding taxes for R&D personnel. Personal and consumption tax incentives are not included. While typically non-discretionary, some countries require pre-approval of R&D projects or accreditation by government agencies or third parties.

The tax subsidy rate is 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).

Change in government support for business R&D through direct funding and tax incentives, 2006-11

As a percentage of total support, and annualised growth rates in constant PPPs

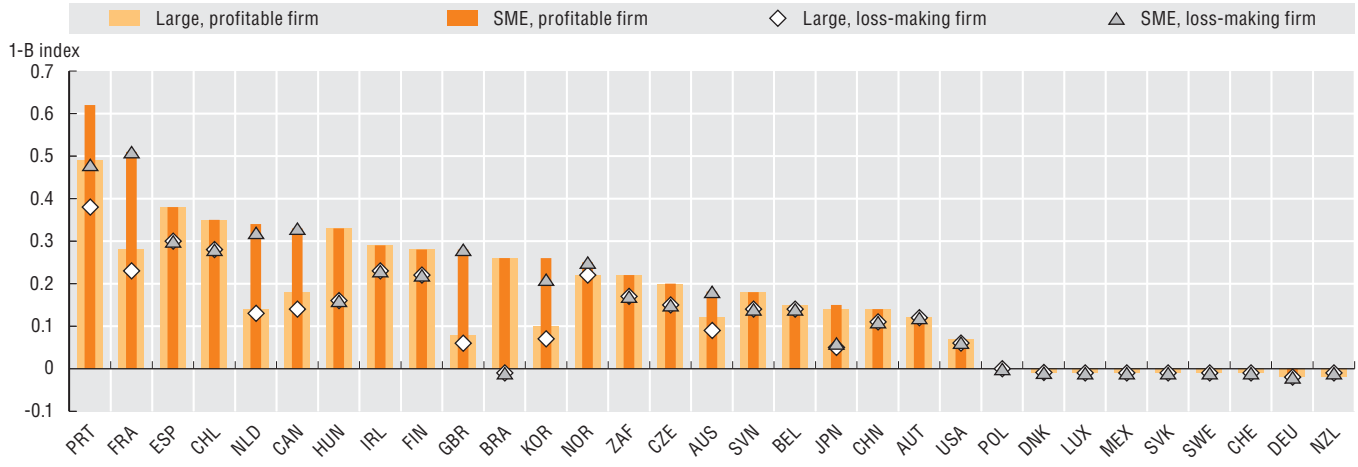


Note: This is an experimental indicator. International comparability may be limited. For more information, see *www.oecd.org/sti/rd-tax-stats.htm*.
Source: OECD, based on OECD R&D tax incentives questionnaires, January 2010, June 2011 and June 2013, publicly available sources, and OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932891131*

Tax subsidy rates on R&D expenditures, 2013

1-B index, by firm size and profit scenario



Note: This is an experimental indicator. International comparability may be limited. For more information, see *www.oecd.org/sti/rd-tax-stats.htm*.
Source: OECD, based on OECD R&D tax incentives questionnaire and publicly available sources, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932891150*

Measurability

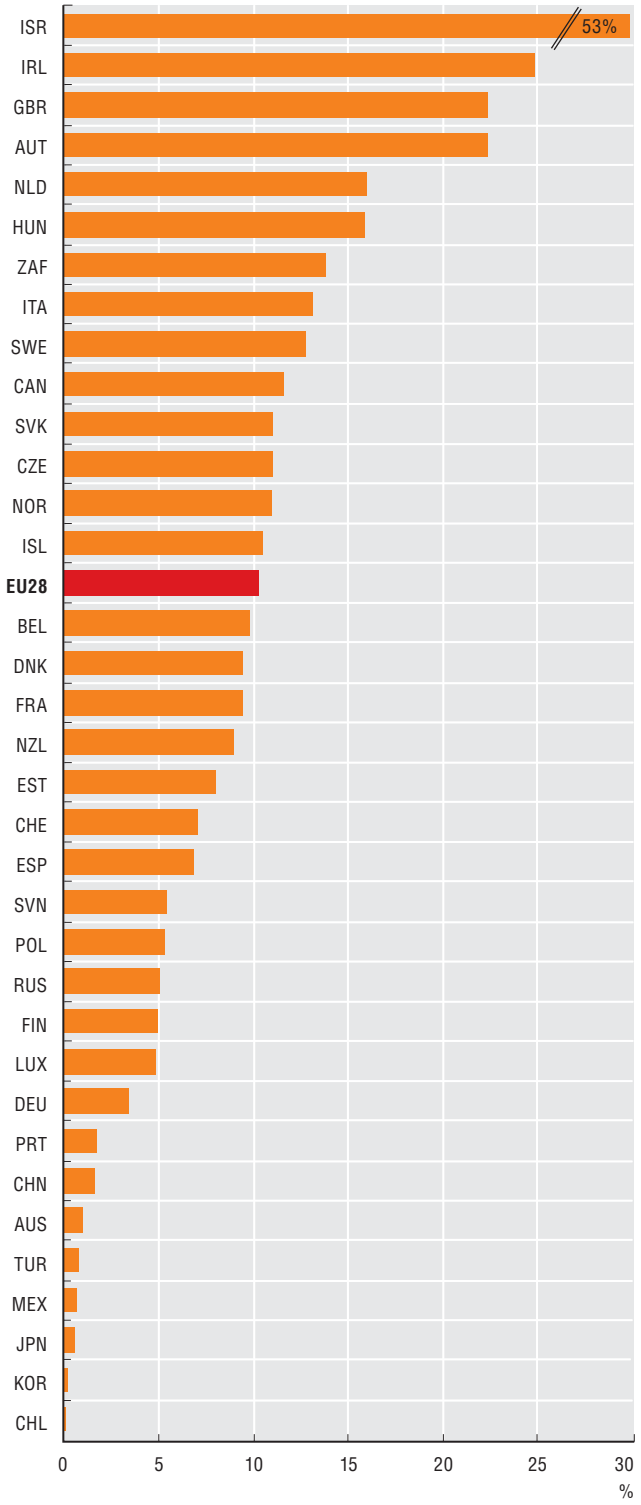
There are several ways to measure the value of R&D tax provisions. Tax expenditures are deviations from a benchmark tax system (OECD, 2010) and countries use different national benchmarks. The 2013 OECD questionnaire adopted a common reference framework based on full deductibility of current R&D expenditures and a country's baseline treatment of capital investments. Available estimates are typically in terms of initial revenue loss, with no or minimal adjustments for behaviour effects. Some only report claims realised in a given year, while others report losses to government on an accrual basis, excluding claims referring to earlier periods and including claims for current R&D to be used in the future.

The B-index traditionally assumes that the "representative firm" is taxable and enjoys the incentive's full benefit. An adjusted B-index is reported for a firm unable to claim tax benefits in the reporting period. When credits or allowances are fully refundable, the B-index of a company in such position is identical to the profit scenario. 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%.

12. International funding of R&D

Business enterprise R&D funded from abroad, 2011

As a percentage of business enterprise R&D



Source: OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891169

Companies draw on a variety of funding sources for their R&D projects: own funds, funding from other enterprises (domestic or foreign, affiliated or not) and from public institutions (government and higher education), and international organisations. R&D funded from abroad includes R&D performed by subsidiaries of foreign-owned companies, R&D undertaken under contract on behalf of companies based abroad or research grants from international organisations. On average, funding from abroad plays quite an important role in the funding of business R&D. In the EU, it represented around 10% of total business enterprise R&D in 2010. The weight of foreign multinationals in the economy and in the domestic production of technology matters: in Austria, the United Kingdom and Ireland, funds from abroad represented 20% or more of total business R&D, and over 50% in Israel.

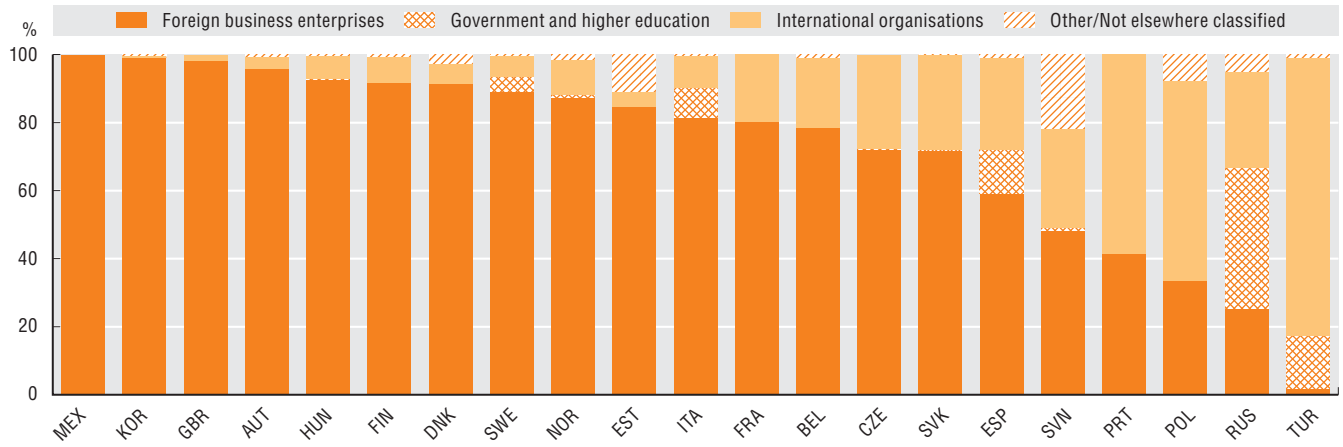
In most countries, the financing of business enterprise R&D from abroad comes mainly from other business enterprises. Among 21 countries for which data are available, only Poland, the Russian Federation and Turkey report that foreign businesses contribute less than 40% of the total foreign funds for R&D, mainly because of funding from the EU and other international organisations.

For the R&D funds reported as coming from foreign enterprises, 18 countries are able to distinguish intra-group funding from funding from non-affiliated firms. In almost all, affiliated enterprises account for the largest share; the exceptions are Korea, where two-thirds of foreign R&D funding comes from non-affiliated enterprises, and Slovenia, where enterprises in the same group account for a negligible share of the funding reported to come from abroad.

Definitions

R&D surveys collect information from R&D performers about the sums a unit has received or will receive from another party for the performance of R&D during a specific period. Companies are asked to provide a breakdown of their R&D expenditures according to the sources of funds. These can be either internal or received from units belonging to the different sectors specified in the *Frascati Manual* (OECD, 2002), one of which is "Abroad". This consists of all non-resident institutions and individuals located outside the political borders of a country, excluding vehicles, ships, aircraft and satellites operated by domestic entities and testing grounds acquired by such entities. It also includes all international organisations (except business enterprises), including facilities and operations within the country's borders. *Affiliated enterprises* are enterprises in a direct investment relationship including their *subsidiaries*.

Business enterprise R&D funded from abroad, by source of funds, 2011

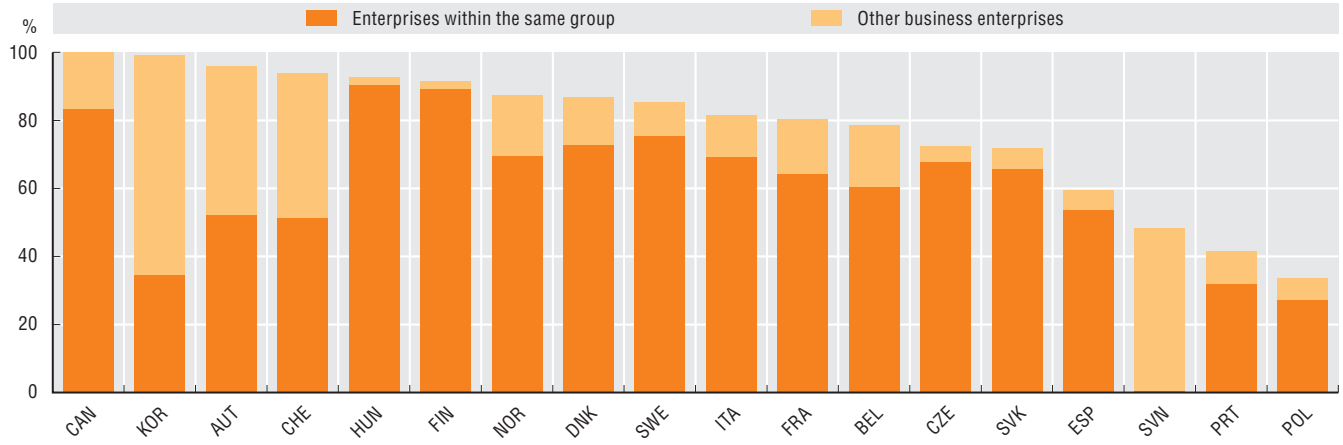


Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891188

Funding of business R&D by foreign enterprises, 2011

As a percentage of funds from abroad



Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, and national sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891207

Measurability

The increasing internationalisation of R&D and other economic activities makes it difficult to identify accurately 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 mainly focus on domestic intramural performance. Therefore, in most countries little or no information is collected on the foreign R&D activities of multinationals. Furthermore, it is very difficult to collect accurate information on the size and economic nature of cross-border R&D flows between firms, as multinationals' practices regarding R&D, including its funding and the exploitation of the resulting intellectual outputs, tend to reflect strategies to minimise tax liabilities. The ongoing revision of the *Frascati Manual* aims to strengthen the links between R&D and globalisation statistics and to address the needs of the System of National Accounts (SNA); see *www.oecd.org/sti/frascatimanual*.

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 recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'."

The following note is included at the request of all 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, 2000 and 2010

Estimates for Canada refer to 2009. Estimates for Chile refer to 2011.

Estimates for Brazil, Canada, Hungary, Ireland, Italy, Poland, Portugal and Switzerland refer to public institutions only.

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. The breakdown of total expenditures is not available for Argentina, Denmark, Iceland, Japan and the Russian Federation.

Gross domestic expenditure on R&D, 2001 and 2011

For Australia, data refer to 2002 and 2010 instead of 2001 and 2011.

For Chile and the Netherlands, data refer to 2010 instead of 2011.

For Iceland and South Africa, data refer to 2009 instead of 2011.

For Luxembourg, data refer to 2000 instead of 2001.

For Switzerland, data refer to 2000 and 2008 instead of 2001 and 2011.

ICT Investment by asset, 2000 and 2011

For Australia, data refer to 2008.

For Denmark and the United Kingdom, data refer to 2009.

For Ireland, Japan, New Zealand, Portugal and Switzerland data refer to 2010.

For the Slovak Republic, data refer to 2004 instead of 2000.

For Denmark, communication equipment is included under IT equipment.

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, the United States Bureau of Economic Analysis (BEA).

2.2. Human resources and knowledge-based capital

General notes for all figures:

Identification of occupations that relate to knowledge-based capital (KBC) is based on survey results from the Occupational Information Network Database of the United States Bureau of Labor Statistics. Results for the United States are based on the Standard Occupational Classification system (SOC, 2010) and those for the other countries are based on the International Standard Classification of Occupations (ISCO, 2008). Therefore, the selection of KBC-related occupations slightly differs between the United States and the other countries.

Additional notes:

Knowledge-based capital related workers, 2012 and;

Workers contributing to more than one activity related to knowledge-based capital, 2012

The category "Overlapping assets" refers to all employed persons who are related to more than one knowledge-based asset.

2.3. Learning for innovation

Transition from upper secondary education to graduation at the university level, 2011

Upper secondary graduation rates include students who graduated at the ISCED 3A, 3B and 3C levels for Portugal, the United Kingdom and the United States and from ISCED 4A programmes "Berufsbildende höhere Schulen" for Austria.

Gross upper secondary graduation rates for China, Germany, Japan, Korea, the Russian Federation, Spain, Switzerland and the United Kingdom.

Gross entry rates into tertiary education for China.

Gross graduation rates at the tertiary level for Japan, Turkey and the United States.

Participation in job-related education and training by level of problem solving in technology-rich environments, 2012

Participation in adult education and training is calculated by excluding students who are considered to be still in their first formal cycle of studies. However, those aged 16 to 19, who recently completed or are still in a programme of short duration at ISCED 3C or below, are considered adult learners. Similarly, those aged 20 to 24 who recently completed or are still at ISCED 3A,B,C or below are considered adult learners.

On the basis of their test results, respondents are assigned a proficiency level. "Below Level 1" is the lowest level and corresponds to a score of less than 241 points out of 500 (12.3% of respondents). "Level-3" is the highest level and corresponds to a score of more than 340 points out of 500 (5.8% of respondents). "No ICT experience/ Failed core ICT test" corresponds to respondents whose ICT skills were insufficiently developed to take the computer-based test and whose problem-solving skills were not evaluated (22.8% of respondents).

2.4. Skills for innovation

Professionals and technicians, 2012

"Professionals" and "Technicians and associate professionals" are defined according to the International Standard Classification of Occupations 2008 (ISCO-08) major groups 2 and 3 respectively, except for Australia, Brazil, Canada, Chile, China, India, Indonesia, Israel and the Russian Federation, for which the corresponding ISCO-88 groups are reported.

For Australia, Brazil, Canada, Chile, India, Indonesia, Israel, Mexico, the Russian Federation and South Africa, data are drawn from the Laborsta Database maintained by the International Labour Organization (ILO).

For China, data are drawn from China's *Labour Statistical Yearbook 2012*.

For India, data refer to the period July 2011-June 2012 covered by the Indian National Sample Survey, Ministry of Statistics and Program Implementation, June 2013.

For the United States, data refer to March 2012, based on the Current Population Survey (CPS). CPS data were converted from US 2010 census codes to 1-digit ISCO-08 major groups via published correspondences with US 2010 Standard Occupational Classification (SOC) codes.

For Brazil, data refer to 2009.

For Canada, Chile, Indonesia, Israel, Mexico and the Russian Federation, data refer to 2010.

For China, data refer to 2011.

Professionals and technicians in business sector services and manufacturing, 2012

The occupations considered here correspond to major groups 2, "Professionals", and 3, "Technicians and associate professionals" of the International Standard Classification of Occupations 2008 (ISCO-08).

Manufacturing refers to the ISIC Rev.4 (NACE Rev.2) Divisions 10-33 (Section C) while Business sector services cover Divisions 45-82 (G-N).

Data refer to total employment (including self-employed).

For the Netherlands data refer to 2011.

For the United States, data refer to March 2012, based on the Current Population Survey (CPS). CPS data were converted from US 2010 census codes to 1-digit ISCO-08 major groups via published correspondences with US 2010 Standard Occupational Classification (SOC) codes.

Firms using innovation-relevant skills, 2008-10

Estimates are based on the voluntary, ad-hoc module in the EU Community Innovation Survey 2010 on the skills available in enterprises and on methods to stimulate new ideas and creativity. The indicator corresponds to the percentage of firms in the relevant innovation category responding affirmatively to the question: "During the three years 2008 to 2010, did your enterprise employ individuals in-house with the following skills, or obtain these skills from external sources?"

Innovative enterprises had innovation activities during 2008-10, relating to the introduction of new products, processes, organisational or marketing methods. This includes enterprises with ongoing and abandoned activities for product and process innovation. The question on innovation-relevant skills also applies to non-innovative enterprises.

Estimates are based on firms with in "core" NACE Rev.2 economic activities (B, C, D, E, G46, H, J58, J61, J62, J63, K and M71).

2.5. New doctorates

Graduation rates at doctorate level, 2000 and 2011

For Australia, Canada, France, Iceland and Indonesia data refer to 2010.

Because of the increasing harmonisation of programme durations among European countries within the Bologna Process, some countries have seen rapid changes in their graduation rates.

General notes:

Graduates at doctorate level, 2011 and;

New doctorates in science and engineering, 2007-11

For Brazil, China, Norway and South Africa, data are based on national sources: for Brazil, Capes Database, Ministry of Education of Brazil, July 2013; for China, Ministry of Education of the Peoples' Republic of China, Educational Statistics website, July 2013; for Norway, the Nordic Institute for Studies in Innovation, Research and Education (NIFU), June 2013; and for South Africa, Higher Education Management and Information System (HEMIS), South African Department of Higher Education and Training, July 2013.

For Brazil, China and South Africa, an approximate conversion of nationally available information was carried out to map to the ISCED-1997 classification of fields of study.

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

Additional notes:

Graduates at doctorate level, 2011

For Australia, Canada, France and Iceland, data refer to 2010.

New doctorates in science and engineering, 2007-11

Owing to data availability by field of education, data refer to the 2007-10 average for Australia, Canada and France; 2009-11 average for China; and the average of the years 2005, 2006 and 2011 for Italy.

2.6. Doctorate holders

Doctorate holders in the working age population, 2009

For Chinese Taipei, data only include 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*.

For Australia and Canada, data refer to 2006; for Finland, data refer to 2008.

For Korea, OECD estimates based on national sources. Data refer to 2010.

General notes:

Doctorate holders working as researchers, 2009 and;

Doctorate holders by sector of employment, 2009

For Belgium, the Netherlands and Spain, data refer to graduation years 1990 onwards.

For Spain, there is limited coverage of graduates who received their doctorate between 2007 and 2009.

For the United States, data exclude those with a doctorate in the humanities.

Recent doctorates (right-hand side bars) are defined as follows: France, 2006/07 graduates between March and July 2010; Japan, 2002-06 graduates in April 2008; United Kingdom, 2006/07 graduates in November 2010.

Additional notes:

Doctorate holders working as researchers, 2009

For Norway, the figure is a lower bound estimate.

For Japan, Norway, Poland, Romania and the United States, data refer to 2008; for France and the United Kingdom, data refer to 2010.

Doctorate holders by sector of employment, 2009

For Chinese Taipei, data only include 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*. Doctorate holders working in the business sector are under-represented.

For the Russian Federation, data relate only to doctoral graduates employed as researchers and teachers.

For Denmark, Japan, Poland and the United States, data refer to 2008; for France and the United Kingdom, data refer to 2010.

2.7. Researchers

R&D personnel, 2001 and 2011

For Australia, 2002 and 2008 instead of 2001 and 2011.

For Austria, 2002 instead of 2001.

For Canada, Chile, EU28, France, Germany and the Netherlands, 2010 instead of 2011.

For Iceland and South Africa, 2009 instead of 2011.

For Luxembourg, 2000 instead of 2001.

For Switzerland, 2000 and 2008 instead of 2001 and 2011.

Researchers by sector of employment, 2011

For Australia and Switzerland, data refer to 2008.

For Austria, Belgium, Germany, Iceland, Luxembourg and South Africa, data refer to 2009.

For Canada, Chile, France, Hungary and the Netherlands, data refer to 2010.

Female researchers by sector of employment, 2011

For Austria, Belgium, Denmark, Germany, Iceland, Luxembourg, South Africa and Sweden, data refer to 2009.

For Chile, Italy, France, Hungary, Portugal and Spain, data refer to 2010.

2.8. R&D

R&D expenditure by performing sectors, 2011

For Australia, Chile and the Netherlands, data refer to 2010.

For Iceland and South Africa, data refer to 2009.

For Switzerland, data refer to 2008.

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

For Hungary, total GERD combines survey data and data from the central budget on R&D support. It includes R&D expenditures that cannot be attributed to a specific sector on a performance basis.

For the Netherlands, expenditures in the private non profit (PNP) sector are included in the government sector.

For the Slovak Republic, defence is excluded from the government sector.

For the United States, capital expenditures are excluded from R&D performed in the business, higher education and PNP sector. Government is federal or central government only.

Direct government funding of business R&D, 2001 and 2011

For Australia, Chile, EU28, France, Israel, Italy, the Netherlands, Portugal and Spain, data refer to 2010 instead of 2011.

For Austria, data refer to 2002 and 2009 instead of 2001 and 2011.

For Belgium, Iceland and South Africa, data refer to 2009 instead of 2011.

For China, data refer to 2000 instead of 2001.

For Luxembourg, data refer to 2000 and 2009 instead of 2001 and 2011.

For Switzerland, data refer to 2000 and 2008 instead of 2001 and 2011.

In Austria, "research premium" funding is part of direct government funding since 2006. In previous R&D surveys (reference years 2002 and 2004) it was not listed as a separate source of funds.

For Israel a substantial part of defence R&D funding is not reported.

Gross expenditures on research and development, by type of R&D, 2001 and 2011

Shares by type of R&D are based on total GERD, except for Chile, Estonia, Norway, Poland, the Russian Federation, Spain and the United States. For these countries, estimates are based on current R&D estimates as complete records with capital costs are not available.

Data refer to 2001 and 2011 except for Australia (2002, 2008), Austria (2002, 2009), Chile (2010), Denmark (2003, 2010), France (2001, 2010), Iceland (2001, 2009), Ireland (2002, 2011), Israel (2001, 2010), Italy (2005, 2010), Mexico (2003, 2009), Portugal (2001, 2010), the Russian Federation (2001, 2010), South Africa (2001, 2009), Spain (2001, 2010), Switzerland (2000, 2008), the United Kingdom (2010) and the United States (2001, 2010).

Estimates for Austria, France, Hungary and Japan are based on R&D expenditures for which a breakdown by type of R&D is available: non-classified R&D accounts for 2.0%, 3.8%, 1.6% and 4.6% of the total, respectively. For Austria, R&D expenditure of provincial hospitals is estimated and no breakdown is available by type of R&D. For France, data by type of R&D for defence are not available. For Hungary, total GERD combines survey data and data from the central budget on R&D support, including R&D expenditure that cannot be allocated by type of R&D. For Japan, classification by type of R&D for natural sciences and engineering is limited to physical sciences, engineering, agriculture and health expenditures.

2.9. Higher education and basic research

Higher education expenditure on R&D, 2001 and 2011

General university funds (GUF) estimates identify the component of general 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: Canada, France, Spain (2010), Belgium and Israel (2009).

For Australia, data refer to 2002 and 2010 instead of 2001 and 2011.

For Austria, data refer to 2002 instead of 2001.

For Chile and the Netherlands, data refer to 2010 instead of 2011.

For Iceland and South Africa, data refer to 2009 instead of 2011.

For Switzerland, data refer to 2002 and 2010 instead of 2001 and 2011.

R&D in the social sciences and humanities are not included in estimates for Israel (2001 and 2011) and Korea (2001).

Government funding of R&D in higher education, by type of funding, 2010

For Canada, Denmark, Israel, the Netherlands, New Zealand and Poland, data refer to 2008.

Basic research performed in the higher education and government sectors, 2011

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

For Australia and Switzerland, data refer to 2008.

For Austria, Iceland, Mexico and South Africa, data refer to 2009.

For Chile, Denmark, France, Israel, Italy, Portugal, the Russian Federation, Spain, the United Kingdom and the United States data refer to 2010.

For Israel and Switzerland, most expenditures on defence R&D are not reported or are excluded from the government sector.

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

For Israel higher education excludes R&D in the social sciences and humanities.

2.10. Business R&D

Business enterprise expenditure on R&D, 2001 and 2011

For Australia, Chile and the Netherlands, data refer to 2010 instead of 2011.

For Austria, data refer to 2002 instead of 2001.

For Iceland and South Africa, data refer to 2009 instead of 2011.

For Luxembourg, data refer to 2000 instead of 2001.

For Switzerland, data refer to 2000 and 2008 instead of 2001 and 2011.

Business R&D by size class of firms, 2011

National statistical agencies use different minimum thresholds for inclusion in R&D surveys and estimates. There are variations in the definition of small and medium-sized firms. Small firms (fewer than 50 employees): for Belgium, 1-49 employees; for the United States, 5-49 employees; for Luxembourg, the Netherlands and Sweden, 10-49 employees. For Japan, the survey excludes firms with capital of less than JPY 10 million.

For Australia, Canada, Chile, France, Germany, Italy, the Netherlands, Portugal, Spain, the United Kingdom and the United States, data refer to 2010.

For Austria, Belgium, Denmark, Luxembourg and Sweden, data refer to 2009.

For Switzerland, data refer to 2008.

R&D expenditures incurred by foreign-controlled affiliates, 2009

Financial intermediation excluded for the Czech Republic, Israel, Japan and Poland.

Community, social and personal services excluded for the Czech Republic and Poland.

For Finland, Hungary, the Netherlands, Slovenia and Spain, only sections B to F of ISIC Rev.4 are covered.

For Japan, data refer to majority and minority foreign-controlled affiliates.

For Australia, Canada, France, Italy, the United Kingdom and the United States, data refer to 2010.

For Switzerland, data refer to 2008.

For Norway, Portugal and the Slovak Republic, data refer to 2007.

2.11. R&D Tax incentives

Direct government funding of business R&D and tax incentives for R&D, 2011

For Australia, Belgium, Brazil, Chile, Ireland, Israel and Spain, data refer to 2010. For China, Luxembourg and South Africa, data refer to 2009 and for Switzerland to 2008.

Estimates of direct funding for Belgium, 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 2009 share is used for 2011. For Brazil, the 2008 share, based on national sources, is used for 2010.

In Austria, Poland 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.

Estonia, Finland, Germany, Luxembourg, Mexico, New Zealand, Sweden and Switzerland did not provide information on expenditure-based R&D tax incentives for 2011. For Israel the R&D component of incentives cannot be separately identified at present.

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 costs 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 available at *www.oecd.org/sti/rd-tax-stats.htm*.

Change in government support for business R&D through direct funding and tax incentives, 2006-11

Results restricted to countries providing information on expenditure-based R&D tax incentives for four or more years between 2006 and 2011. A minimum 2% threshold for the tax incentive share of government support for R&D (2011 or latest year) is applied to ensure reliable estimates of growth rates.

For Australia, Belgium, Ireland and Spain data refer to 2010 instead of 2011. For South Africa data refer to 2009 instead of 2011.

For Belgium, Denmark, Korea, Mexico and Slovenia data refer to 2007 instead of 2006. For Turkey data refer to 2008 instead of 2006. For New Zealand figures for tax incentives refer to 2008 instead of 2006, and for direct government support for BERD, figures are an average of 2007 and 2009 values.

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.

Estimates of direct funding for Belgium, France, Italy and Portugal in 2011 are based on imputing the share of direct government-funded BERD in the previous year to the current ratio of BERD to GDP. The same applies to the Netherlands for 2006. For Austria, the 2009 share is used for 2011.

In Austria, Poland 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.

Estonia, Finland, Germany, Luxembourg, Mexico, New Zealand, Sweden and Switzerland did not provide expenditure-based R&D tax incentives for 2011. For Israel the R&D component of incentives cannot be separately identified at present.

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 costs 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.

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

Tax subsidy rates on R&D expenditures, 2013

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.

Benchmark tax data information, including statutory corporate income tax rates, is obtained from the OECD Tax Database, basic (non-targeted) corporate income tax rates, May 2013.

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*).

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 are based on multiple sources of information about the benchmark tax treatment of capital expenditures. 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 also for payroll withholding tax incentives and wage taxes). Tax benefits are treated as taxable when appropriate (e.g. Canada).

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).

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.

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.

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 Germany, Israel, Luxembourg, Mexico, New Zealand, Sweden and Switzerland, which apply no special treatment to R&D, reflect the value (or lack thereof) of available allowances for current and capital expenditures.

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

2.12. International funding of R&D

Business enterprise R&D funded from abroad, 2011

For Australia, Chile, the EU28, France, Israel, Italy, Portugal and Spain, data refer to 2010.

For Austria, Belgium, Iceland, Luxembourg, the Netherlands and South Africa, data refer to 2009.

For Switzerland, data refer to 2008.

Business enterprise R&D funded from abroad, by source of funds, 2011

"Other/Not elsewhere classified" also includes the private non profit (PNP) sector which accounts at most for 1.4% of all BERD funded from abroad.

For Denmark, France, Italy, Portugal, the Russian Federation, Spain and the United Kingdom, data refer to 2010.

For Austria, Belgium and Sweden, data refer to 2009.

Funding of business R&D by foreign enterprises, 2011

For Canada, France, Italy, Portugal and Spain, data refer to 2010.

For Austria, Belgium and Sweden, data refer to 2009.

For Denmark and Switzerland, data refer to 2008.

Data for Canada and Switzerland are from national sources and separately reported to the OECD.

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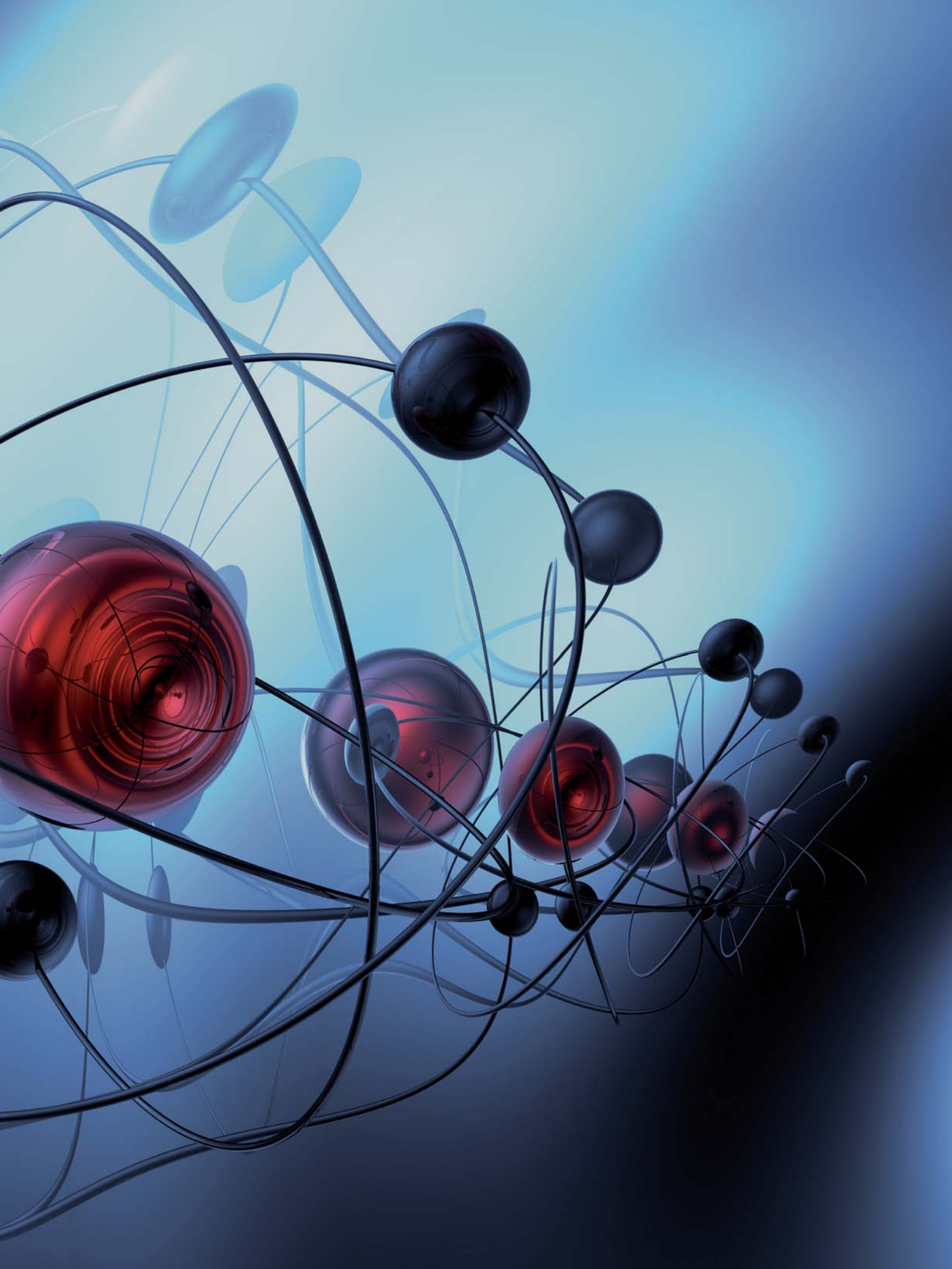
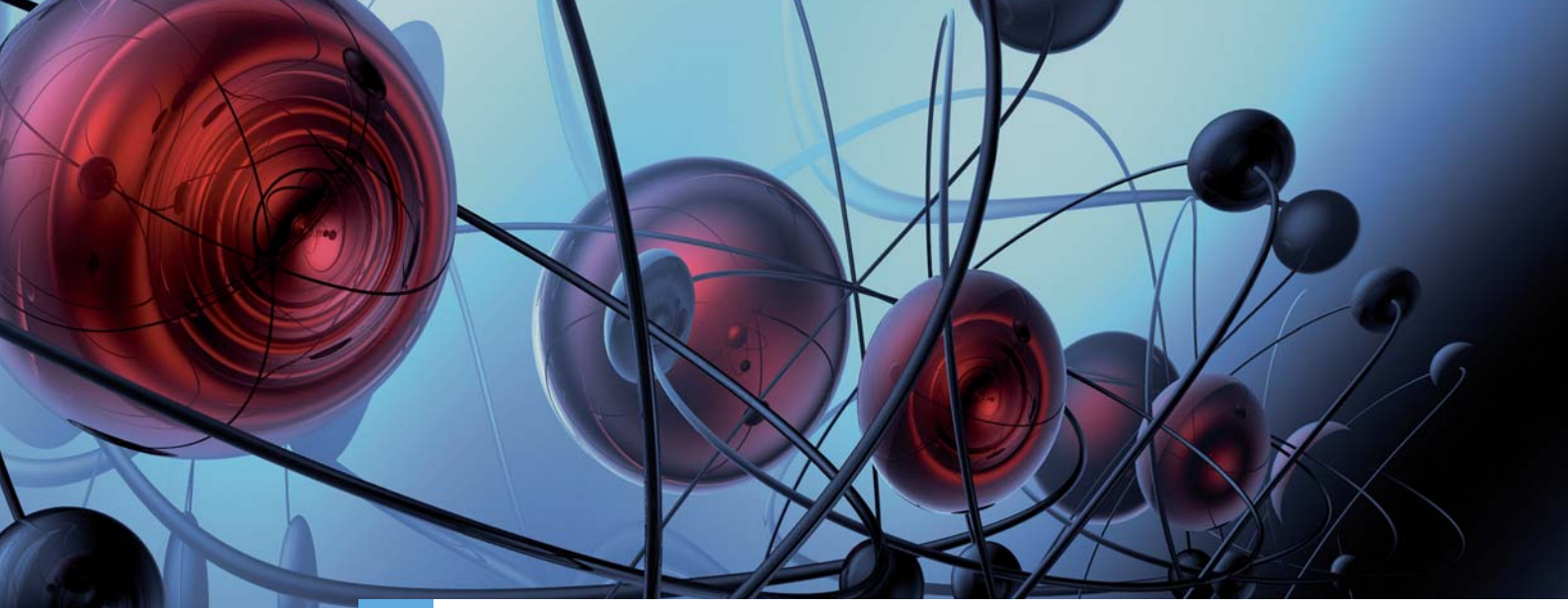




3. CONNECTING TO KNOWLEDGE

1. R&D and knowledge flows
2. Open innovation
3. Collaboration on innovation
4. International collaboration
5. Skills mobility
6. Researchers on the move
7. Research excellence
8. Science for innovation
9. From knowledge to inventions
10. Inventions across borders
11. Technology flows and markets

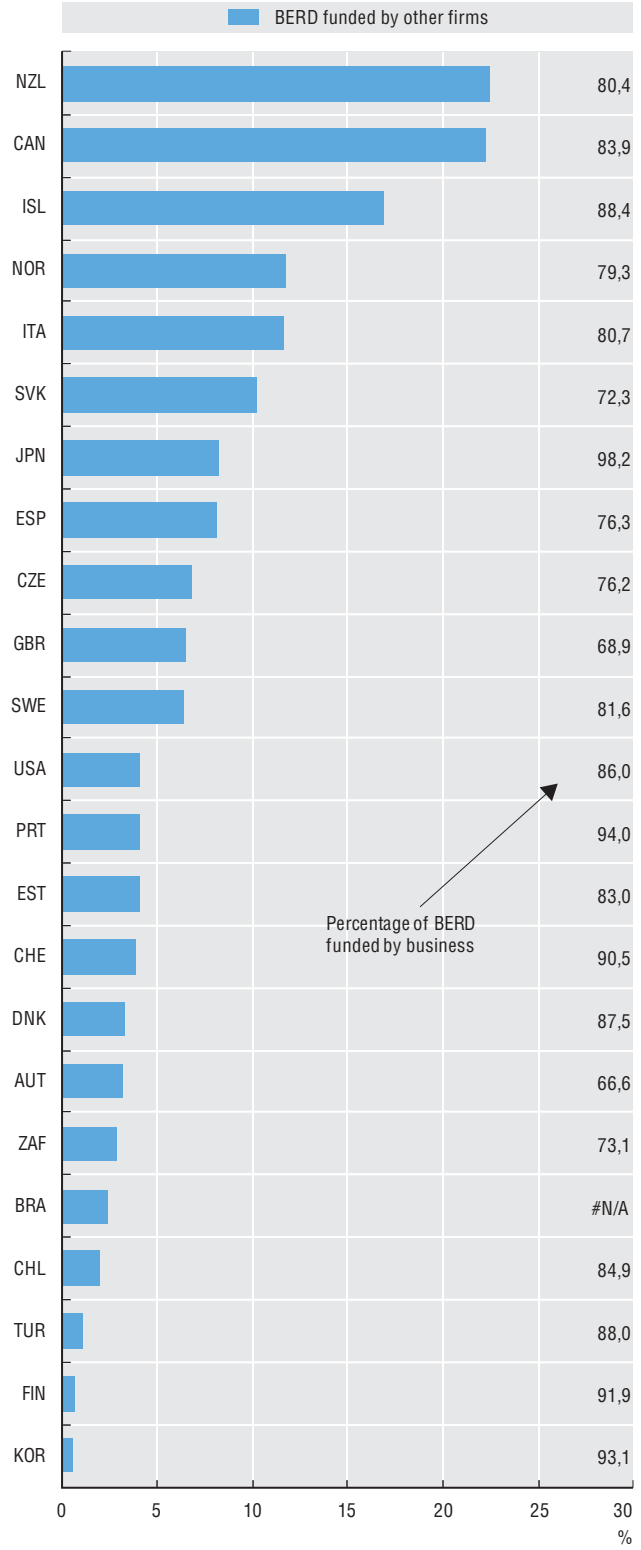
Notes and References

Improving the efficiency and effectiveness of the innovation effort requires strong knowledge transmission channels. New metrics help inform the policy debate by demonstrating the variety and nature of available mechanisms for exchanging knowledge. An experimental indicator reveals that business sourcing of R&D from other businesses is still limited, but open innovation goes beyond R&D interactions, as shown by the importance of institutional and market-based collaboration when introducing new innovations. Combining innovation survey and patent data points to the role of international collaboration. The international mobility of the highly skilled, from students to scientists, is hard to track. An experimental indicator follows the careers of scientists who publish in scholarly journals; the mobility patterns and quality of scientific output of those who stay, move or return to their home country differ sharply. New citation-based indicators show that collaboration by institutions is an increasingly pervasive feature of top-quality research. Linking patents and scientific publications reveals the importance of research crossing several disciplines in new technology development. Data on foreign ownership of inventions indicate which countries own the rights to patents invented elsewhere. Data on licensing revenues provide evidence on knowledge markets, and the role of intermediaries, although these metrics are still in their infancy.

1. R&D and knowledge flows

Business enterprise R&D funded by other companies, 2010

As a percentage of BERD funded by business



Note: This is an experimental indicator. International comparability may be limited.

Source: OECD, based on OECD data collection on intra- and extramural R&D; OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

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There is increasing awareness of open innovation and its relevance to corporate R&D. Companies often procure R&D services from other firms in order to draw on external sources of R&D expertise. R&D data collected under OECD guidelines but reported for the first time show that R&D funding by other companies still plays a small role relative to internal sources of funding. Countries differ significantly: more than 20% of industry-funded BERD comes from other firms in New Zealand and Canada but only 1-2% in Finland and Korea.

Business expenditures on R&D carried out externally are moderate but significant. In Denmark, Sweden and Belgium, they are the equivalent of more than 30% of intramural R&D. These figures are an indicator of the openness of business R&D strategies to external inputs. Other domestic firms and enterprises abroad (which include affiliates) are the main sources of external R&D.

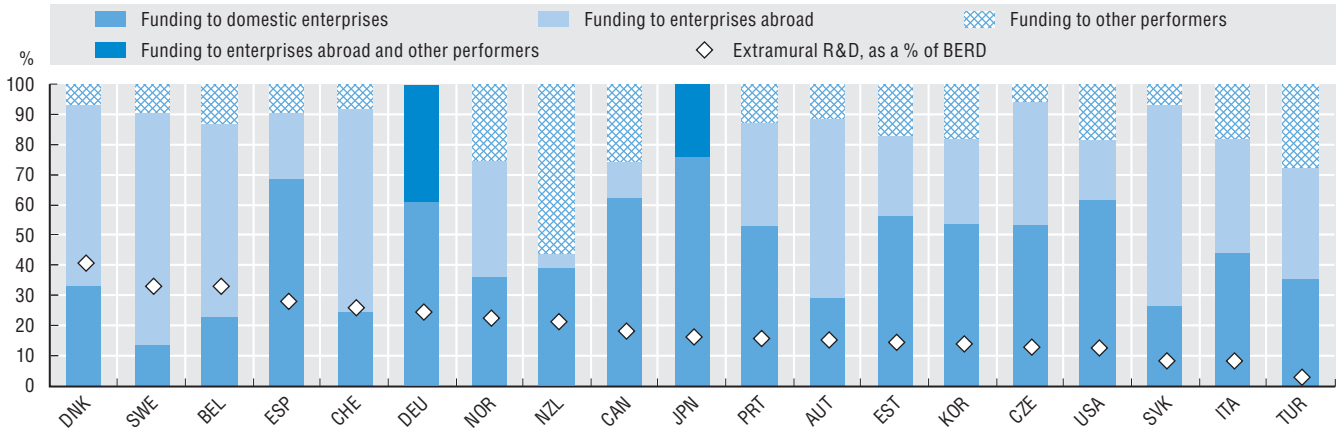
Official R&D data show that, across the OECD area, nearly 5% of R&D performed in the higher education and government sectors is funded by business. European countries appear to have larger shares of R&D funding from business. However, these figures do not show the extent to which companies make use of other mechanisms, such as collaborative R&D, access to facilities or access to outputs of research results through licensing, acquisition of patents rights or spin-outs.

Definitions

Data on R&D expenditures and sources of funds focus on intramural R&D and are collected from performers of R&D to avoid double counting. *Intramural R&D* performed and funded by the business sector comprises R&D funds from other domestic enterprises – both unrelated and in the same group – as well as companies' own funds. *Flows of R&D funds* involve a direct transfer of resources between parties and have to be intended and used for the performance of R&D. *Extramural R&D expenditures* represent payments by a unit, organisation or sector for the performance of R&D by a third party. This includes acquisition of R&D services and grants to others to perform R&D. The concept of intramural R&D performance is closest to the "supply" notion of new knowledge production. The concept of R&D funding, including extramural R&D but not R&D funded by other parties, approaches more closely the "demand" notion of investment, on condition that the relevant unit owns the rights to the outcomes of the research it funds. The OECD is working, as part of the revision of the *Frascati Manual* (OECD, 2002), to obtain R&D data that provide information on both of these policy-relevant concepts.

Business funding of extramural R&D, by type of performer, 2010

As a percentage of extramural funding and total BERD



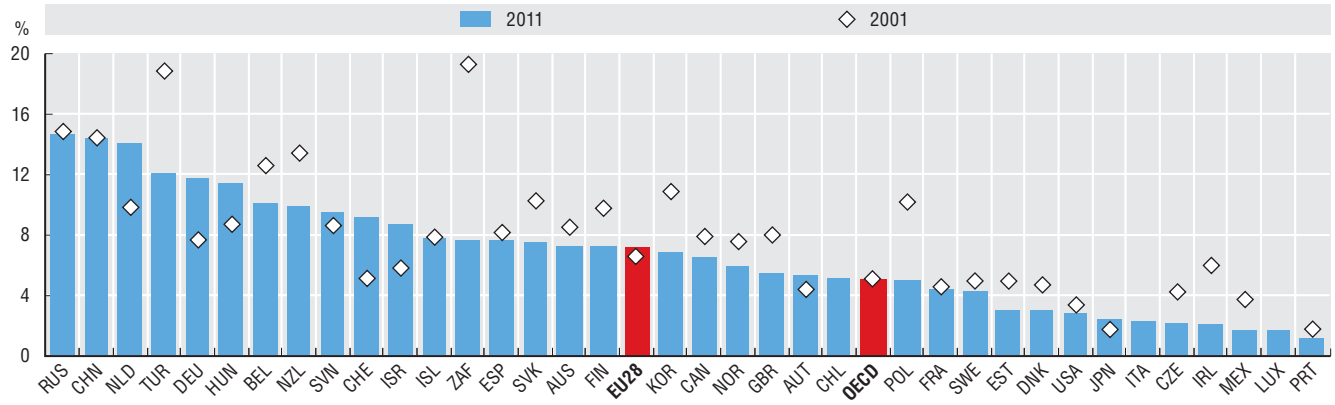
Note: This is an experimental indicator. International comparability may be limited. For Germany and Japan, "other" also includes funding to enterprises abroad.

Source: OECD, based on OECD data collection on intra- and extramural R&D; OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891245

Business-funded R&D in the higher education and government sectors, 2001 and 2011

As a percentage of R&D performed in these sectors



Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891264

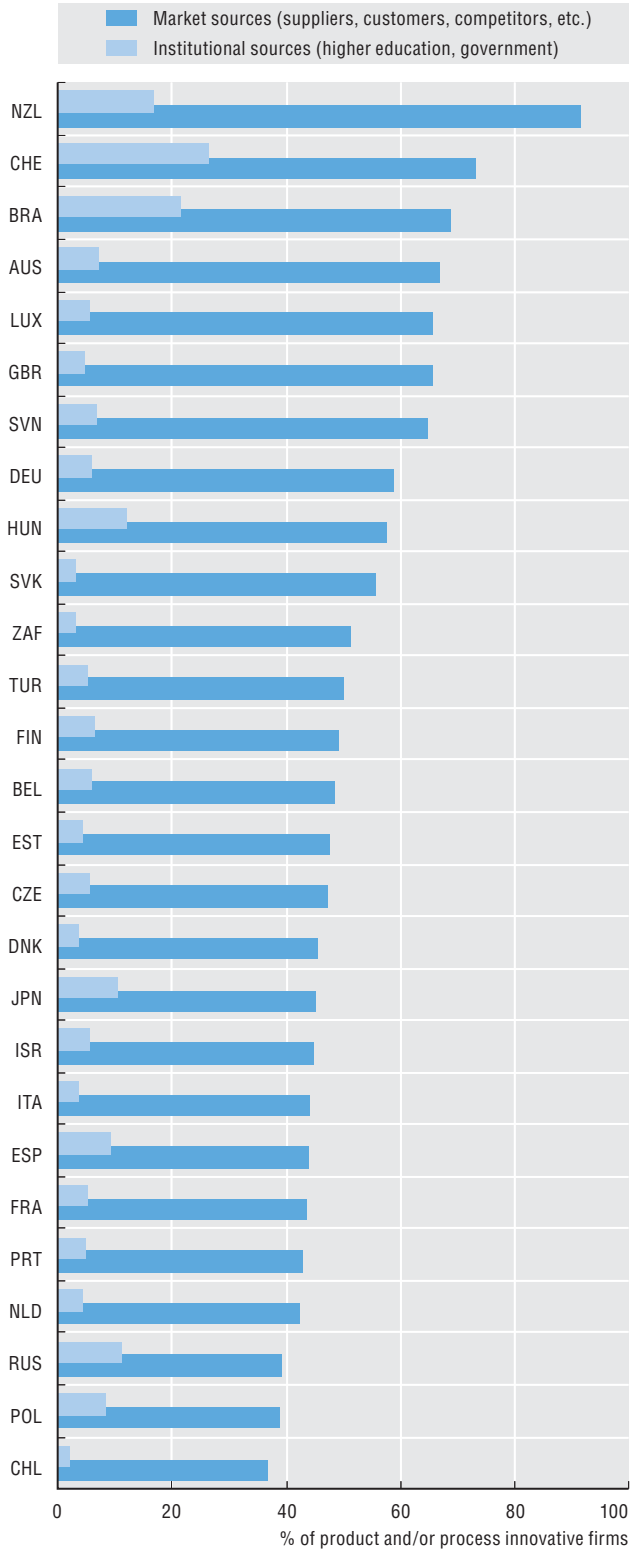
Measurability

Flows of funds for R&D are an indicator of knowledge flows when they represent payments for the performance of new R&D and the output becomes available to the R&D funder. This measure excludes payments for rights to the output of previous R&D but may include unconditional payments, such as grants, which do not represent knowledge flows. The coverage of R&D surveys is sometimes limited to intramural R&D performers and thus results in underestimation of extramural R&D. Funders' and performers' views of the nature and value of R&D-related activities may differ. When financing is provided by an intermediary it may be difficult for the performer to know the source of funds. In some cases, companies may fail to report R&D funded by third parties as intramural R&D. In the higher education and government sectors, R&D funds from business may understate the extent to which firms benefit from the research carried out, as governments often fund these units directly to undertake collaborative R&D activities and companies sometimes pay for the R&D on a *ex post* basis, e.g. through licence agreements.

2. Open innovation

External sources of knowledge for innovation, by type, 2008-10

Percentage of product and/or process innovative firms citing source as "highly important"



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891283

Innovation is a complex process and often involves several actors and linkages. One way to capture its systemic dimension is to examine the information sources that firms use for their innovation activities. Market sources predominate in all countries. Institutional sources play a much smaller role; generally, 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 their 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. For service innovation, more than 35% of innovating firms drew on some form of external development during 2008-10, compared to 30% for product innovation.

In terms of collaboration on innovation, large firms are far more likely to collaborate than small and medium-sized enterprises (SMEs). Among SMEs, the rate of collaboration is between 20% and 40% of innovative firms in two-thirds of the countries surveyed. For large innovative firms, collaboration rates range from more than 70% in the United Kingdom, Austria, Belgium, Finland, Denmark and Slovenia to less than a third in Brazil, Mexico and Chile.

Definitions

The guidelines on measurement of innovation, the *Oslo Manual* (OECD/Eurostat, 2005), 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".

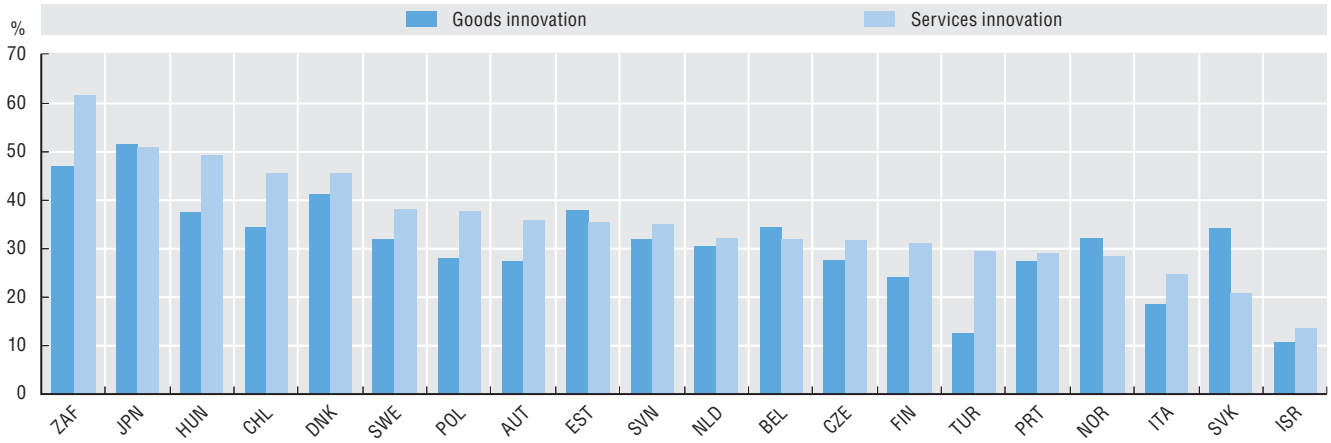
In line with the EU Community Innovation Survey (CIS), *product and/or process innovative firms* are defined as those having implemented product or process innovations, or with ongoing/abandoned innovation activities relating to product/process innovation.

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.

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, 2008-10

As a percentage of firms introducing each type of innovation



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

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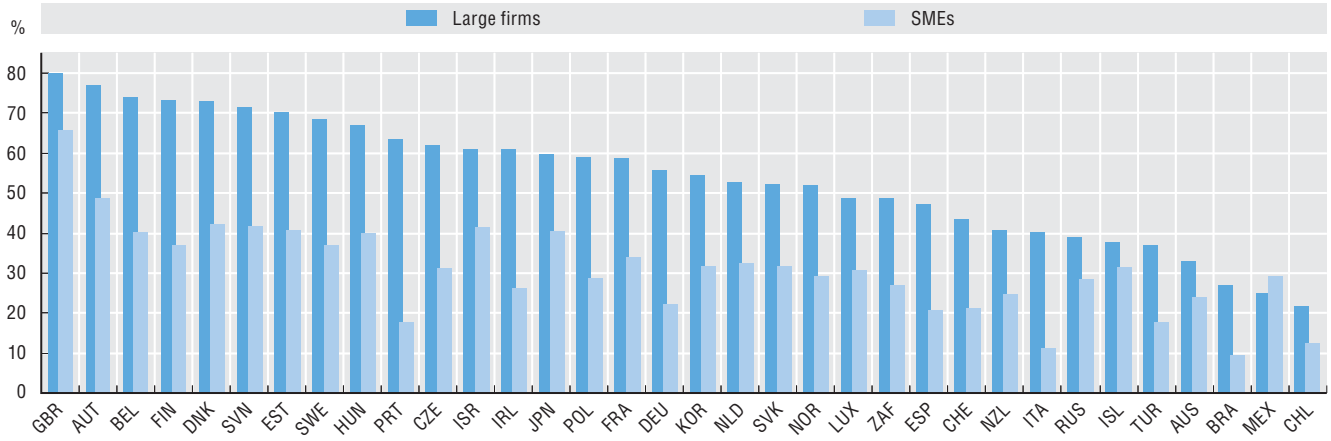
Firms collaborating on innovation activities, by size, 2008-10

As a percentage of product and/or process innovative firms in each size category



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891321

Measurability

Despite a gradual process of harmonisation based on the *Oslo Manual*, national innovation surveys still have some significant differences in methodology and design. Indicators of external engagement in innovation are subjective and 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 of analysis is the firm, not the innovation, and therefore ask about the use of a particular knowledge sourcing strategy across one or more innovations.

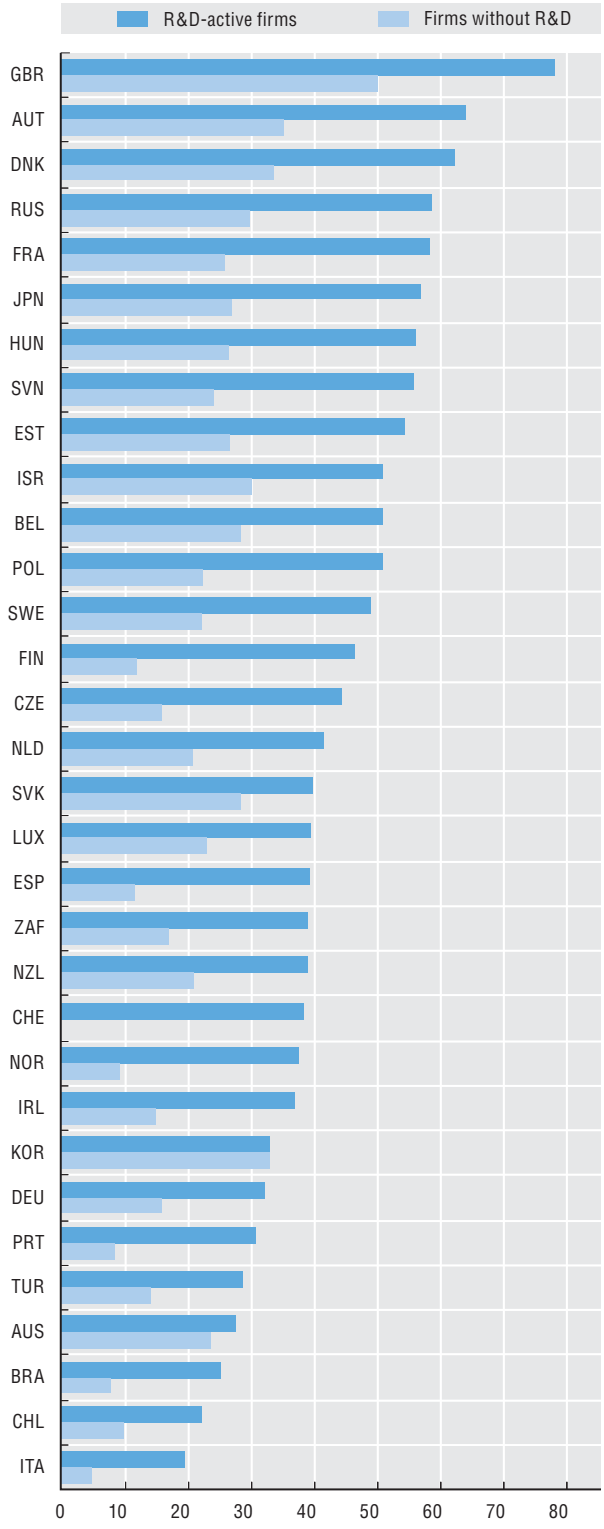
Innovations can be developed mainly by the enterprise itself or in co-operation with others. They can also be mainly developed outside and implemented by the innovating firm. The measure of externally developed innovation used here is based on firms that did not report that they mainly developed innovations themselves and thus excludes those that developed innovations both internally and externally.

Differences in the scope of the variables used to measure external engagement can limit comparability. For example, questions on collaboration in the CIS refer only to product and/or process innovations, while in other surveys they cover all types.

3. Collaboration on innovation

Firms engaging in collaboration on innovation, by R&D status, 2008-10

As a percentage of R&D-active and non R&D-active firms



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891340

Collaboration is a key vector of 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. In all countries for which data are available, R&D-active firms tend to collaborate more frequently on innovation than non-R&D-active firms, although in Korea (manufacturing only) and Australia, both types of firms have similar rates of collaboration.

Patterns of collaboration differ in terms of partners' characteristics. Collaboration with higher education or public research institutions is mainly an important source of knowledge transfer for large firms. In most countries, these firms are usually two to three times more likely than small and medium-sized enterprises (SMEs) to engage in this type of collaboration. More than half of all innovating large firms in Finland, Slovenia, Austria and Hungary collaborate with these institutions but less than one in ten in Mexico and Australia do so.

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, while in Finland, the United Kingdom, Korea, South Africa and Iceland, collaboration with clients is equally or more important, a potential indication of the growing importance of user-driven innovation.

Definitions

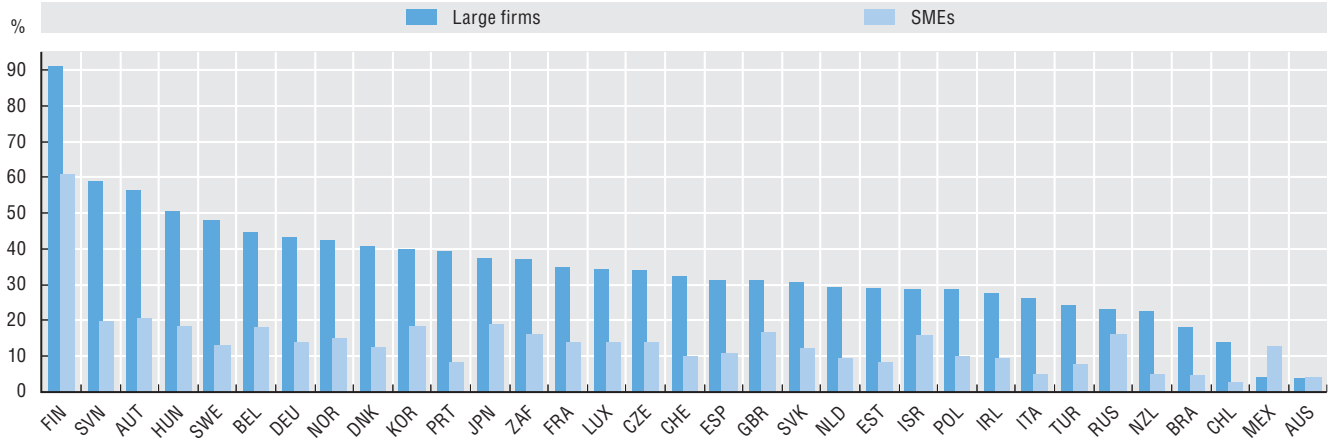
R&D-active firms are those engaged in intramural or extramural R&D activities.

Collaboration involves "active participation in joint innovation projects with other organisations" but excludes pure contracting out of innovation-related work. It can involve the joint implementation of innovations with customers and suppliers, as well as partnerships with other firms or organisations.

The classification of firms by size follows the recommendations of the *Oslo Manual*. In a majority of countries, it is calculated on the basis of the number of employees. SMEs are defined as firms with 10-250 employees, with some exceptions: New Zealand 6+; the Russian Federation 15+, Mexico 20+. For South Africa, firm size categories are based on turnover levels.

Firms collaborating on innovation with higher education or public research institutions, by firm size, 2008-10

As a percentage of product and/or process innovative firms in each size category



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

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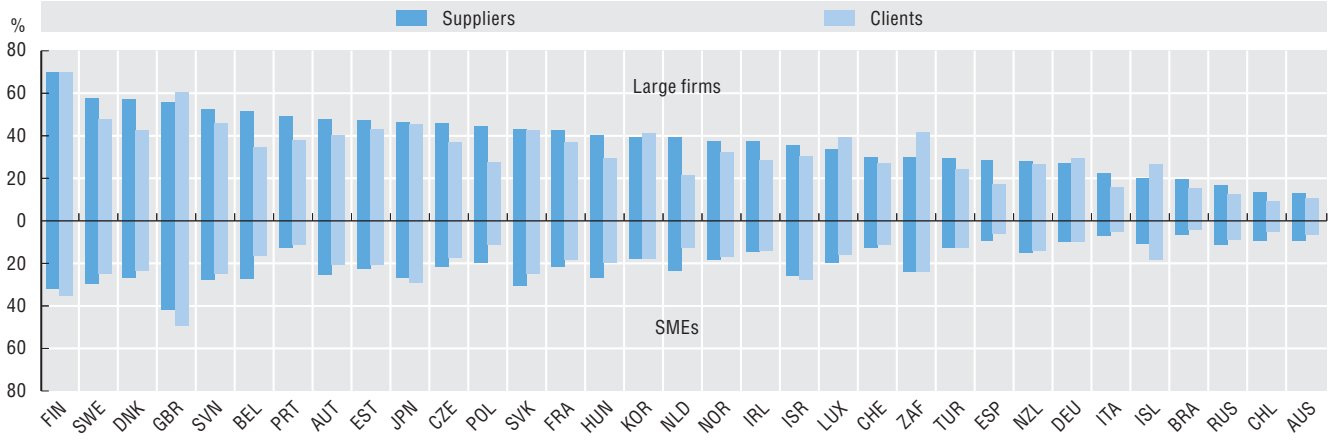
Firms collaborating with suppliers and clients, by firm size, 2008-10

As a percentage of product and/or process innovative firms



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891378

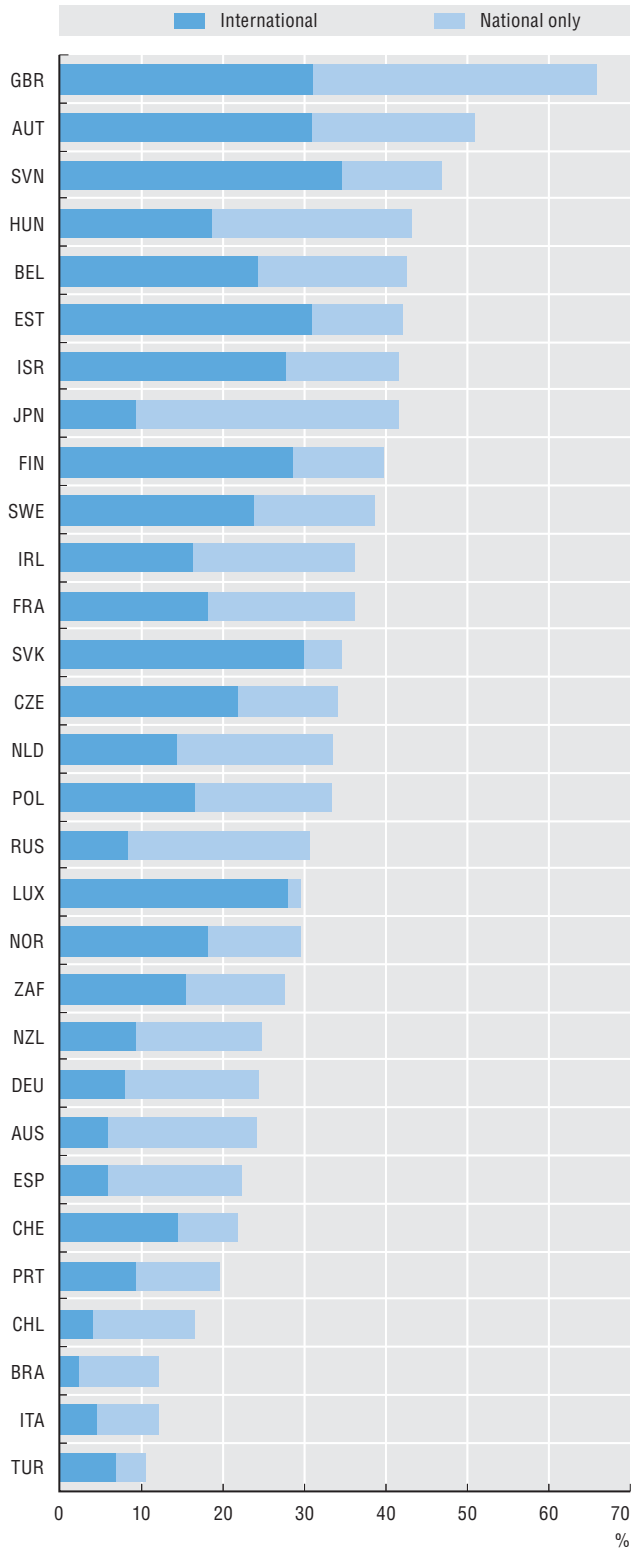
Measurability

Because R&D and innovation are related phenomena, some countries collect information on innovation as part of business R&D surveys. In dedicated surveys that adopt the Community Innovation Survey (CIS) model, firms are typically identified as being R&D-active when they report carrying out internal or external R&D as part of their product and/or process innovation activities. In other innovation surveys such as those in Australia and New Zealand, this information is asked of all innovative firms (including firms with only organisational or marketing innovations). Indicators of collaboration on innovation reflect the existence of some sort of collaboration, but not the type, frequency or intensity. In the CIS, collaboration refers to product and/or process innovation, but in other innovation surveys it refers to all types of innovation (including organisational or marketing). For Switzerland it only includes collaboration on R&D. Survey design features such as question order, scope or combination with other types of surveys may influence respondents' answers to questions on innovation activity and collaboration with other parties.

4. International collaboration

National and international collaboration on innovation by firms, 2008-10

As a percentage of product and/or process innovative firms



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

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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. It can take a variety of forms and levels of interaction, ranging from simple one-way information flows to highly interactive and formal arrangements.

Innovation collaboration rates vary widely across countries. In Brazil and Japan, collaboration centres on national partners, but in most countries there is more of a balance between national and international collaboration. In some small open economies – Luxembourg, the Slovak Republic, Slovenia and Estonia – 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 Germany, Portugal and Italy.

International collaboration can also be examined through co-patenting indicators. These focus on the invention stage and provide a complementary view of the collaborative nature of the innovation process. Combining national survey and patent data shows that countries with higher international co-invention rates also tend to have higher international collaboration rates, as measured in innovation surveys (34% correlation). However, in Slovenia and Israel, the share of international co-patenting appears to be low given the relative propensity of firms to collaborate on innovation with foreign partners.

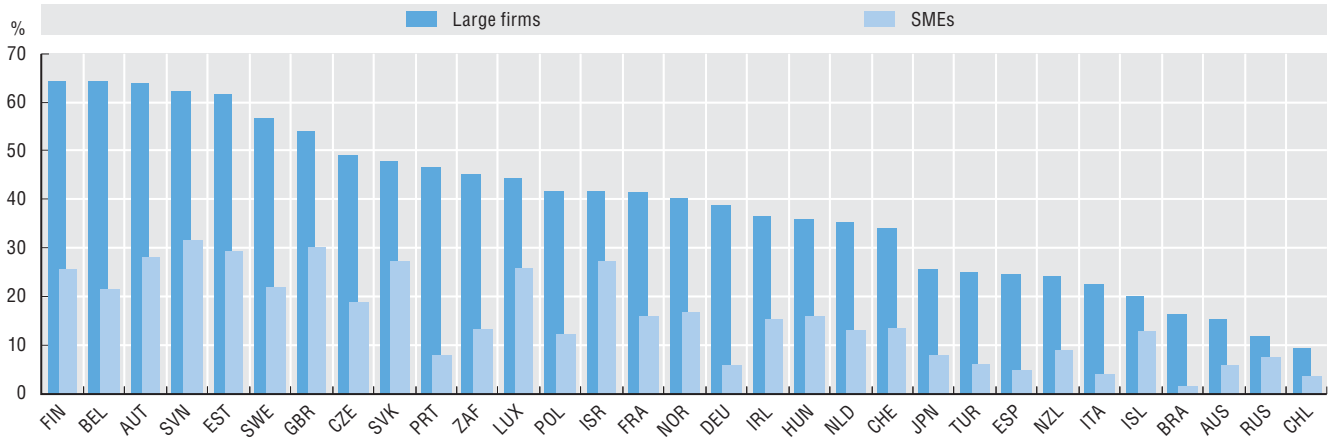
Definitions

International collaboration on innovation refers to active cross-border participation even if both parties do not benefit commercially; it excludes pure contracting out. The classification of firms by size follows the recommendations of the *Oslo Manual* and is calculated on the basis of the number of employees. SMEs are firms with 10-250 employees, with some exceptions: New Zealand: 6+; the Russian Federation: 15+; China: at least CNY 5 million in turnover. For South Africa and Chile, firm size is based on turnover.

International co-inventions are measured as the share of patent applications with at least one co-inventor abroad in total patents invented domestically.

Firms engaged in international collaboration by firm size, 2008-10

As a percentage of product and/or process innovative firms in each size category

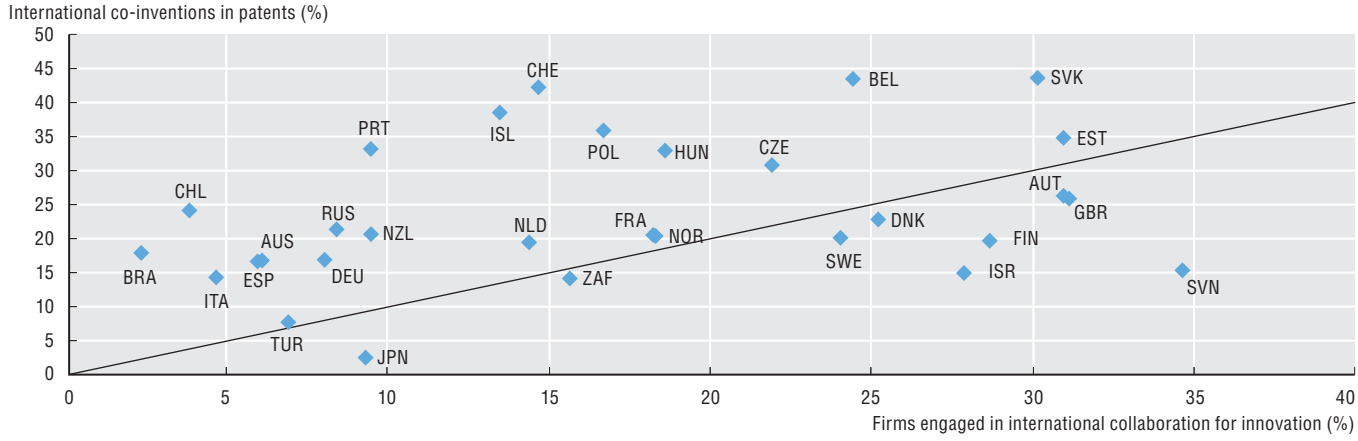


Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891416

International collaboration on patents, 2007-11 and innovation, 2008-10

As a percentage of PCT patent applications and of product and/or process innovative firms



Source: OECD, Patent Database, June 2013; OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891435

Measurability

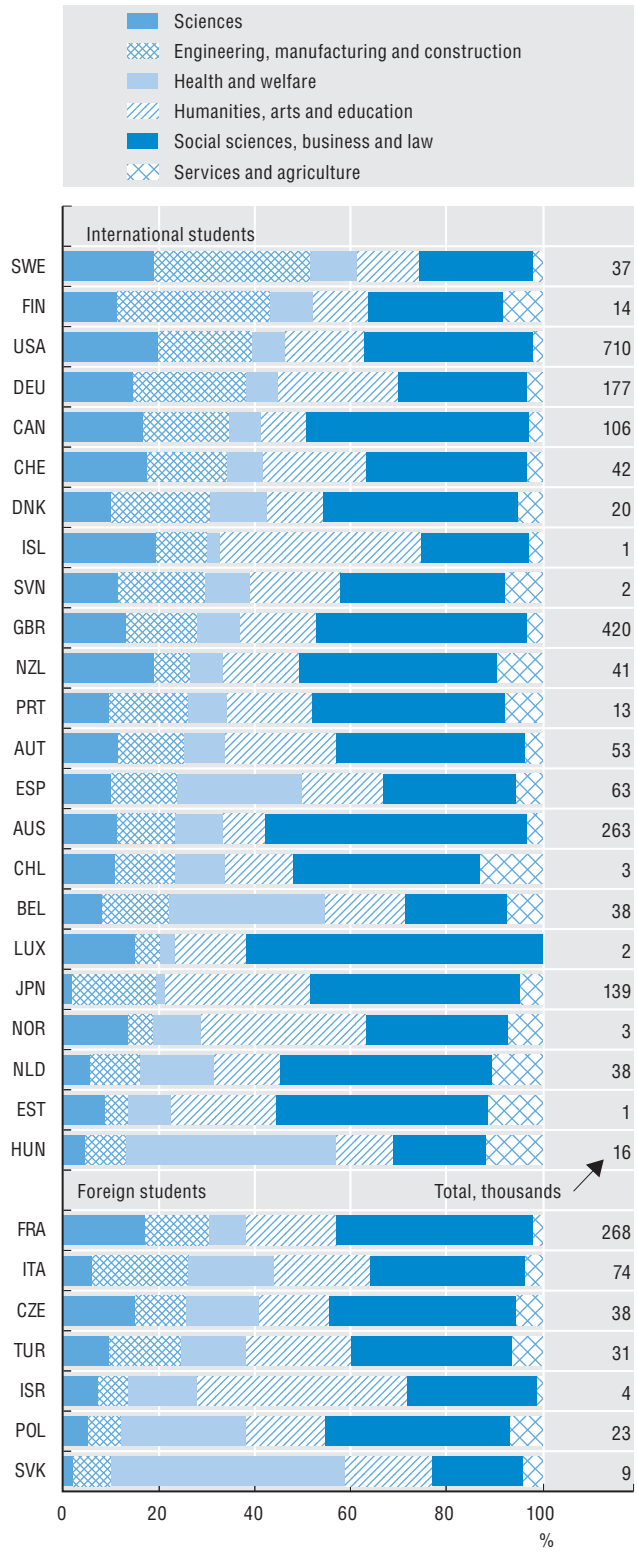
Innovation surveys differ in the way they collect information about international collaboration. The Community Innovation Survey asks firms about the location of each type of partner in several regions; in other surveys they are only asked to report whether each type of partner was domestic or foreign.

The indicator on international collaboration on patents and innovation combines two related but distinct phenomena. Firms may collaborate internationally on innovation without being jointly involved in the inventive process that gives rise to patents (e.g. joint marketing/distribution). The two indicators are calculated for different units of analysis (firm level for collaboration and invention level for patents) and cover slightly different periods. The former measures the share of patent applications with a least one foreign co-inventor (and may be driven by a small number of large firms with many co-inventions), while the latter measures the relative propensity of innovative firms to collaborate with foreign partners. Future work linking patent and innovation data at firm level should provide further insights into the links between invention and other innovation activities.

5. Skills mobility

International and foreign students enrolled in tertiary education, 2011

Totals and breakdown by field of education



Source: OECD calculations based on OECD (2013), *Education at a Glance: OECD Indicators*, OECD Publishing. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891454

Students moving abroad to study are an important source of knowledge flows between countries. High-quality tertiary education attracts skilled individuals in search of training and career opportunities, some of whom later return to their home countries. The United States is the main recipient of international students, followed by the United Kingdom, Australia, France and Germany. The distribution of international students by subject reveals key strengths in a country's knowledge base. Science and engineering attract a sizeable share of international students, particularly in Sweden, Finland, the United States, and Germany. In most OECD countries, the share of international students in this field exceeds that of domestic students.

Job mobility is an important driver of knowledge transfer and spillovers. There are significant differences among OECD countries in the share of employees who have been in their jobs for less than one year. Mobility rates appear to be higher in non-European countries. In most cases, tertiary-educated individuals have longer job tenures than their less educated counterparts. The economic downturn may have accentuated this pattern.

Among countries for which data are available, there are major differences in mobility of doctorate holders; it is highest in Germany, Denmark, Iceland and Poland. Those in research positions (a group that accounts for the majority of doctorate holders) are less likely to have moved jobs than those not working as researchers, partly because they are more likely to have tenured academic positions.

Definitions

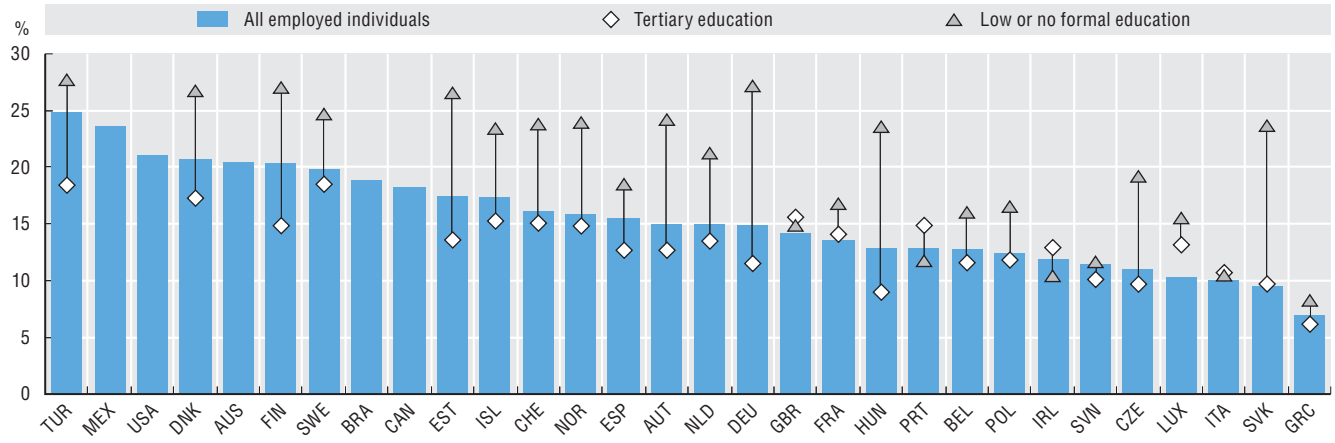
International students are students who have crossed borders expressly with the intention to study. The UNESCO Institute for Statistics, the OECD and Eurostat define as international students those who are not residents of their country of study or those who received their prior education in another 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 classification.

Labour turnover or mobility is defined as the share of individuals in employment who have been in their current or main job or with their current employer for less than one year.

Doctorate holders have received an advanced research qualification at Level 6 of ISCED-97. In the context of the Careers of Doctorate Holders (CDH) data collection, they are considered to have moved jobs if they worked for a different employer in the previous 10 years.

Labour turnover, by educational attainment, 2011

Individuals less than one year in their current job, as a percentage of employment



Source: OECD, based on the OECD Job Tenure Database, ad hoc tabulation of the European Labour Force Survey, July 2013; and Bureau of Labor Statistics, Employee Tenure statistics, *www.bls.gov/news.release/tenure.nr0.htm*, September 2012. See chapter notes.

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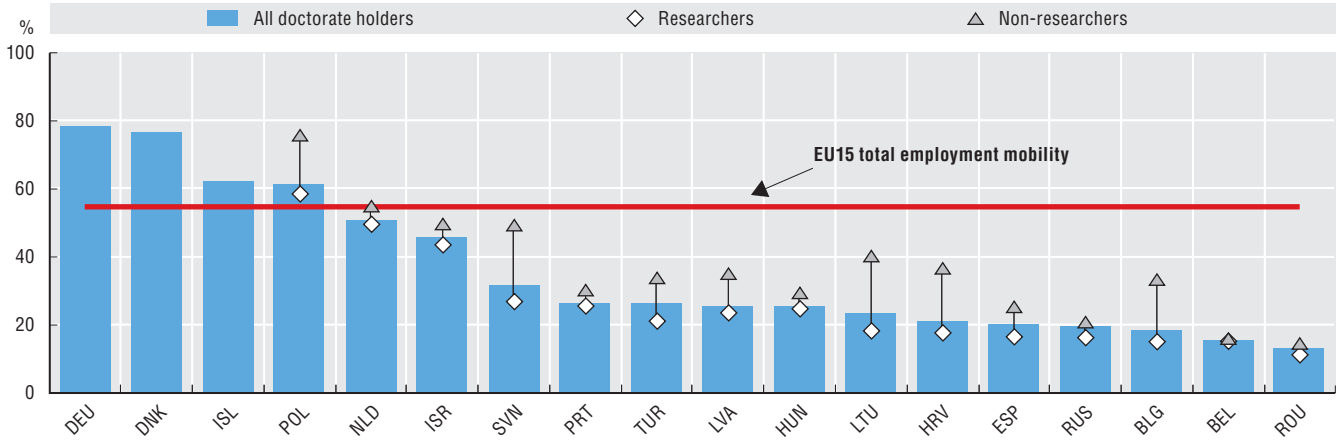
Doctorate holders who changed jobs in the last ten years, 2009

As a percentage of employed doctorate holders



Source: OECD, based on OECD/UNESCO Institute for Statistics/Eurostat data collection on careers of doctorate holders 2010 *www.oecd.org/sti/cdh* and OECD Job Tenure Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891492

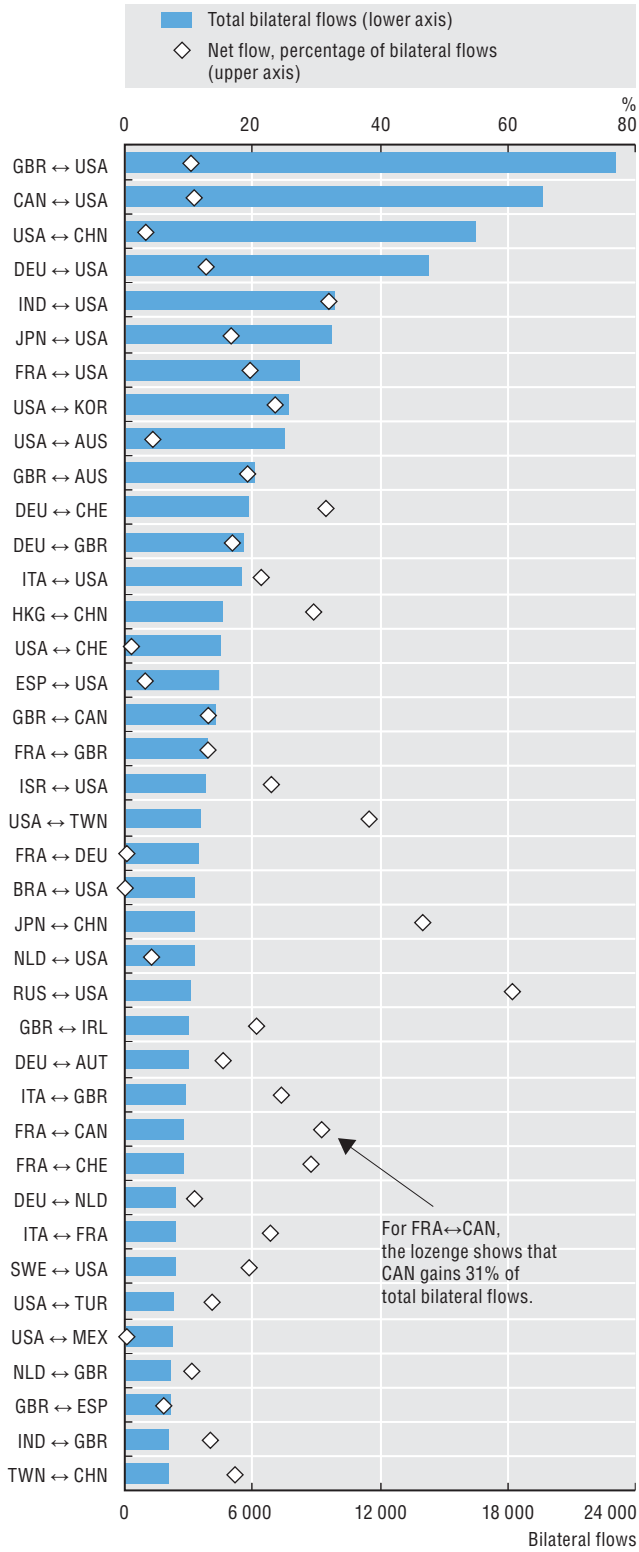
Measurability

Data on international students are from the 2012 OECD-UNESCO data collection on education statistics, based on tertiary enrolment data from countries of destination. 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 European Labour Force Surveys (LFS) are among the few internationally harmonised data sources that can be used to identify job mobility with job and personal characteristics. Information on whether job tenure of employees exceeds 12 months has been used as a proxy for job mobility. To ensure consistency with data collected for the OECD Job Tenure Database, estimates by qualification level based on EU LFS include individuals who were not in employment one year ago, thus combining job-to-job mobility and mobility into employment. Surveys carried out in the framework of the project on Careers of Doctorate Holders use a relatively broad ten-year reference window for recording mobility, but follow-on questions provide more detailed information for analytical purposes.

6. Researchers on the move

International flows of scientific authors, 1996-2011

Largest bilateral flows, by first and last affiliation



Source: OECD calculations based on Scopus Custom Data, Elsevier, version 5.2012, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891511

Scientific progress depends significantly on researcher mobility. A new experimental indicator tracks changes in the affiliation of scientists who publish in scholarly journals. The top nine international bilateral flows involve exchanges with the United States. While the total inflow exceeds the outflow, more scientists who start by publishing in the United States move to affiliations 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 in non-English speaking countries. These statistics do not account for the mobility of individuals before their first publication, e.g. as students.

Swiss-based authors have the largest mobility rates; nearly 20% have a previous affiliation abroad. In Japan, Brazil and China, researcher mobility stands at less than 5%. Mobility patterns vary across economies. In Italy, a majority of inflows are returnees (researchers who had an Italian affiliation for their initial recorded publication(s)); in Switzerland and Singapore the majority of researchers with an international mobility record are new inflows.

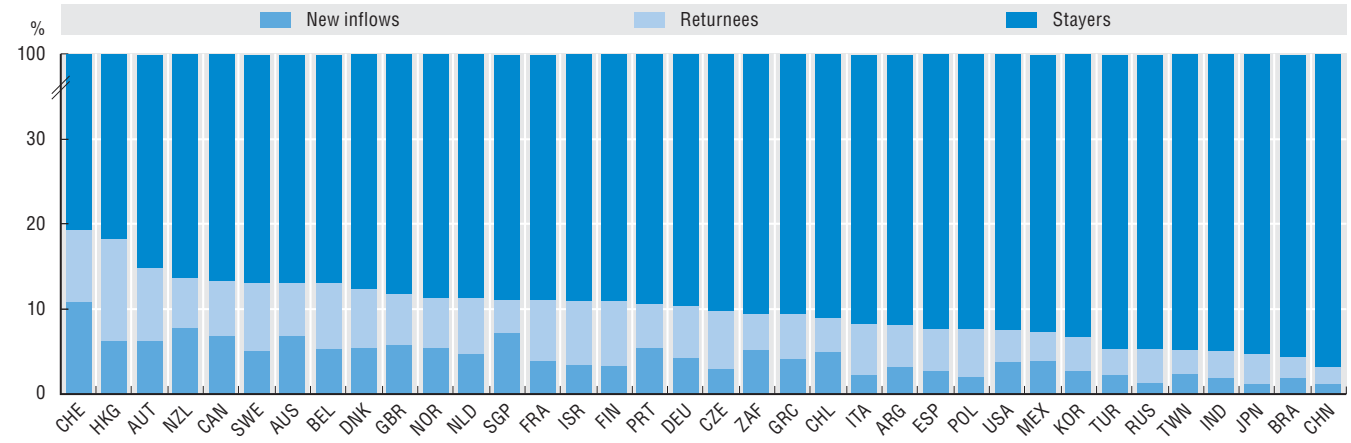
With few exceptions, stayers are more likely to publish in journals of lower quality. In economies with lower average research quality, outflows tend to have the largest impact factors. Returnees help to increase quality scores, as do new inflows. For many economies, raising the performance of stayers to the level of returnees would allow them to catch up with leading research nations.

Definitions

Scientific authors are listed in the Scopus database of peer-reviewed scientific publications and identified by the 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 their entire record. *Returnees* begin in the final country but "move" before returning, while *new inflows* are not first affiliated to institutions in their last recorded country. *Outflows* concern those who do not return to their first affiliation. A proxy of scientific impact is estimated by calculating, for each author and mobility profile, the median across journals' source-normalised impact per paper (SNIP). SNIP measures citation impact by calculating the ratio of a journal's citation count per paper and the citation potential in its subject field.

International mobility of scientific authors, 1996-2011

As a percentage of authors with two or more publications, by last reported affiliation



Source: OECD calculations based on Scopus Custom Data, Elsevier, version 5.2012, May 2013. See chapter notes.

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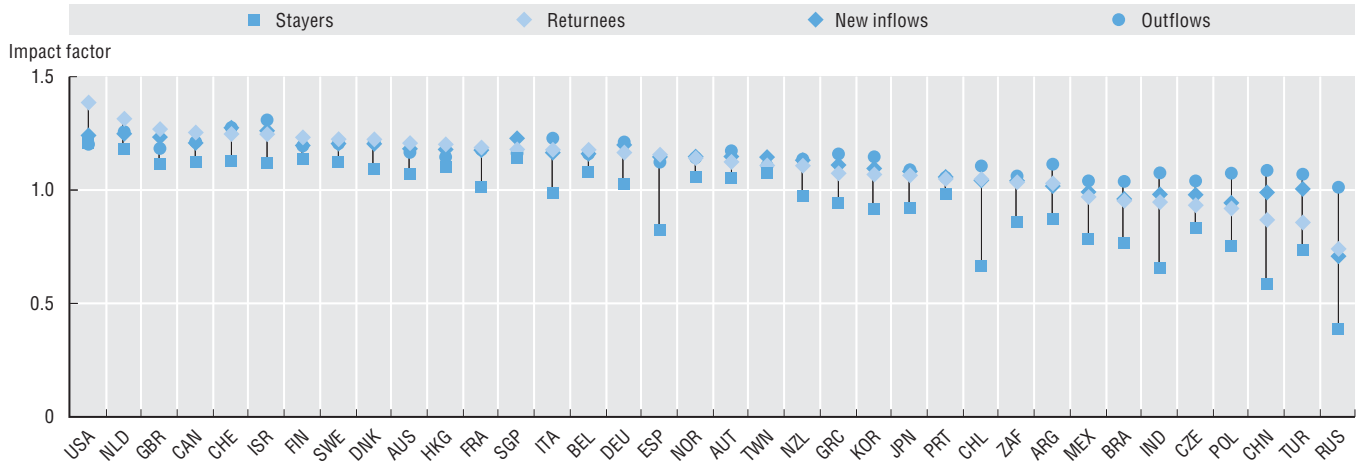
Impact of scientific authors, by category of mobility, 1996-2011

Based on the median source-normalized impact per paper (SNIP)



Source: OECD calculations based on Scopus Custom Data, Elsevier, version 5.2012, and SNIP2 Database, *www.journalmetrics.com*, Elsevier, Scimago and University of Leiden. May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891549

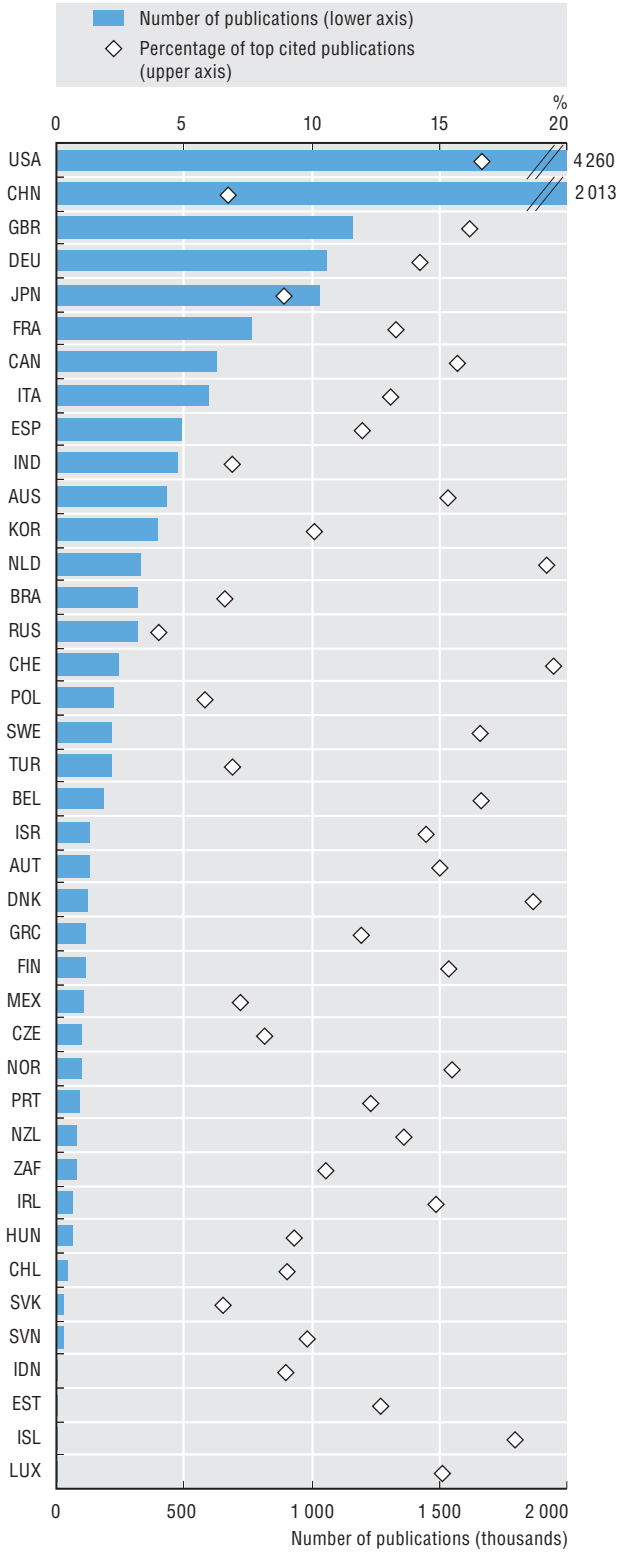
Measurability

Bibliometric indicators provide a complementary picture of researcher mobility at a global level. First developed by Elsevier (2011), these are experimental and require careful interpretation (Moed et al., 2013). Mobility records are less accurate for less prolific authors and for those who move from and into roles for which disclosure in scholarly journals is not the norm. Expanding the reference period can help capture more complex mobility patterns (e.g., to show that an individual returns to an initial affiliation requires at least three observations) but can introduce other biases. Institutional affiliations are often recorded with a lag and may not reflect where the research took place. Affiliations may also be multiple and require disambiguation. 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. A global initiative – the open researcher and contributor ID (ORCID) – seeks to deal with this problem by assigning unique identifiers linkable to an individual's research output.

7. Research excellence

The quantity and quality of scientific production, 2003-11

Number of documents and percentage of world's top-cited



Source: OECD and SCImago Research Group (CSIC), *Compendium of Bibliometric Science Indicators 2014*, based on Scopus Custom Data, Elsevier, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891568

Top-cited publications provide a measure of "quality-adjusted" research output. The United States led the production of scientific publications over 2003-11. Although China accounts for the second largest number of scientific documents, it lags 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 among domestic publications, closely followed by the Netherlands and Denmark.

Top-cited publications are more likely to involve scientific collaboration across institutions (international and domestic) than "average" publications. The collaboration gap is particularly large for the Russian Federation, Poland, the Slovak Republic and Estonia.

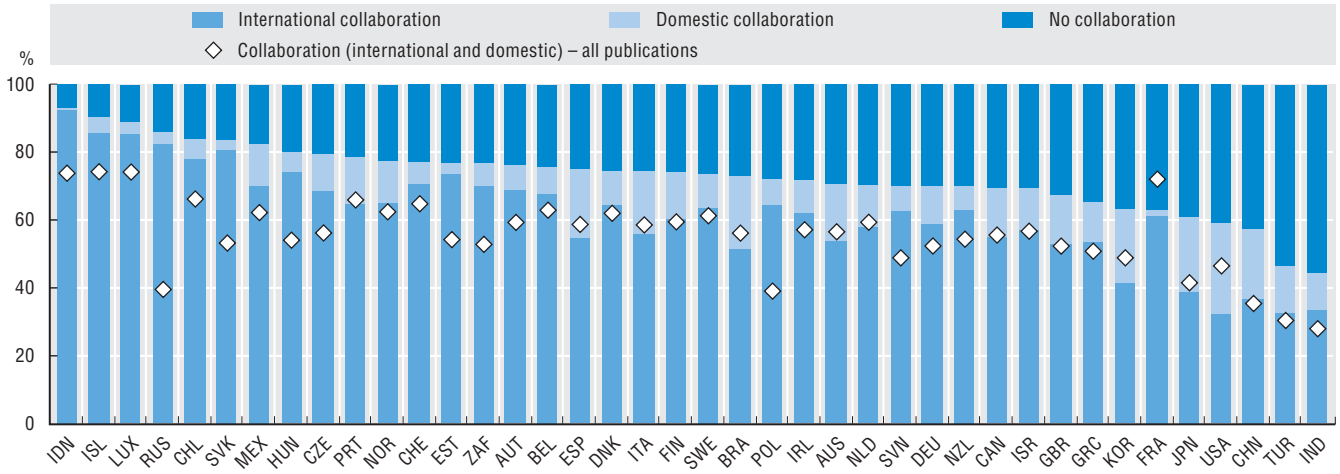
International collaboration rates and average impact are highly correlated. Countries with high shares of top-cited publications tend to have higher collaboration rates. Exceptions include the United States (high impact but low collaboration) and Indonesia (low impact but high collaboration). International collaboration appears to allow countries to attain higher citation impact rates than they would otherwise achieve. For many, this involves participating in projects led by experts in centres of excellence located abroad. Adjusting counts of high-impact documents for documents with a non-resident corresponding (i.e. leading) author would significantly reduce most economies' share of top-cited publications. For example, in Switzerland, the share would drop from nearly 20% to 10%. However, for the United States, the adjustment is fairly minor, from 17% to 14% of domestic publications. It is therefore the economy with the largest share of high-impact, domestically led documents, followed by the Netherlands and the United Kingdom. This suggests that authors from these countries are more likely to feature as leading authors in international collaborations.

Definitions

Estimates of scientific production are based on whole counts of documents by authors affiliated to institutions in each economy. The number of *top-cited publications* is an indicator of *research excellence* and represents the 10% most-cited papers in each scientific field. *Collaboration* is defined at the institutional level. A scientific document is deemed to involve collaboration if multiple institutions are listed in the affiliations of the author(s). Top-cited publications attributed to a given economy are defined as having a *domestic leading author* when the document's corresponding author is affiliated to a domestic institution.

Top-cited publications, by type of collaboration, 2003-11

As a percentage of top-cited and all documents, whole counts

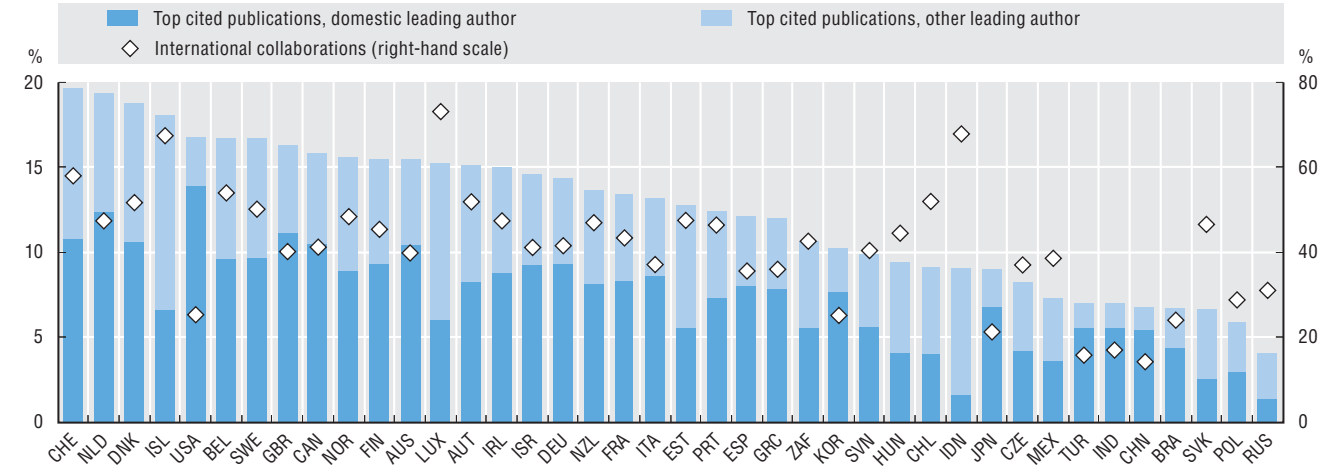


Source: OECD and SCImago Research Group (CSIC), *Compendium of Bibliometric Science Indicators 2014*, based on Scopus Custom Data, Elsevier, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891587

The quality of scientific production and international collaboration, 2003-11

As a percentage of scientific publications



Source: OECD and SCImago Research Group (CSIC), *Compendium of Bibliometric Science Indicators 2014*, based on Scopus Custom Data, Elsevier, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891606

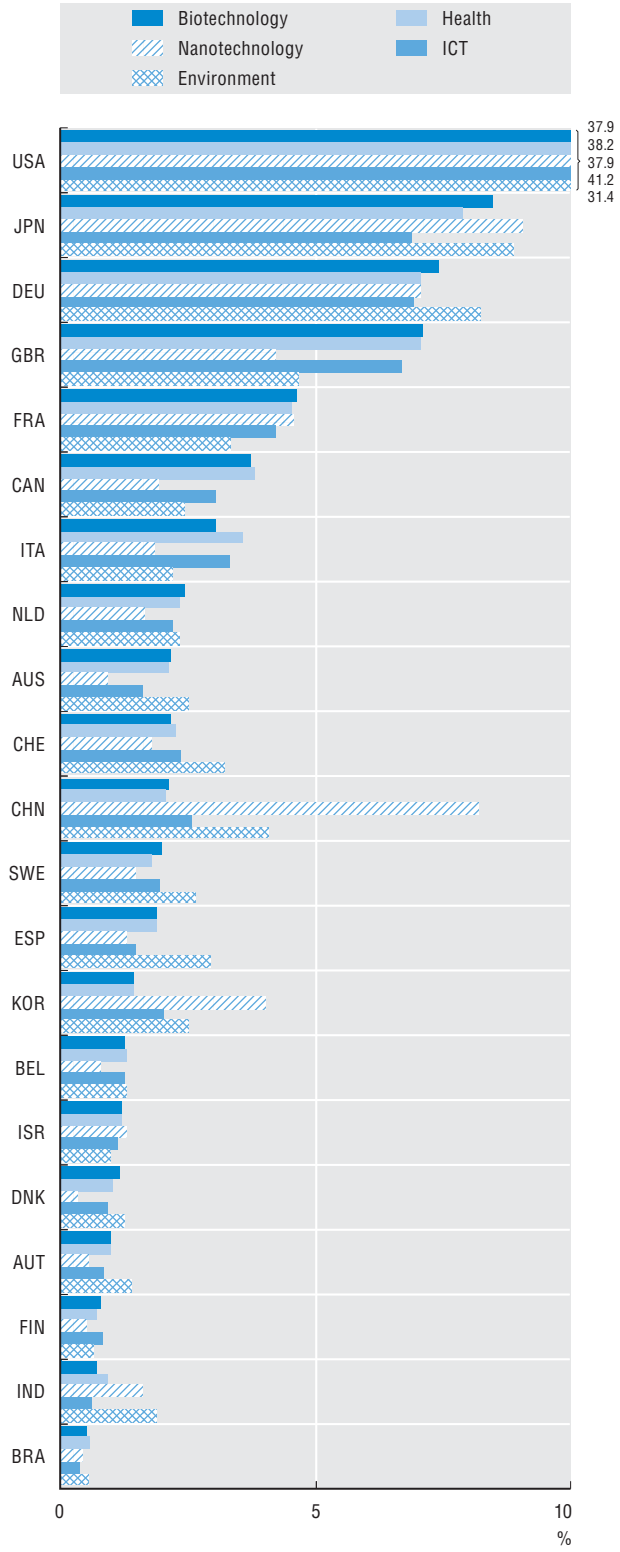
Measurability

Peer-reviewed scientific publications convey the research findings of scientists worldwide. Subsequent citations by other authors provide an indirect but objective source of information about the quality of research outputs. This does not however take into account the use of the scientific information by inventors or practitioners who are less likely to publish in peer-reviewed journals. Publications are attributed to countries on the basis of the authors' institutional affiliations. This requires a means of counting publications with co-authors from different units. One approach is to fractionalise publications by contributing units, so that reported figures add up to the total number of publications (each document has the same weight). An alternative is to report total counts per unit (the whole counts approach), which gives equal weight of one to each of the document's authoring units. Although the choice does not much affect country rankings, care should be exercised when interpreting either type of results. An alternative is to attribute the entire document to its leading author's affiliation using information on the identity of the corresponding author (Moya-Onegón et al., 2013).

8. Science for innovation

Main sources of scientific documents cited in patents, selected technology areas, 2001-11

As a percentage of scientific documents cited, by technology area



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 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891625

References to scientific literature in patents provide an indicator of knowledge flows between the science base and the innovation system. Scientific authors affiliated to US-based institutions account for more than a third of all scientific documents cited in patents in the areas of biotechnology, health, nanotechnology, ICT and environment. Available figures reveal a degree of specialisation in the production of patent-relevant science across technology areas. China, Japan and Korea have relatively larger shares of science relevant to nanotechnology and the environment. The United States accounts for 41% of total patent citations in ICT, well above its share in other areas. Among the areas considered, environment technologies are an important focus of patent-relevant science in Germany, while biotechnology and health-relevant science play an important role in the United Kingdom.

Biotechnology patents draw on a wide range of life sciences disciplines, among which clinical science leads with 30% of citations. The distribution is similar in health-related technology. For nanotechnology, instead, just five scientific fields account for 90% of citations. ICT patents draw on many of the life sciences, owing in part to the importance of ICT for new medical devices.

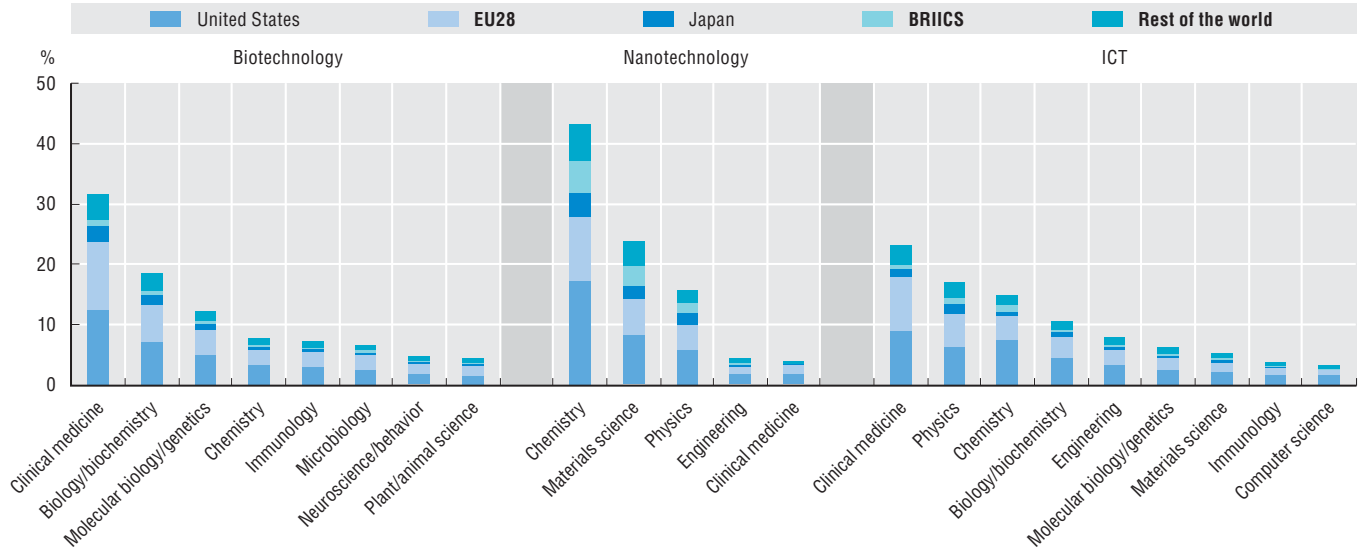
For each technology, differences in the shares accounted for by different geographical areas in the contributing science fields are not pronounced. The United States accounts for 50% of all computer science relevant to ICT, a higher share than for other fields cited by ICT patents. Japan accounts for nearly 15% of physics documents cited in environment-related patents and the BRIICS specialise in chemistry and materials science for nanotechnology patents.

Definitions

A field of science is described as relevant to a given technology area if it accounts for a significant share of the peer-reviewed scientific literature in references to non-patent literature in patent documents. Fields of science correspond to the Thomson Reuters Essential Science Indicators 22-field classification of journals. International Patent Classification (IPC) codes provide the basis for defining the relevant technology areas. Patents in health-related technologies comprise medical technologies and pharmaceuticals. The list of environment-related patent codes is available at *www.oecd.org/env/consumption-innovation/indicator.htm*. The list of biotechnology and ICT-related patent codes is available at *www.oecd.org/sti/inno/40807441.pdf*. Nanotechnology-related patents are defined as those with IPC codes B82B and B82Y. The geographic distribution of scientific publications cited in different areas is based on the institutional affiliation of authors.

Main scientific sources of biotechnology, nanotechnology and ICT patents, 2001-11

As a percentage of cited scientific publications, by technology area



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 2013. See chapter notes.

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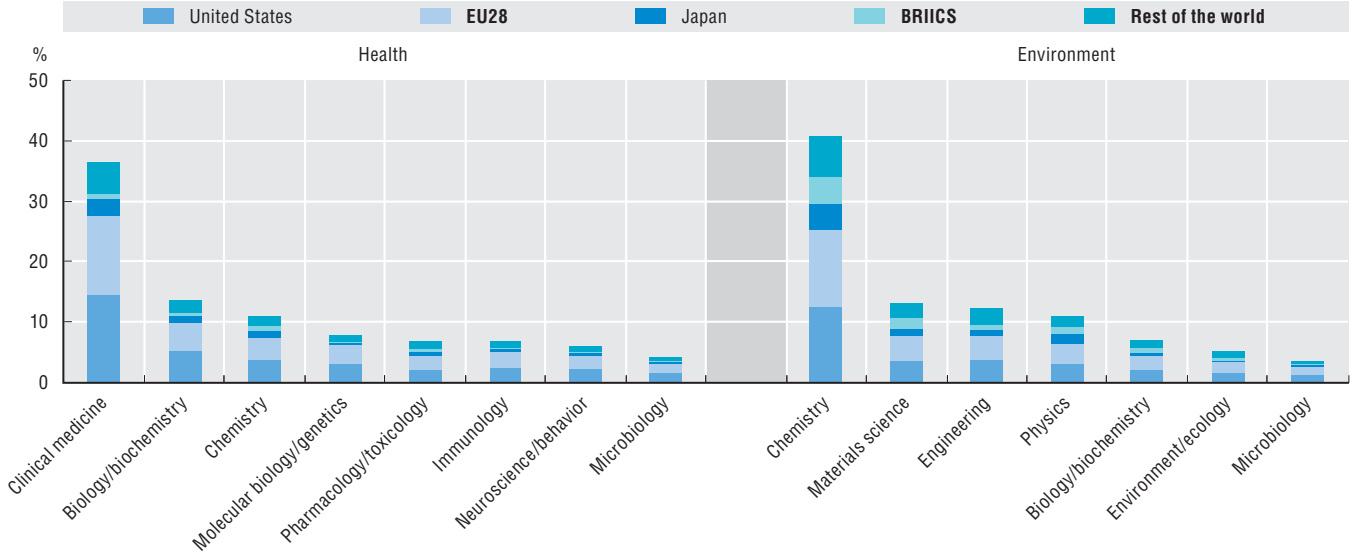
Main scientific sources of health and environment-related patents, 2001-11

As a percentage of cited scientific publications, by technology area



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 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932891663*

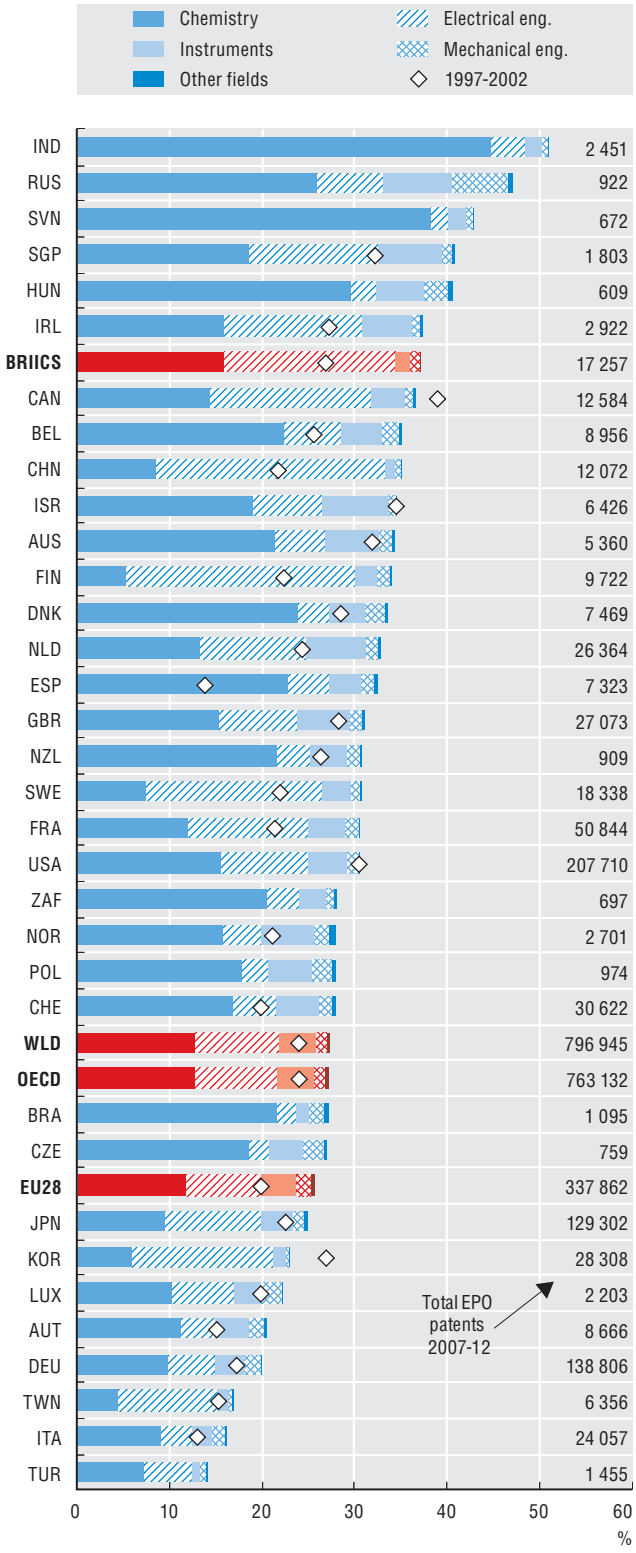
Measurability

Constructing indicators on the sources of scientific knowledge in patent documents, e.g. fields of science and author affiliation, requires linking references in the patent document to scholarly publications. The link is based on the non-patent literature (NPL) in commercial novelty-based patent families with priority dates 2001-11, using the Thomson Reuters Derwent World Patents Index and Derwent Patents Citation Index database of patent publications by major patent offices. It relies on an algorithm developed by Thomson Reuters and Japan's Science and Technology Agency, and matches NPL references to the Thomson Reuters Web of Science database, an index of peer-reviewed scientific literature. In order to focus on recent scientific literature, only publications from 2001 to 2011 are considered. The attribution of field of science and country of origin is based on unambiguously matched references. Estimates are on a whole counts basis and give full credit to each combination of reference and contributing country. Results may be sensitive to the choice of data sources, observation period, matching process and counting method used.

9. From knowledge to inventions

Patents citing non-patent literature by technology field, 1997-2002 and 2007-12

As a percentage of total patents by economies



Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891682

Inventions seeking patent protection must disclose the prior knowledge on which they rely: existing patents, scientific work and other sources of knowledge. These so-called backward citations are used to assess an invention's patentability and to define the legitimacy of its claims. They can also be used to uncover science-technology links, i.e. the extent to which technology developments, in the form of patented inventions, rely on science contained in non-patent literature (NPL): scientific publications, conference proceedings, databases and other relevant literature.

The share of inventions that build on NPL varies widely across technology fields and economies. Industrial structure, level of development, technological specialisation and the maturity of technology fields help to explain differences in observed propensities to cite NPL. More than 50% of Indian patents cite NPL, whereas the world and OECD averages are below 30%. Reliance on NPL has generally increased over time, in terms of the number of patents citing NPL and the average share of NPL citations per patent in biotechnology, nanotechnology, ICT, health and environmental technologies.

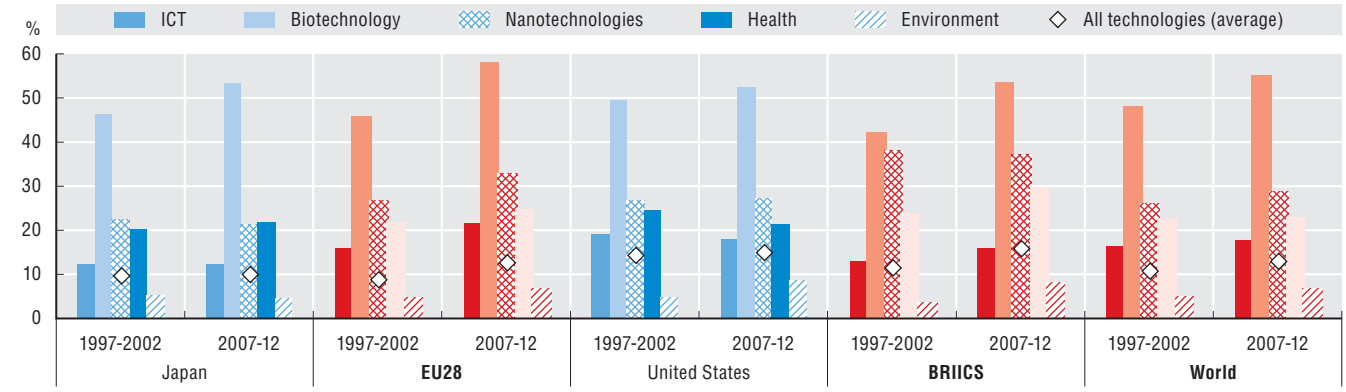
More than 20% of forward citations are to patents that cite NPL, with shares that exceed 50% in biotechnology and biomaterials, pharmaceuticals and digital communications. On average, around 4% of forward citations are to patents that do not cite any prior art, although for IT methods, engines and pumps, and thermal devices they are above 9%. The novelty of the fields and the lack of relevant prior art may explain these patterns.

Definitions

Backward citations are references to prior art contained in patent documents. Forward citations are citations received by a patent. Non-patent literature refers to backward citations to peer-reviewed scientific papers, conference proceedings, databases (e.g. DNA structures, gene sequences, chemical compounds, etc.) and other relevant literature, with the exception of patent abstracts and commercial patent databases. The share of NPL citations is calculated as the ratio of the number of NPL citations to the overall number of citations contained in a patent document. Technology fields are defined according to Schmoch's classification (WIPO, 2013) and rely on the International Patent Classification (IPC) codes of the patent document. Key domains, here called selected technologies, were identified by groups of experts on the basis of the IPC classes and the *ad hoc* tagging systems of the European Classification System (ECLA) that highlight the area of application of patented inventions.

Patents citing non-patent literature, selected technologies, 1997-2002 and 2007-12

Share of citations to NPL in backward citations, average

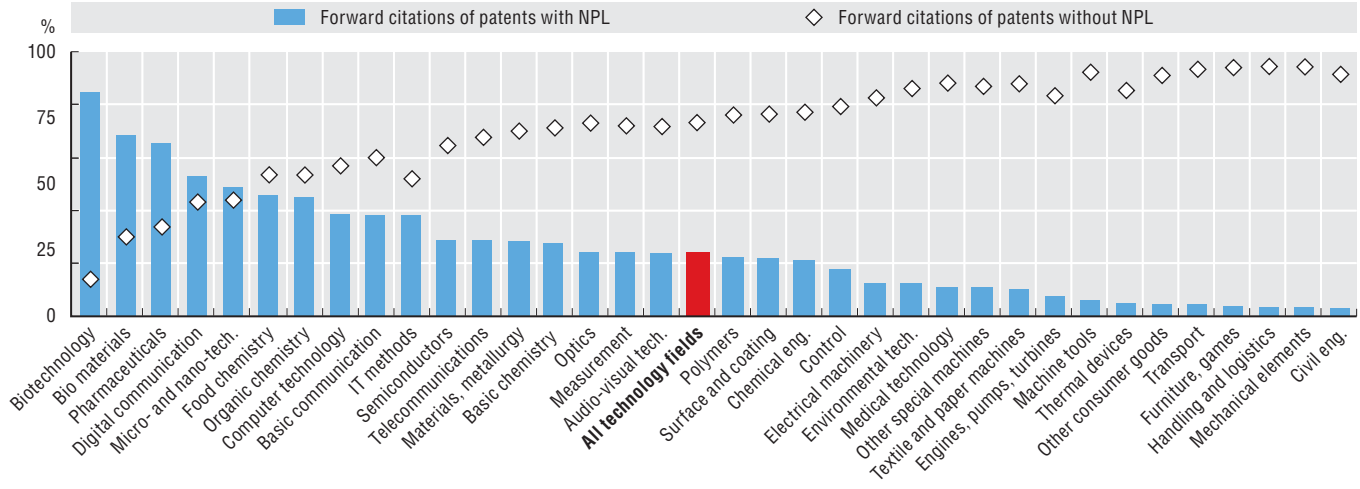


Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891701

Citations to patents that include non-patent literature, by technology fields, 2007-12

Share of total forward citations



Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891720

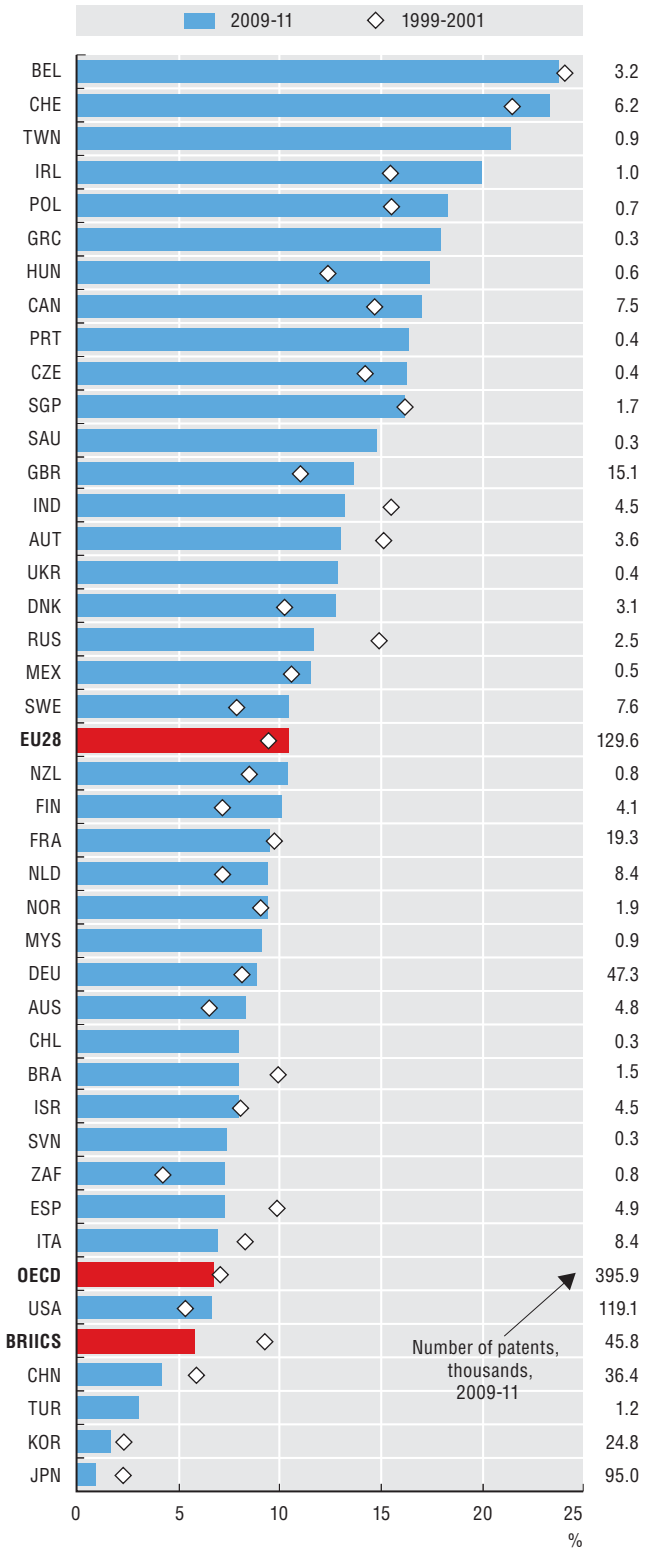
Measurability

Only patents published by the European Patent Office (EPO) are considered. Forward citation counts are based on EPO patents cited and take into account patent equivalents, that is, patent documents protecting the same invention at several patent offices. Only forward citations deemed particularly relevant for the examined patent – i.e. citations that examiners classify as I, X or Y (see Squicciarini, Dernis and Criscuolo, 2013) – are considered. Forward citations are counted over a period of 5 years after the publication date (typically 18 months after the filing date of the application). This should allow time for observing the citation patterns that characterise the technology fields. Backward counts instead concern all NPL cited in the patent document and are not restricted to I, X or Y classes. Fractional counts are used to assign patents to technology fields and to economies for both backward and forward citations. All citation counts include self-citations. The results may be contingent upon the data source used, the citation and counting methods followed and the observation period.

10. Inventions across borders

International co-inventions in patents, 1999-2001 and 2009-11

As a percentage of the economy's total patents



Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891739

The degree to which patented innovations result from collaboration by inventors located in different economies can be used as a measure of the internationalisation of research, of international R&D co-operation and of knowledge exchange among innovators.

The general rise in international co-inventions of patents shows that knowledge creation increasingly relies on external contacts, collaboration and exchanges that allow innovators to gain access to the competences and skills they need. Across economies, however, the share of patented inventions due to international teams ranges from 2% to 24%. Over time, economies such as India, Brazil and the Russian Federation have relied relatively more on their own science base than on international co-invention. In contrast, Ireland, Hungary and the United Kingdom appear to rely increasingly on international teams of inventors.

There are also marked differences in the extent to which patents in different technology fields involve international collaboration of inventors. In polymers and organic or food chemistry, international co-inventions account for more than 12% of patented inventions, whereas in audio-visual technologies, transport, furniture and games, they generally account for around 4%.

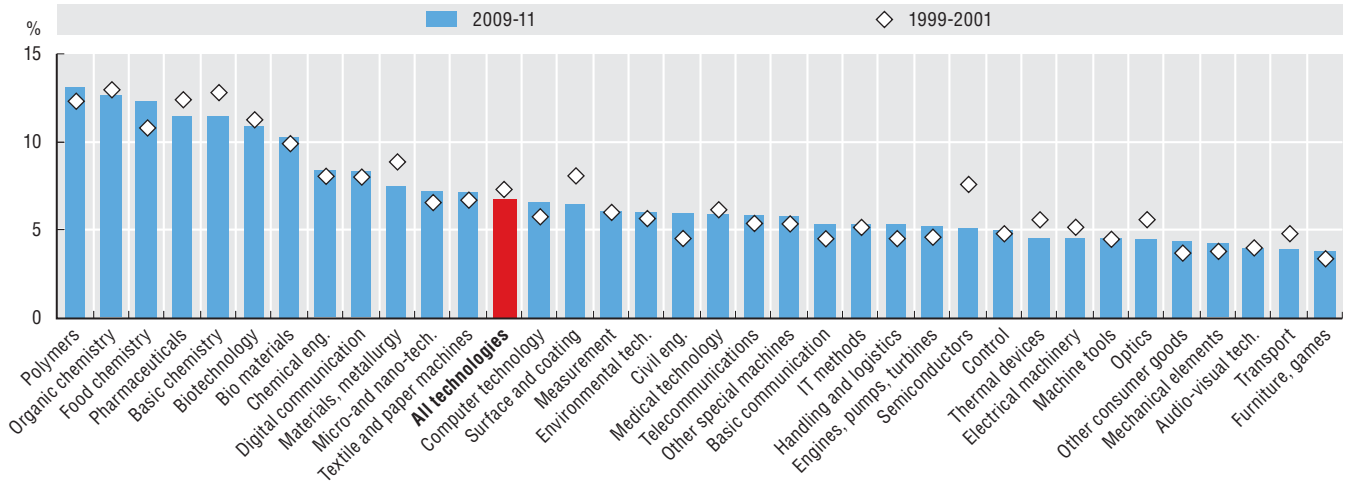
When comparing the share of patents owned by an economy with the proportion of these patents that were fully invented in another economy or economies, it appears that many economies owning a large share of patents invented by foreign businesses have large multinational firms that perform R&D abroad. The tax environment is also likely to play a role in the location of the intellectual property.

Definitions

International co-inventions feature at least one foreign co-inventor in patents invented domestically. Patents in different technology fields may have a different propensity to involve co-invention. The co-invention indicator is calculated by dividing the percentage of international co-inventions by the total number of patents invented domestically in the same field. Technology fields are defined according to Schmoch's classification (WIPO, 2013) and rely on the International Patent Classification (IPC) codes contained in the patent document. *Foreign inventions* are patents for which all of the inventors reside in economies other than that of the owner(s). Data relate to published patent applications filed through the PCT system.

International co-inventions by technology fields, 1999-2001 and 2009-11

As a percentage of PCT patent applications.

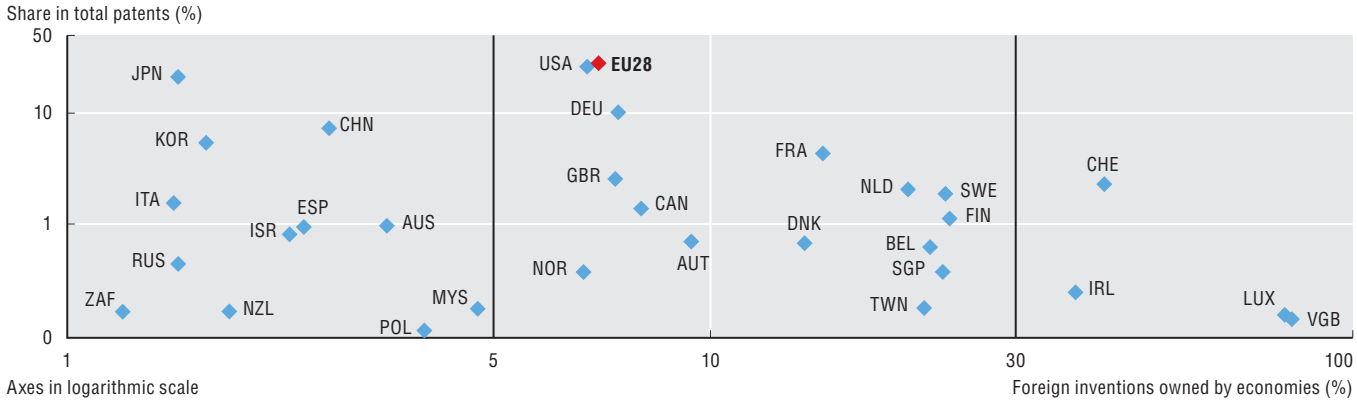


Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891758

Foreign inventions owned by economies, 2009-11

Relative to their share in patent applications, percentages, axis in logarithmic scale



Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891777

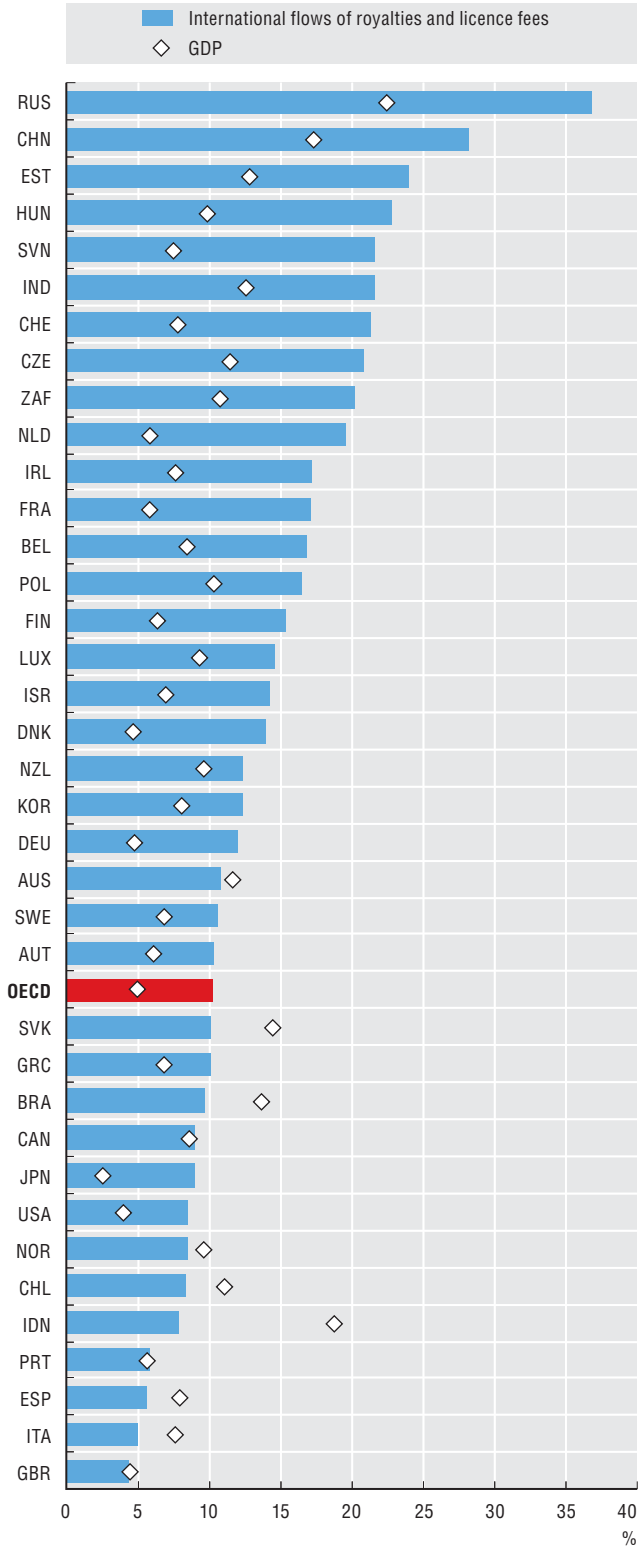
Measurability

Inventors have differing specialisations and knowledge assets and often require competences or resources beyond their national borders. The resulting international collaboration may take the form of 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); or formal and informal networks of scientists. In the case of multinational corporations, international collaboration often reflects companies' wish to obtain geographically dispersed knowledge and/or to develop complementarities with foreign inventors. The location of patent ownership may reveal the importance of intellectual property (IP) tax regimes and indirectly points to the attractiveness of tax incentives for IP revenues and the importance of tax planning strategies. Using data from different patent offices may lead to different results.

11. Technology flows and markets

International technology flows of royalties and licence fees, 2000-11

Average annual growth rate, based on current USD, percentages



Source: OECD, Technology Balance of Payments Database; OECD, Trade in Services Database; World Bank, World Development Indicators; OECD, Annual National Accounts Database and OECD estimates, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891796

Royalties and licence fees are an important part of international technology flows. Over the past decade, they grew faster than GDP in most countries. In the Russian Federation and China, international flows of royalties increased by more than 25% a year.

Intermediaries play a small but important role in knowledge markets. New official statistics provide information on companies whose main economic activity is the licensing of intellectual property (IP). This sector is particularly developed in the United States, with over USD 25 billion in revenue. Among countries for which data are available, Luxembourg has the highest ratio of revenues to total expenditures on knowledge-based capital (KBC) assets within the scope of this sector's activities. The United Kingdom and Italy appear to have low levels of specialist licensing activity in relation to their investment in KBC.

Specialist firms account for only a fraction of total licensing revenue. Tax-based data from the US Statistics of Income show that computer and electronics manufacturing firms and chemicals manufacturers, including pharmaceuticals, account for the largest volumes of reported royalty income. The specialist licensing sector has the largest share of income from royalties (close to 55%), followed by the computer and film and sound recording industries (close to 6%) and publishing and chemical industries (close to 4%). In most industries, the share of revenue accounted for by royalties has increased significantly over the last decade.

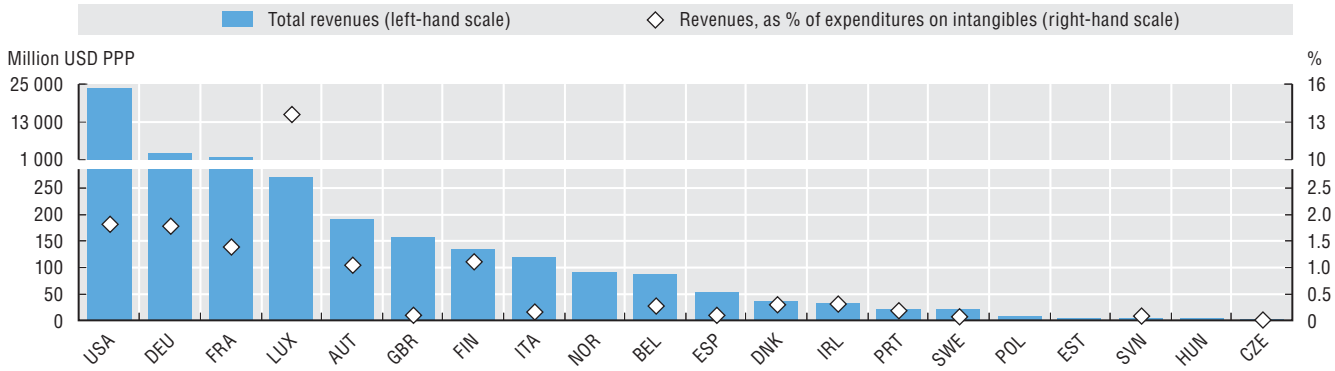
Definitions

In international trade statistics, *Royalties and licence fees* are payments and receipts between residents and non-residents for the use of intangible, non-produced, non-financial assets and proprietary rights such as patents, copyrights, trademarks, industrial processes and franchises; and for the use of produced originals or prototypes.

Specialist intellectual property leasing firms refers to European firms in the NACE Rev.2 sector 774 (Leasing of intellectual property and similar products, except copyrighted works) and US firms in the equivalent North-American Industrial Classification System (NAICS) sector 533 (Lessors of nonfinancial intangible assets – excluding copyrights). This includes establishments primarily engaged in assigning rights to *intangible assets*, such as patents, trademarks, brand names, and/or franchise agreements, for which a royalty payment or licensing fee is paid to the asset holder. Royalties are one component of income (receipts) reported in US Corporation Income Tax Return Form 1120. *Knowledge-based capital* is a recent term used by OECD to encompass the pre 2008 SNA definition of intangible assets, some of which now fall under the category of *Intellectual Property Products*.

Revenues of specialist intellectual property leasing firms, 2010

Total and as a percentage of business investment in R&D, other innovative property and economic competences

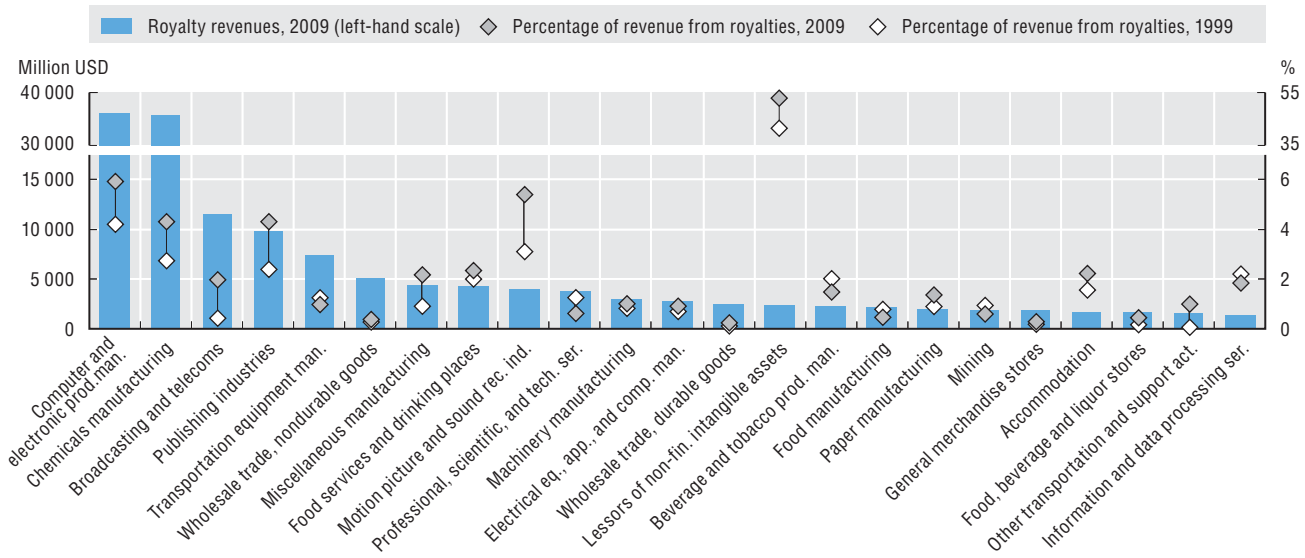


Source: OECD, based on data from Eurostat, Annual detailed enterprise statistics for services; United States Census Bureau, 2011 Annual Services Report; and INTAN-Invest Cross-country Intangible Investment Database, *www.intan-invest.net*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891815

Royalty income by industry, United States, 1999 and 2009

As a percentage of revenues reported to the United States Internal Revenue Service



Source: OECD calculations based on United States Internal Revenue Service's Statistics of Income, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891834

Measurability

The measurement of licensing flows is subject to various conceptual and practical difficulties. Licensing transactions may not involve the transfer of knowledge and may purely reflect tax planning strategies. 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 knowledge products. Many firms in the IP leasing sector are subsidiaries managing their parents' IP portfolio without necessarily engaging in arms-length transactions. As information on this sector has only become recently available, comparability may be limited while business registers and classification criteria adapt to the latest international classification of economic activities. Statistics of Income (SOI) data for active US-based corporations are estimated from a sample of corporate income tax returns. They may include payments for the exploitation of natural resources. For more information on knowledge flows, knowledge markets and their measurement, see *www.oecd.org/sti/knowledge*.

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 recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'."

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

"The Republic of Cyprus is 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. R&D and knowledge flows

Business enterprise R&D funded by other companies, 2010

Data refer to 2010 except for Austria (2009), Brazil (2009), the Czech Republic (2011), Denmark (2009), Iceland (2009), New Zealand (2009), Norway (2011), South Africa (2009), Sweden (2009), Switzerland (2008) and the United States (2009).

Reported funding by other firms includes funding from other domestic enterprises that are part of the same group, except for Finland and New Zealand.

For Brazil, data on the share of BERD funded by industry are not available.

Business funding of extramural R&D, by type of performer, 2010

Data refer to 2010 except for Austria (2009), Belgium (2009), the Czech Republic (2011), Germany (2009), New Zealand (2009), Norway (2011), Sweden (2009), Switzerland (2008) and the United States (2009).

"Other" includes funding to non-business institutions, both domestic and abroad. For Germany and Japan, it also includes funding to enterprises abroad.

For the Czech Republic, Estonia, Italy, Korea, the Slovak Republic, Spain and Turkey, reported data exclude funding by non-R&D performers.

Business-funded R&D in the higher education and government sectors, 2001 and 2011

For Australia, data refer to 2000 and 2008 instead of 2001 and 2011.

For Austria, data refer to 2002 and 2009 instead of 2001 and 2011.

For Belgium, Iceland, Israel, the Netherlands and South Africa, data refer to 2009 instead of 2011.

For Chile, EU28, France, Germany, Italy, OECD, Portugal and Spain, data refer to 2010 instead of 2011.

For China, data refer to 2000 instead of 2001.

For Switzerland, data refer to 2000 and 2010 instead of 2001 and 2011.

3.2. Open innovation

General notes for all figures:

For Australia, data refer to financial year 2010/11 and include product, process, marketing and organisational innovating firms (including ongoing or abandoned innovation activities).

For Brazil, data refer to 2006-08. Only the following activities are included in the services sector: ISIC Rev.4 Divisions 58, 61, 62 and 72.

For Chile, data refer to 2009-10 and to firms with more than UF 2 400 in annual revenue. Data include product, process, organisational and marketing innovating firms. Ongoing or abandoned innovative activities are not identified. The industries covered are based on ISIC Rev.3.1 and include a wider range of activities than the CIS, such as agriculture, forestry, fishing, construction and some services.

For Israel, data refer to 2006-08.

For Japan, data refer to financial years 2009/10 and 2010/11. Data are provisional estimates.

For Korea, data refer to 2005-07 and to firms with more than 10 employees in the manufacturing sector.

For Mexico, data refer to 2008-09 and to firms with 20 or more employees. The industries covered are based on ISIC Rev.3.1 and include a wider range of activities, such as agriculture, construction and some services.

For New Zealand, data refer to financial years 2009/10 and 2010/11, and to firms with six or more employees with an annual goods and services tax (GST) turnover figure greater than NZD 30 000. Data refer to product, process, organisational and marketing innovating firms (including ongoing or abandoned innovation activities).

For the Russian Federation, data refer to 2009-11 and to firms with 15 or more employees. The industries covered are based on NACE Rev.1.1 and include manufacturing (D), and services (64, 72, 73, 74).

For South Africa, data refer to 2005-07 and to firms with 20 or more employees, with a minimum turnover of between ZAR 3 million and ZAR 6 million depending on the industry. Data also include the retail trade sector.

For Switzerland, data refer to 2009-11. Collaboration only refers to collaboration on R&D.

Additional notes:

External sources of knowledge for innovation, by type, 2008-10

In the Australian questionnaire it is only asked whether the relevant source was used, not the degree of importance of the source.

For Germany, Israel, Luxembourg, the Netherlands and Switzerland, data refer to 2006-08.

In the New Zealand questionnaire, sources of information are defined as important, rather than highly important.

3.3. Collaboration on innovation

General notes for all figures:

See under 3.2.

Additional notes:

Firms engaging in collaboration on innovation, by R&D status, 2008-10

For Luxembourg, data refer to 2006-08.

For Spain, R&D status corresponds to 2010 only.

Firms collaborating on innovation with higher education or public research institutions, by firm size, 2008-10

For Ireland, Israel and Luxembourg, data refer to 2006-08.

For Mexico, data refer to collaboration with higher education institutions only.

3.4. International collaboration

General notes for all figures:

See under 3.2.

Additional notes:

National and international collaboration on innovation by firms, 2008-10 and Firms engaged in international co-operation, by firm size, 2008-10

For Ireland and Luxembourg, data refer to 2006-08.

International collaboration on patents, 2007-11 and innovation, 2008-10

International co-inventions are measured as the share of patent applications filed under the Patent Cooperation Treaty (PCT) with at least one co-inventor located in a different country in total patents invented domestically. Patent counts are based on the priority date, the inventor's country of residence and whole counts.

3.5. Skills mobility

International and foreign students enrolled in tertiary education, 2011

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 chart.

Total enrolments include all international or foreign students. Distribution is based on the number of students with a known field of education.

Data for Austria, Finland, Germany and Switzerland exclude tertiary-type B programmes.

Data for Canada and Luxembourg refer to 2010.

Data for the Netherlands exclude programmes in private education.

Labour turnover, by educational attainment, 2011

With the exception of the United States, the indicator for all employed individuals is computed on the basis of the OECD Job Tenure Database as a share of declared figures for total employed (dependent employees and self-employed) of all age groups. Estimates by level of educational attainment are based on an *ad hoc* tabulation of European Labour Force Survey data and computed on a similar basis.

For the United States, data refer to the share of all wage and salary workers aged 16 and over with a year or less of tenure with their current employer in January 2012.

Tertiary education refers to individuals who have graduated from tertiary education (ISCED 5 and 6 levels); low or no formal education refers to individuals with at most lower secondary education (ISCED 0, 1 and 2 levels).

For Australia and Canada, data refer to 2010.

For Brazil, data refer to 2009.

For Mexico, data refer to 2008.

Doctorate holders who changed jobs in the last ten years, 2009

For Belgium, Hungary, the Netherlands and Spain, data refer to graduates only from 1990 onwards.

For the Russian Federation, data refer only to those doctoral graduates employed as researchers and teachers.

For Spain, there is limited coverage of graduates who received their doctorate between 2007 and 2009.

EU15 total employment mobility is computed on the basis of the OECD Job Tenure Database and corresponds to the share of 25-69 year-old employed individuals who have changed jobs in the last ten years.

3.6. Researchers on the move

International flows of scientific authors, 1996-2011

The minimum threshold for inclusion is over 2 000 bilateral flows.

General note:

International mobility of scientific authors, 1996-2011 and;

Impact of scientific authors, by category of mobility, 1996-2011

The minimum threshold per economy is over 25 000 scientific authors in the stayer category.

Additional note:

Impact of scientific authors, by category of mobility, 1996-2011

International mobility of scientific researchers is inferred from authors listed in the Scopus Custom database of peer-reviewed scientific publications, with at least two documents over the reference period, based on changes in the location of their institutional affiliation. Stayers maintain an affiliation in a given reference country over the period. Outflows are defined on the basis of the first affiliation. New inflows are defined on the basis of the final affiliation and exclude individuals who "return" to their original country of affiliation. The latter group are defined as "returnees".

A proxy measure of scientific impact for researchers with different mobility patterns is estimated by calculating, for each author and mobility profile, the median across the relevant journals' source-normalised impact per paper (SNIP) over the entire period. A SNIP impact value that is higher than one means that the median attributed SNIP for authors of that country/category is above average.

3.7. Research excellence

General note for all figures:

Estimates are based on whole counts of documents by authors affiliated to institutions in each economy.

3.8. Science for innovation

General notes for all figures:

The link between patents and scientific literature is based on the non-patent literature (NPL) listed as relevant references in patent documents in the Thomson Reuters Derwent World Patents Index and Derwent Patents Citation Index databases. It is applied to patents in selected technology areas, based on the International Patent Classification (IPC) codes in the patent document.

In order to identify whether NPL corresponds to a scientific document, NPL references were matched to the Thomson Reuters Web of Science Database, an index of scientific literature. For matched references, scientific domains correspond to the Thomson Reuters Essential Science Indicators 22-field classification (*http://archive.sciencewatch.com/about/met/fielddef/*). Geographical attribution of scientific documents is based on the document's author's affiliation, using a "whole counts" approach.

Only the main scientific domains accounting for 90% of total patent citations to the scientific literature are reported.

Additional notes:

Main sources of scientific documents cited in patents, selected technology areas, 2001-11

Patents in health-related technologies comprise medical technologies and pharmaceuticals. The list of environment-related patent codes is available at *www.oecd.org/env/consumption-innovation/indicator.htm*. The list of biotechnology and ICT-related patent codes is available at *www.oecd.org/sti/inno/40807441.pdf*. Nanotechnology-related patents are defined as those with IPC codes B82B and B82Y.

Main scientific sources of biotechnology, nanotechnology and ICT patents, 2001-11

The list of biotechnology and ICT-related patent codes is available at *www.oecd.org/sti/inno/40807441.pdf*. Nanotechnology-related patents are defined as those with IPC codes B82B and B82Y.

Main scientific sources of health and environment-related patents, 2001-11

The link between health-related patents and scientific literature is applied to patents in medical technologies and pharmaceuticals following the classification presented in Schmoch (WIPO, 2008, revised in 2013).

The list of environment-related patent codes is available at *www.oecd.org/env/consumption-innovation/indicator.htm*.

3.9. From knowledge to inventions

General notes:

Patents citing non-patent literature by technology field, 1997-2002 and 2007-12 and;

Patents citing non-patent literature, selected technologies, 1997-2002 and 2007-12

Data refer to the citations made in patent applications filed at the European Patent Office (EPO), according to the publication date of the citing patent, the applicant's residence and fractional counts.

Additional notes:

Patents citing non-patent literature by technology field, 1997-2002 and 2007-12

Only economies with more than 500 patents in 2007-12 are included in the figure. Patents are allocated to technology fields using International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised in 2013).

Patents citing non-patent literature, selected technologies, 1997-2002 and 2007-12

Patents are allocated to technological fields using the International Patent Classification (IPC) or the European Patent Classification (ECLA).

Citations to patents that include non-patent literature, by technology fields, 2007-12

Data refer to the citations made in patent applications filed at the European Patent Office (EPO), according to the publication date of the citing patent. Forward citations of patents refer to patents with NPL backward citations that are cited as particularly relevant documents (I, X, Y) by EPO patents up to five years after the first publication. Patents are allocated to technology fields using International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised in 2013).

3.10. Inventions across borders

International co-inventions in patents, 1999-2001 and 2009-11

International co-inventions are measured as the share of patent applications filed under the Patent Cooperation Treaty (PCT) with at least one co-inventor located in a different economy in the total patents invented domestically. Patent counts are based on the priority date, the inventor's residence and fractional counts. Only economies with more than 250 patents in 2009-11 are included.

International co-inventions by technology fields, 1999-2001 and 2009-11

International co-inventions are measured as the share of patent applications filed under the Patent Cooperation Treaty (PCT) with at least one co-inventor located in a different country in total patents. Patents are allocated to technology fields using International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised in 2013). Patent counts are based on the priority date and fractional counts by technology fields.

Foreign inventions owned by economies, 2009-11

Data refer to counts of patent applications filed under the Patent Cooperation Treaty, by priority date, applicant's residence and fractional counts. 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. Only economies that applied for more than 250 patents over the period are included.

3.11. Technology flows and markets

International technology flows of royalties and licence fees, 2000-11

For Belgium and the Russian Federation, data refer to 2003-11.

For Denmark and Indonesia, data refer to 2005-11.

For the Netherlands, data refer to 2004-11.

For Norway, data refer to 2000-10.

For Italy, data refer to 2000-07.

OECD excludes Iceland, Mexico and Turkey.

Revenues of specialist intellectual property leasing firms, 2010

For European countries, revenue estimates correspond to firms in NACE Rev.2 sector 774 ("Leasing of intellectual property and similar products, except copyrighted works"). For the United States, estimates correspond to NAICS sector 533 ("Lessors of nonfinancial intangible assets – excluding copyrights"). Revenue estimates are divided by INTAN-Invest estimates of business sector investment in "new intangible assets" (R&D, design, new financial products, advertising, market research, training and organisational capital). This category approximately corresponds to the products within the scope of the IP leasing sector.

Royalty income by industry, United States, 1999 and 2009

Data on royalties and revenues (receipts) from the United States Internal Revenue Service's Statistics of Income (SOI), Table 6 – Returns of Active Corporations, Form 1120, *www.irs.gov/uac/SOI-Tax-Stats-Returns-of-Active-Corporations-Table-6*, "Balance Sheet, Income Statement, Tax, and Selected Other Items, by Major Industry". Figures are estimates based on samples. Last accessed June 2013.

Only the 23 industries with the highest royalty income are reported. For 2009, Broadcasting and telecommunication is calculated as the sum of Broadcasting except Internet and Telecommunication (including paging, cellular, satellite, cable, internet, service providers, etc.). For 2009, Information and data processing services were calculated as the sum of Data processing services and Other information services.

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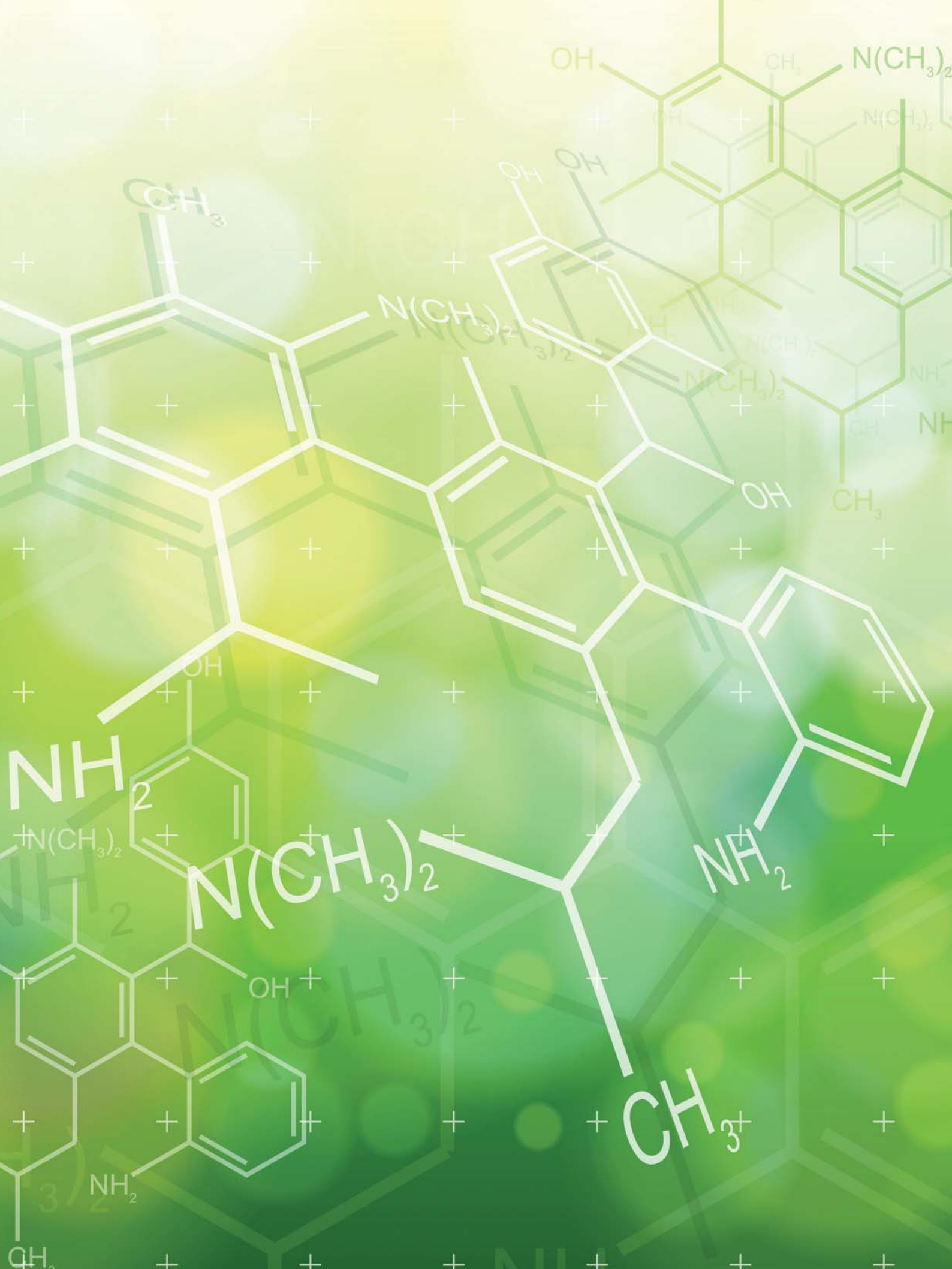
Squicciarini, M., H. Dernis and C. Criscuolo (2013), "Measuring Patent Quality: Indicators of Technological and Economic Value", *OECD Science, Technology and Industry Working Papers*, No. 2013/03, OECD Publishing. Doi: *http://dx.doi.org/10.1787/5k4522wkw1r8-en*.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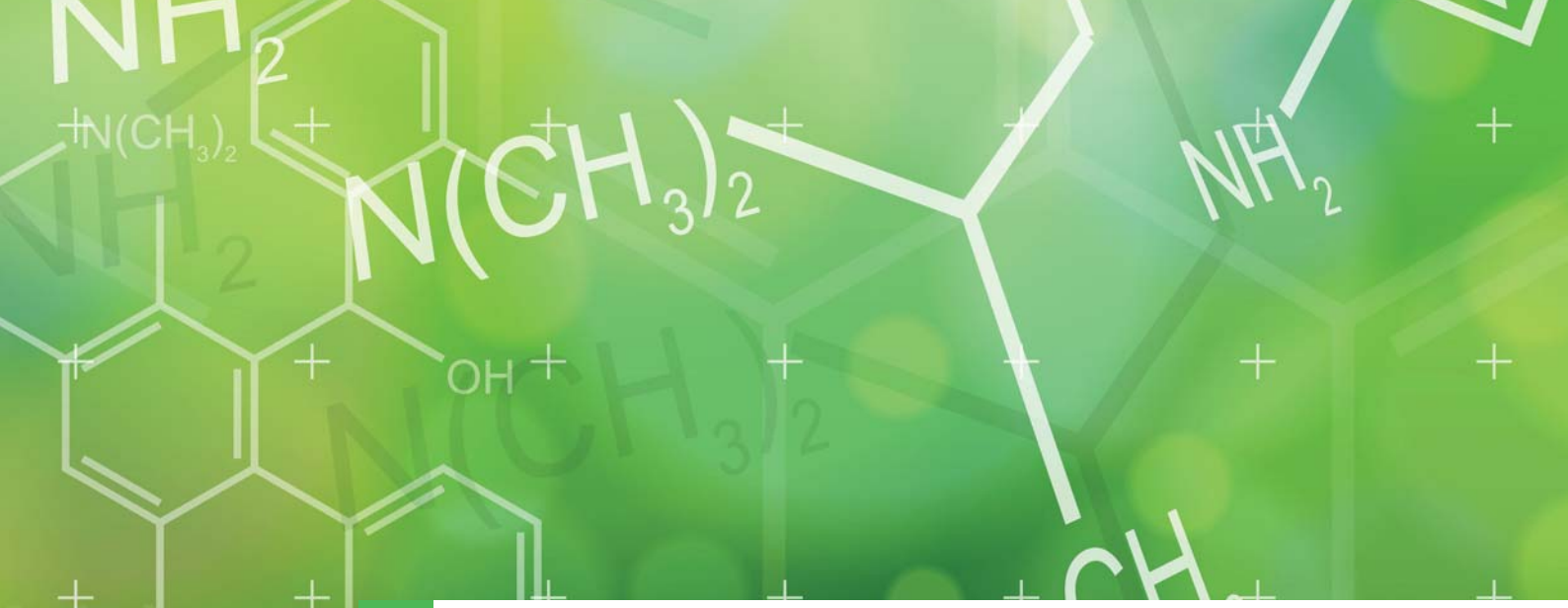


4. TARGETING NEW GROWTH AREAS

1. R&D funding and specialisation
2. Green innovation
3. Health innovation
4. Biotechnology R&D
5. Nanotechnology R&D
6. ICT innovation
7. Broadband price and quality
8. Fixed and wireless broadband
9. Internet users
10. Emerging technologies

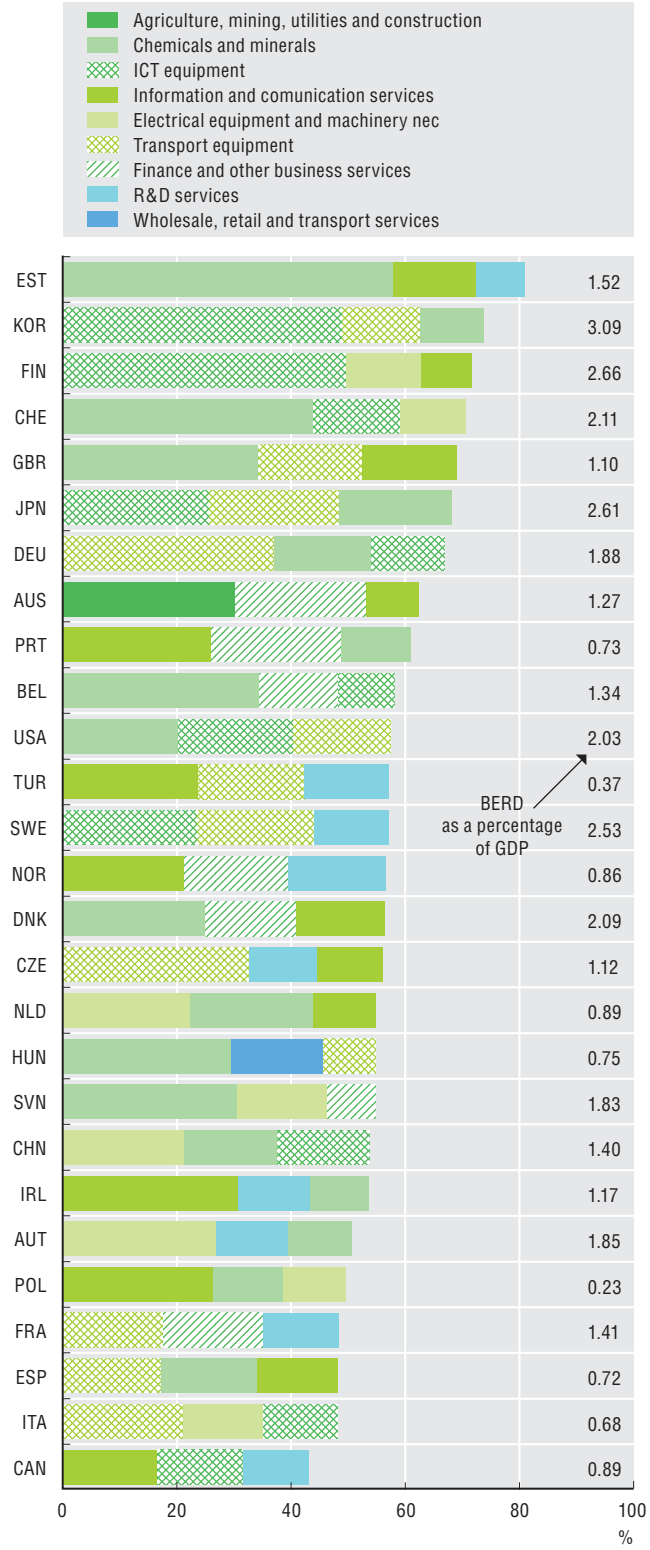
Notes and References

The idea that innovation and technological change are important means of dealing with global and social challenges is well established. With this in mind, many countries have developed research priorities and implemented funding programmes aimed at maximising research quality and impact. This chapter monitors recent developments by presenting a selection of R&D and innovation indicators in new growth areas, including biotechnology, nanotechnology and health, environmental and information and communication technologies. The development of next-generation high-capacity broadband networks provides a platform for developing and diffusing smart infrastructures for energy, health, transport and education, and indicators on broadband availability, quality and access compare developments across countries. An experimental methodology reveals how the development of technologies accelerates over time and innovations emerge from the combination of different technologies.

1. R&D funding and specialisation

R&D specialisation, top three performing industries, 2011

Industry R&D expenditure as a percentage of total business enterprise R&D



Source: OECD, ANBERD Database, *www.oecd.org/sti/anberd*; Research and Development Statistics Database, *www.oecd.org/sti/rds*; and national sources, June 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891853

The distribution of business R&D by economic activity reveals a pattern of specialisation that is influenced, but not entirely driven, 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. Chemicals, broadly defined to encompass fuels, pharmaceuticals, other chemicals and minerals, is the major R&D activity in 8 out of the 27 countries for which data are available. ICT equipment manufacturing is particularly important in Finland and Korea, while information services prevail in Ireland, Poland and Portugal. In the Czech Republic, France, Germany, Italy and Spain, transport equipment, including motor vehicles and aerospace, ranks first.

Public policy plays an important role in influencing the direction of innovation efforts. Government R&D budgets (GBAORD) provide an indication of policy priorities in the relative importance of various socio-economic objectives, such as defence, economic development or general funding of the science and research base. In 2012, OECD governments invested the equivalent of 0.8% of GDP in direct funding of R&D at home or abroad. In relative terms, R&D budgets are largest in Finland and Korea at over 1% of GDP. The importance attributed to different objectives varies widely across countries, reflecting national priorities and differences in their innovation systems. For example, the United States devotes a significant share of funds to defence, while Ireland and Korea place comparatively more emphasis on economic development. Most countries, especially Switzerland, dedicate the largest shares to support for advancement of knowledge and general university funds.

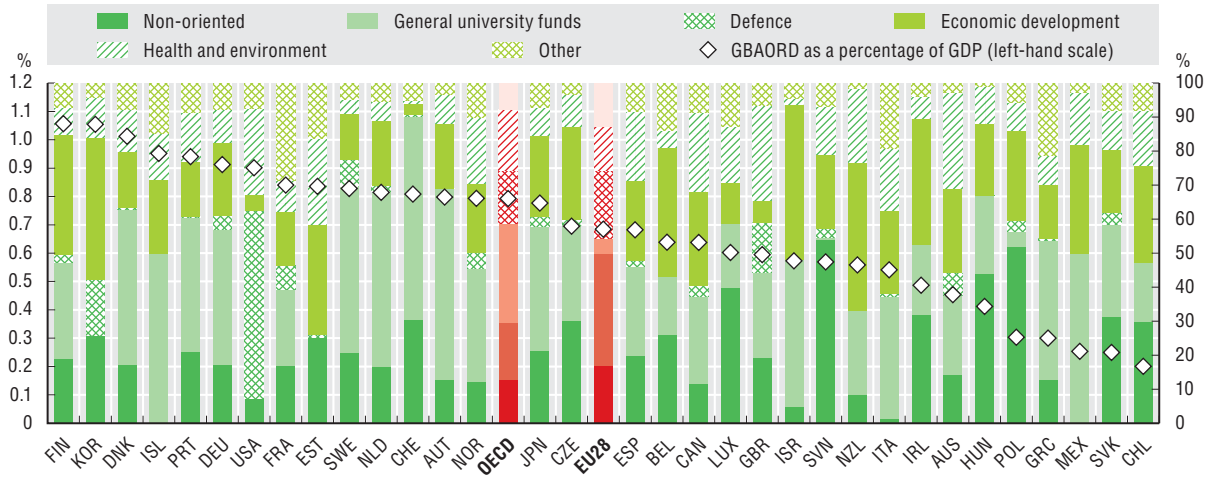
R&D efforts by firms and governments may become reflected in patented inventions. Medical technology is the leading patenting field in the United States and the United Kingdom, while electrical machinery dominates in Germany, Japan and the EU28. Digital communication technologies feature as the top technology field for patenting in Canada, Korea and China. Patenting by technology area is more concentrated in the BRIICS than in OECD economies.

Definitions

GBAORD (government budget appropriations or outlays for R&D) measures the funds committed by governments for R&D. These funder-reported estimates allow for a breakdown by socio-economic objective, a classification system intended to capture the primary objective of the research being funded (OECD, 2002). "Economic development" includes support for agriculture, industry and energy research; "Other" includes research on education and society and exploration and exploitation of space. *Technology fields* are based on International Patent Classification (IPC) codes in patents, following Schmoch's classification (2008, revised in 2013).

R&D budgets by socio-economic objectives, 2012

Government budget appropriations or outlays on R&D, percentages

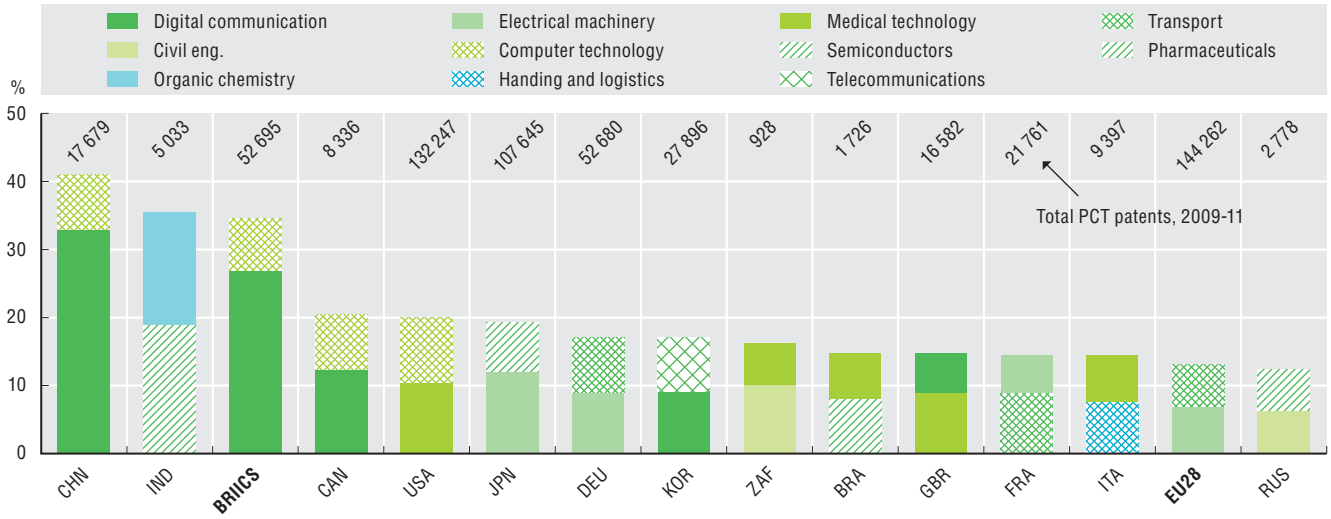


Source: OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891872

Top two technologies patented by countries, 2009-11

Share of patents by technology fields in total patent applications



Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891891

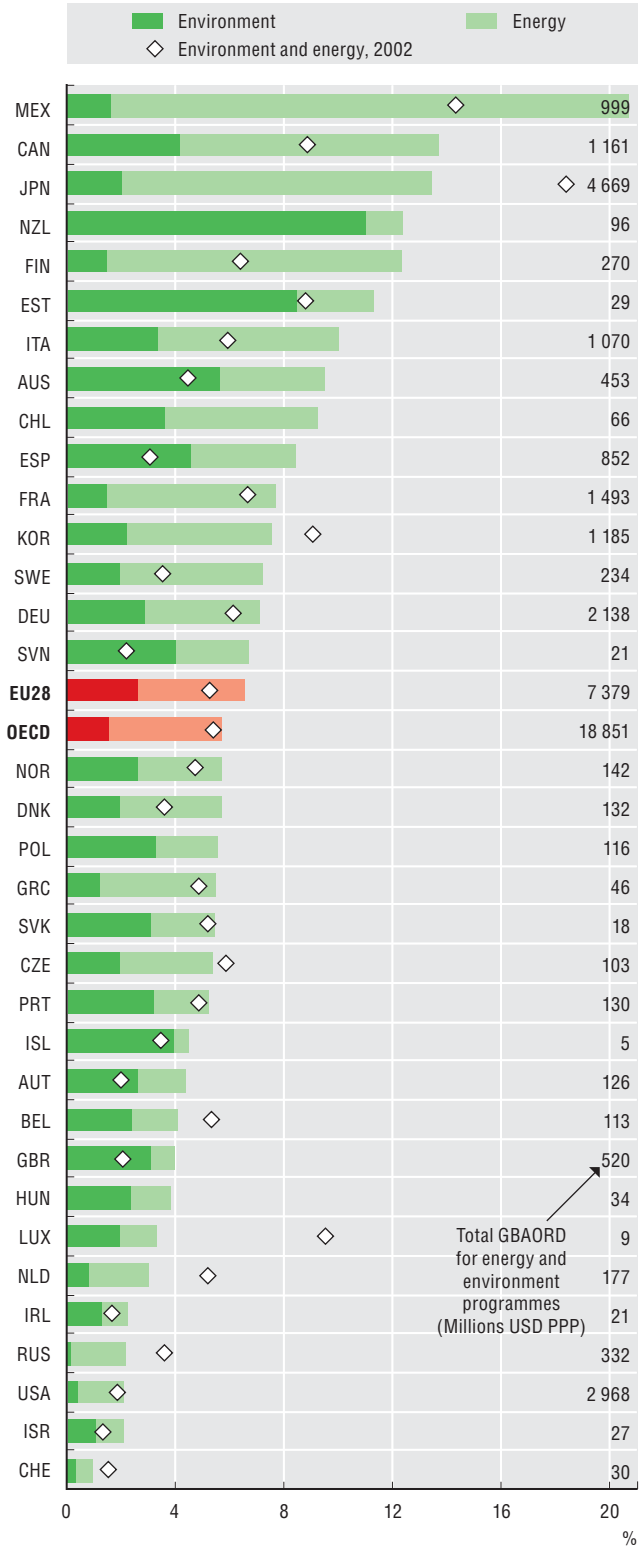
Measurability

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, the product that R&D is intended for, or a mixture of both. The ongoing revision of the *Frascati Manual* (OECD, 2002) attempts to promote greater uniformity of R&D data reporting. To protect the confidentiality of business data, agencies report BERD at different levels of aggregation. R&D data by activity have been 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; 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, 55-56. The allocation of patents by technology area is based on patent applications filed under the Patent Cooperation Treaty, by priority date, inventor's country of residence and fractional counts.

2. Green innovation

R&D budgets for energy and the environment, 2002 and 2012

As a percentage of government budget appropriations or outlays for R&D



Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891910

Fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services necessary for societies' well-being is at the heart of green growth policies. Finding cleaner, affordable and reliable energy sources and developing environmental technologies also play a central role in competitiveness. Governments are supporting research, fostering innovation and the use of new technologies, and encouraging the creation of markets for and the uptake of "green" technologies.

Data on government budget appropriations or outlays for R&D (GBAORD) show the public resources that economies invest in research on energy and the environment. In absolute terms, Japan, the United States and Germany are the largest funders, while Mexico, Canada and Japan are top investors in relative terms. With few exceptions, energy-related R&D accounts for the vast majority of GBAORD spent for the environment. Compared to the 2002 most economies have increased the percentage of GBAORD going to energy and environment-related programmes.

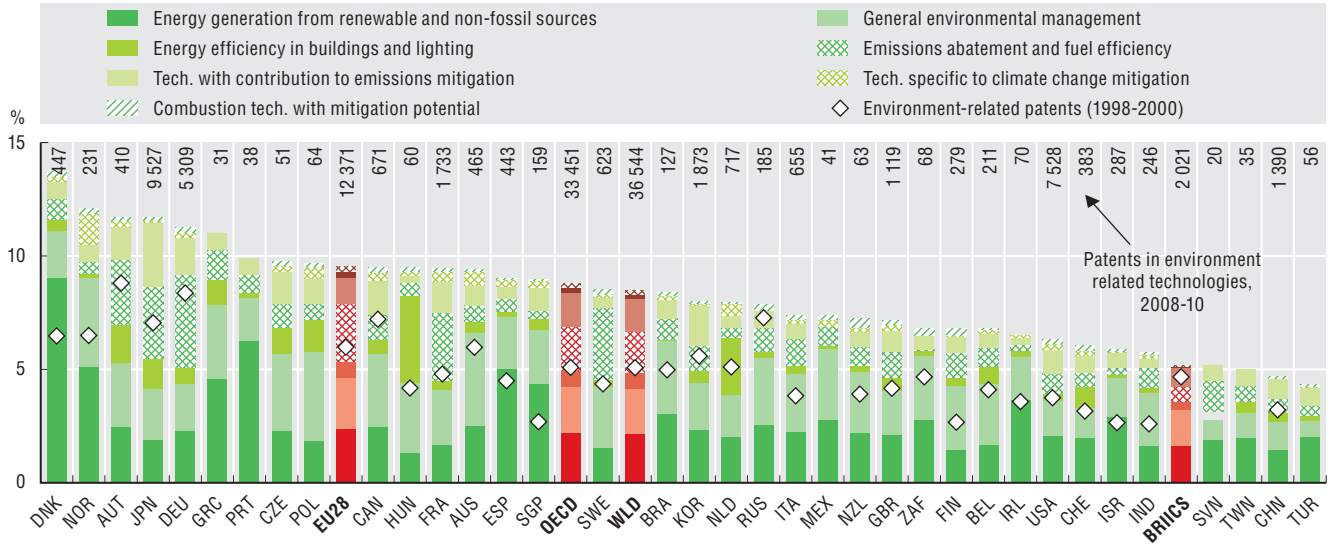
Over time, all economies considered show a marked increase in the propensity to patent in environment-related technologies. Differences exist however in the overall size of patent portfolios, in the share of environment-related inventions in total patents, and in the types of technologies countries are specialised in. The United States, Japan and Germany own the largest patent portfolios in absolute terms, and account for the majority of environmental patents filed under the Patent Cooperation Treaty (PCT): more than 61% of environmental management patents, and about 54% of all energy generation patents. Denmark conversely is the economy most specialised in environment-related patenting (about 14% of Danish patents are filed in the field), followed by Norway, Austria, Japan and Germany, all with shares above 11% of total patenting. In all economies considered, most patenting occurs in energy generation and environmental management.

Definitions

Government budget appropriations or outlays for R&D (GBAORD) measure the funds that governments allocate to R&D to meet various socio-economic objectives. These are defined on the basis of the primary purpose of the funder and include control and care for the environment as well as energy. *Patents in environmental technologies* are identified using refined search strategies based on the International Patent Classification (IPC) and the detailed European Classification System (ECLA), and drawing upon the expertise of patent examiners at the European Patent Office (see OECD, 2011, and Hascic et al., 2012, for details).

Patents in selected environmental technologies, 1998-2000 and 2008-10

As a percentage of total Patent Cooperation Treaty patent applications

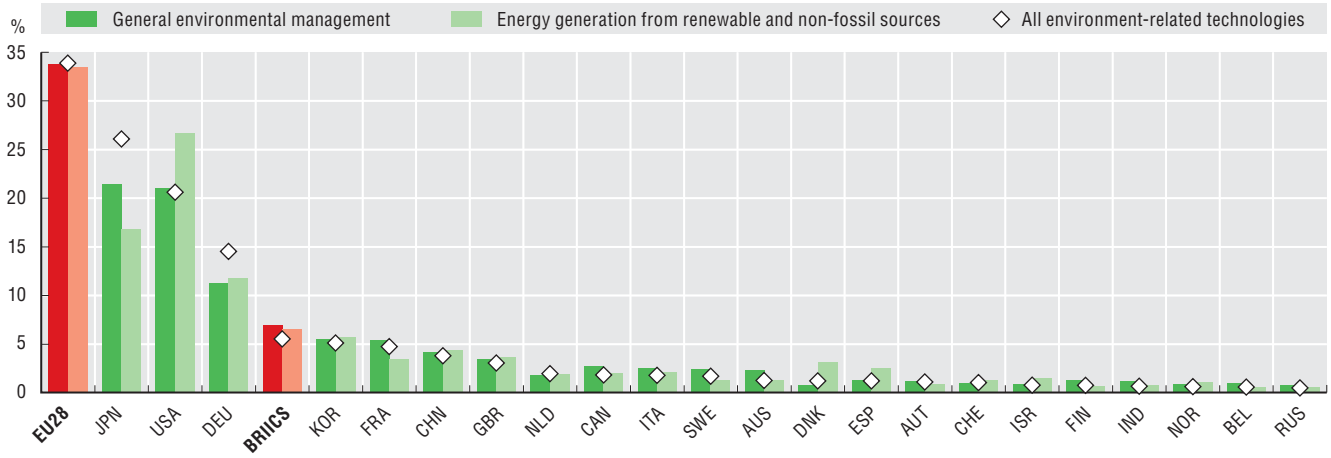


Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891929

Countries' share in selected environmental technologies, 2008-10

Percentage of Patent Cooperation Treaty patent applications



Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891948

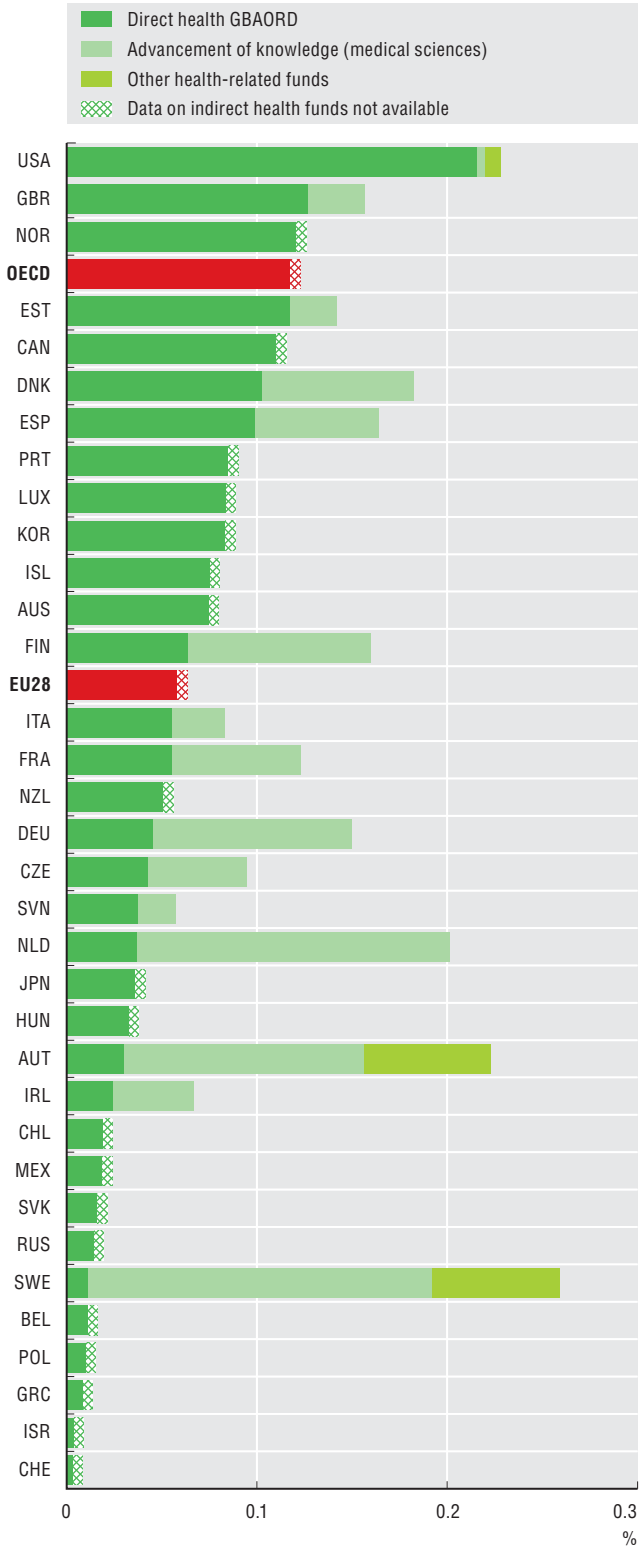
Measurability

R&D budgets for control and care for the environment include research on the control of pollution and on developing monitoring facilities to measure, eliminate and prevent pollution. *Energy R&D budgets* include research on the production, storage, transport, distribution and rational use of all forms of energy, but exclude research on prospecting and on vehicle and engine propulsion. In addition to R&D, the International Energy Agency collects and publishes related data on government support for energy demonstration projects, typically referred to as RD&D. The notion of which technologies are considered "environmental" evolves over time, as it tries to reflect the public consensus on the comparative usefulness of different technologies in reducing environmental impact. Patent data allow for identifying more "integrated" technological innovations, even though patents do not cover all innovations. Using data from different patent authorities, especially national ones, and tracking priorities may provide useful information about where and when different environmental technologies are born and develop and how they spread (or not) across economies.

3. Health innovation

Government funding of health-related R&D, 2012

As a percentage of GDP



Source: OECD, based on OECD Research and Development Statistics Database, *www.oecd.org/sti/rds*, and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891967

Economies worldwide face important social challenges. Health care for ageing populations, long-term chronic illnesses such as diabetes, drug-resistant diseases or global pandemics are among governments' most important policy challenges. Innovation can greatly improve the capacity of health systems to address these problems and help contain costs. The public sector plays a significant role, alongside businesses and non-profit organisations, by supporting R&D and innovation both directly and indirectly and through procurement of new treatments resulting from R&D.

Data on government budget appropriations or outlays for R&D (GBAORD) show that direct government support of health-related R&D in OECD countries was about 0.1% of their combined GDP in 2012. Health R&D funding is largest in the United States, in both absolute and relative terms, at around 0.23% of GDP. Adjusting for institutional differences in the funding, however, health R&D reaches some 0.26% of GDP in Sweden and above 0.22% of GDP in Austria.

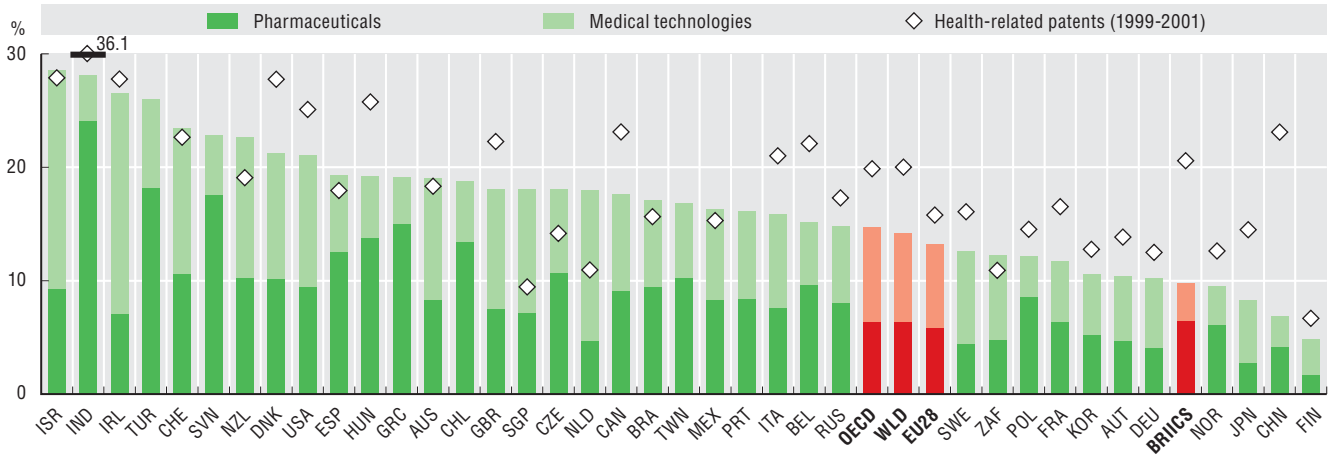
Economies also differ in the extent to which they appropriate the results of health-related innovative activities and in the importance of health patents in overall patenting. In Israel and India health patents account for more than 28% of total patents filed under the Patent Cooperation Treaty (PCT), whereas in Japan, China and Finland they represent well under 10%. Over time, the relative weight of health patents in overall patenting has generally decreased in OECD and BRIICS economies. The United States, Japan and Germany account for the majority of pharmaceutical patents filed under the PCT system.

Definitions

Direct health GBAORD comprises government R&D budgets primarily committed to the socio-economic objective of protecting and improving human health. Funds related to the *advancement of knowledge* are non-oriented research funds and general university funds, i.e. the estimated R&D content of government block grants to universities, for which it is possible to identify the amount dedicated to R&D in the medical sciences. *Other health-related funds* are *ad hoc* OECD estimates based on national sources that cover general support for R&D in hospitals and related areas that are excluded from GBAORD estimates. *Health-related patents* are identified using Schmoch's classification (2008, revised in 2013): *pharmaceuticals* are patents filed in class A61K, excluding A61K8/* (cosmetics) of the International Patent Classification (IPC); *medical technologies* patents relate to IPC classes A61 [B, C, D, F, G, H, J, L, M, N] and H05G. 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 and massage devices.

Health-related patents, 1999-2001 and 2009-11

As a percentage of total Patent Cooperation Treaty patent applications

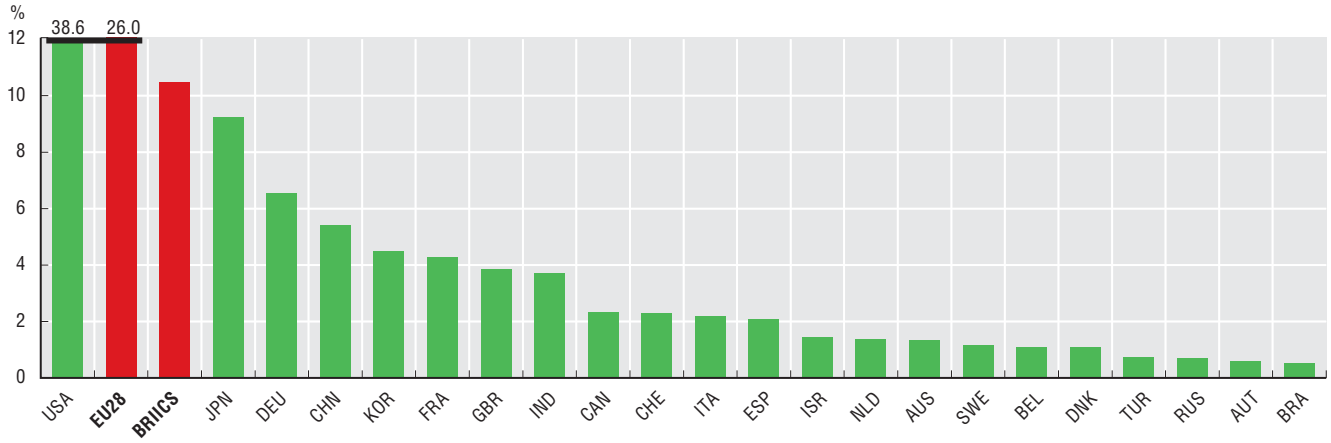


Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932891986

Countries' share in pharmaceutical patents, 2009-11

Patent Cooperation Treaty patent applications



Source: OECD, Patent Database, June 2013. See chapter notes.

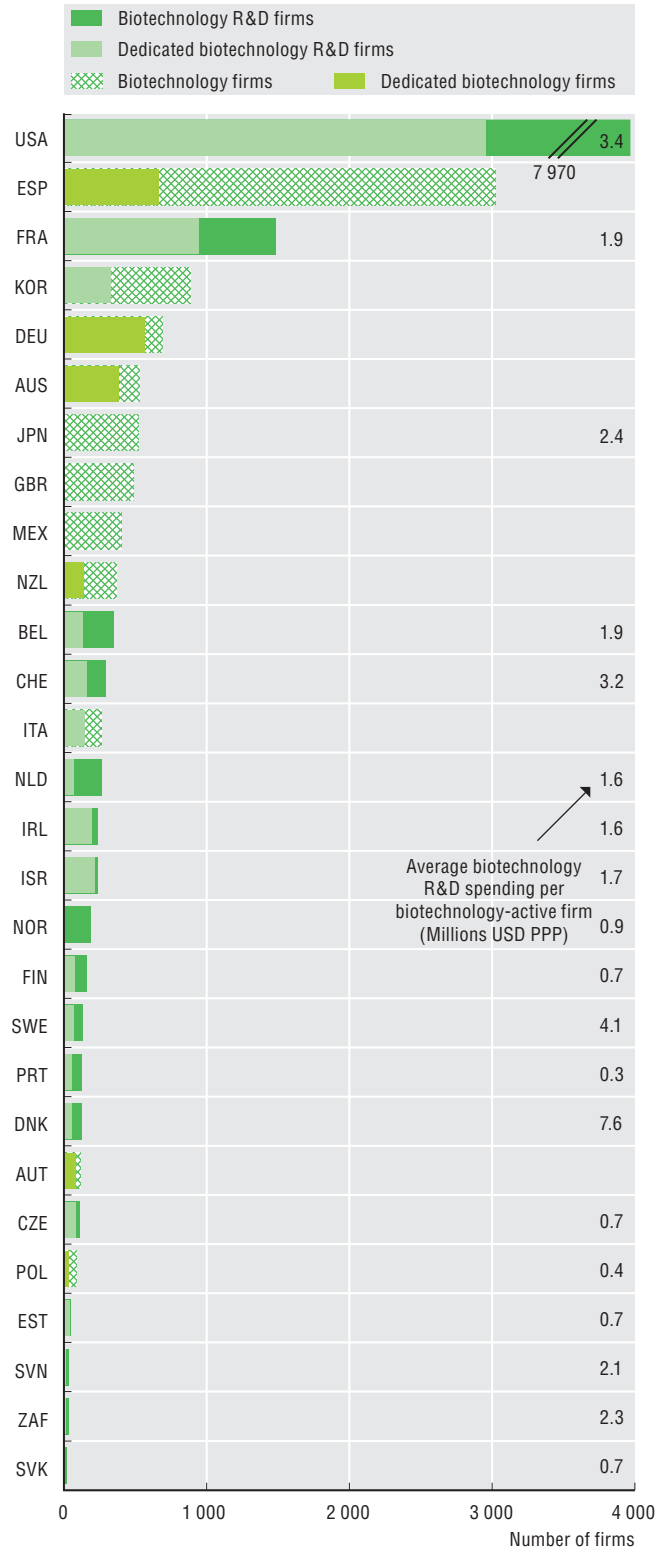
StatLink http://dx.doi.org/10.1787/888932892005

Measurability

Public funding of health R&D is difficult to measure owing to institutional complexity and diversity. It may be publicly or privately funded and be carried out in firms, universities, hospitals and private not-for-profit institutions. The GBAORD health category is used as a proxy for total central government funding of health-related R&D, even though it only covers programmes for which health is the primary objective. The classification of funds depends on how governments present R&D priorities and on the formal mandate of the institutions concerned. Arrangements for funding R&D in hospitals also vary. To address some of these limitations and to provide a more complete picture of health-related R&D, funding of medical sciences via non-oriented research and general university funds is included when available as are other relevant funds, notably general support for R&D in hospitals. Health patent data relate to patent applications filed under the PCT and are based on the priority date, the inventor's residence and fractional counts. Only economies that applied for more than 250 patents in 2009-11 are included. Different data sources might lead to different results.

4. Biotechnology R&D

Number of firms active in biotechnology, 2011



Source: OECD, Key Biotechnology Indicators, *http://oe.cd/kbi*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892024

Biotechnology comprises a number of related technologies with a wide range of current and potential applications in many sectors and is of significant interest to policy makers.

Number of biotechnology firms is the most widely available indicator but it is not the best measure of a country's activity in biotechnology, owing to large differences in firm size and R&D intensity. The United States has 7 970 biotechnology R&D firms, followed by Spain with 3 025 biotechnology firms, and France with 1 481 biotechnology R&D firms.

Data on business enterprise expenditures on research and development (BERD) for biotechnology provide a direct measure of research effort. The United States devotes almost 10% of total US BERD to biotechnology (USD 27 374 million PPP) and accounts for about 66% of total biotechnology BERD expenditures in the 28 countries for which data are available.

On average, biotechnology accounted for 5.9% of total BERD in 2011. Denmark spends the most on biotechnology R&D as a percentage of BERD (19.4%) followed by Ireland (17.2%) and Switzerland (12.6%).

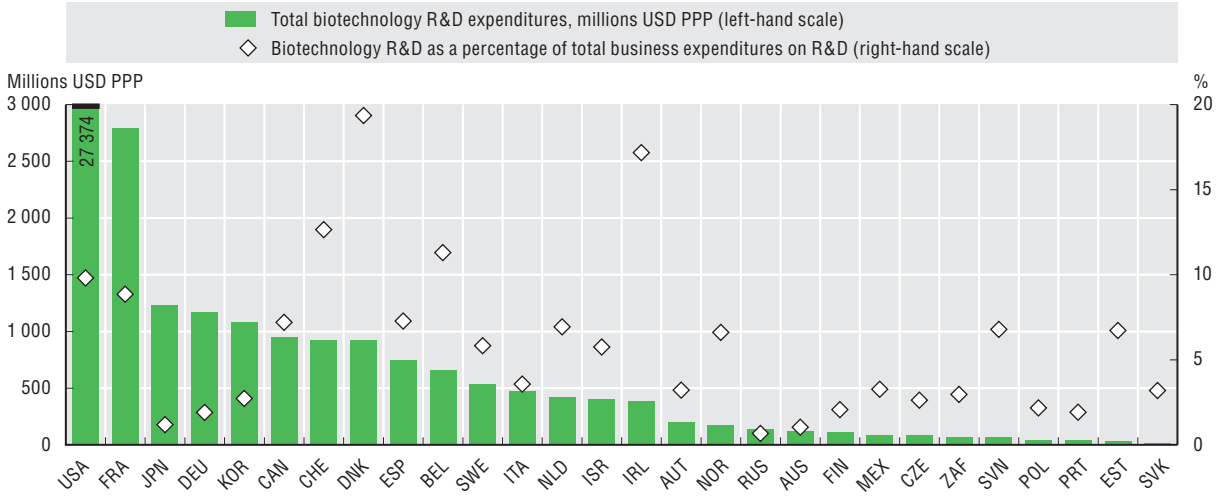
The government and higher education sectors play a key role in supporting biotechnology R&D. Data on biotechnology R&D expenditures in the government and higher education sectors are available for 18 countries. In 11 countries the amount spent by the two sectors exceeds that of the business sector. Reflecting this strong public support, the highest levels are found in Germany (USD 5 972 million PPP), followed by Korea (USD 2 468 million PPP) and Spain (USD 1 346 million PPP). The biotechnology share of total R&D expenditures is highest in Germany, at 21.2%, followed by Korea (19.8%) and Spain (14.3%).

Definitions

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.

This definition is deliberately broad, covering modern biotechnology but also many traditional or borderline activities. For this reason, the OECD recommends that it should always be accompanied by a list-based definition based on seven categories that serves as an interpretative guideline. The categories are: DNA/RNA, Proteins and other molecules, Cell and tissue culture and engineering, Process biotechnology techniques, Gene and RNA vectors, Bioinformatics, and Nanobiotechnology. In addition, respondents are usually given write-in option for new biotechnologies that do not fit any of the categories. A firm that reports activity in one or more of the categories is defined as a biotechnology firm.

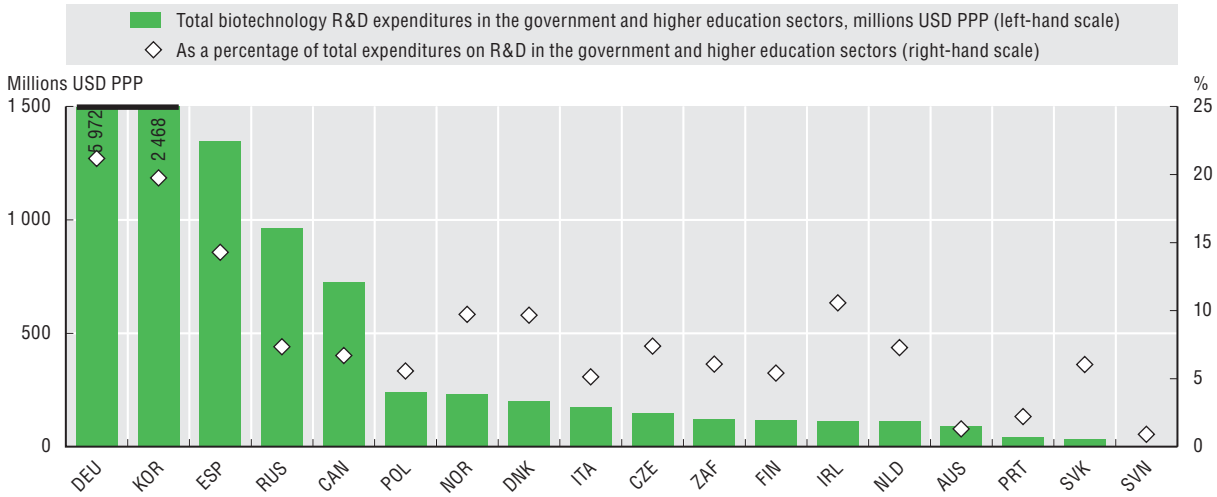
Biotechnology R&D in the business sector, 2011



Source: OECD, Key Biotechnology Indicators, *http://oe.cd/kbi*, and OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932892043*

Biotechnology R&D in the government and higher education sectors, 2011



Source: OECD, Key Biotechnology Indicators, *http://oe.cd/kbi*; and OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932892062*

Measurability

Firms' biotechnology activities can be measured by dedicated surveys of these firms, questions on biotechnology added to national R&D surveys of firms and available secondary sources. Data comparability depends on how biotechnology statistics are collected.

There are three types of biotechnology firms:

1. A biotechnology firm engages in biotechnology using at least one biotechnology technique (as defined in the OECD list-based definition) to produce goods or services and/or to perform biotechnology R&D. These firms are captured by biotechnology firm surveys.

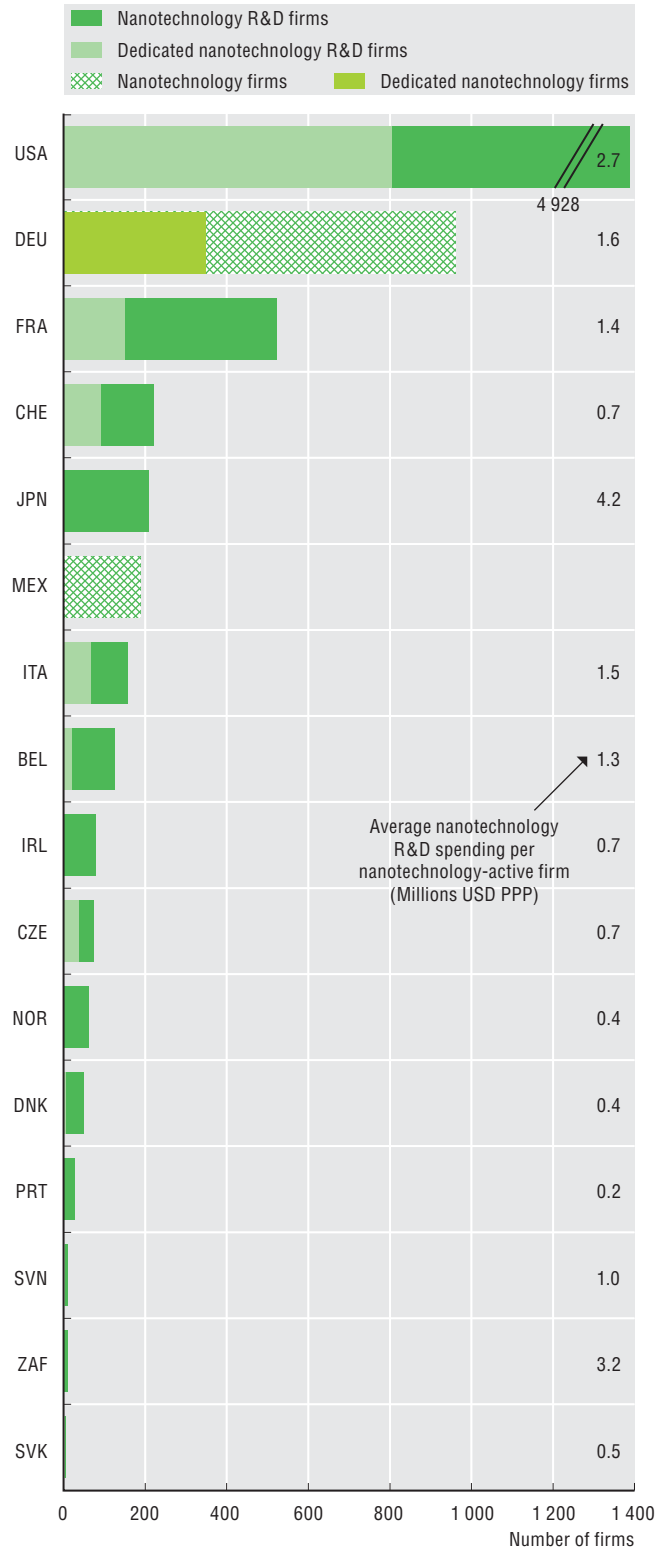
Two subgroups of biotechnology firms are largely defined by the method of data collection.

2. A dedicated biotechnology firm devotes at least 75% of its production of goods and services, or R&D, to biotechnology. These firms are captured by biotechnology firm surveys.
3. A biotechnology R&D firm performs biotechnology R&D. Dedicated biotechnology R&D firms, a subset of this group, devote 75% or more of their total R&D to biotechnology. These firms are captured by R&D surveys.

The OECD 2009 guidelines provide a common basis for collecting and reporting biotechnology R&D statistics in the government and higher education sectors.

5. Nanotechnology R&D

Number of firms active in nanotechnology, 2011



Note: This is an experimental indicator. International comparability may be limited.
Source: OECD, Key Nanotechnology Indicators, *http://oe.cd/kni*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892081

Nanotechnology is commonly considered a very promising technology domain in terms of business opportunities in various industries, especially in the context of pressing societal challenges relating to energy, health care, clean water and climate change. However, nanotechnology metrics are lacking. Better metrics are necessary to monitor and benchmark nanotechnology for future policy needs.

In 2013, the OECD undertook an experimental data collection on nanotechnology R&D. The United States has the largest number of nanotechnology-active firms (4 928), followed by Germany (960) and France (524). In 8 out of 17 countries firms could report the same R&D in multiple research areas. In this respect, the overlap of nanotechnology and biotechnology ranges between 19% in Italy, where only about 19% of firms are active both in nanotechnology and biotechnology, to 65% in the United States.

Data on business enterprise expenditures on research and development (BERD) for nanotechnology provide a better measure of the research effort. On average, nanotechnology accounted for almost 2% of total BERD in 2011. The United States has the strongest focus on nanotechnology R&D (4.8% of total BERD), followed by Mexico (4.6%) and the Russian Federation (3.5%). The United States spends the most on nanotechnology BERD (USD 13 500 million PPP), representing almost 75% of total nanotechnology BERD expenditures in the 17 countries for which data are available.

The share of nanotechnology in the government and higher education sector's total expenditures on R&D provides an indicator of the importance governments accord to nanotechnology R&D. The share is highest in the Russian Federation, at 5.6%, followed by Korea (4.7%) and Portugal (3.5%).

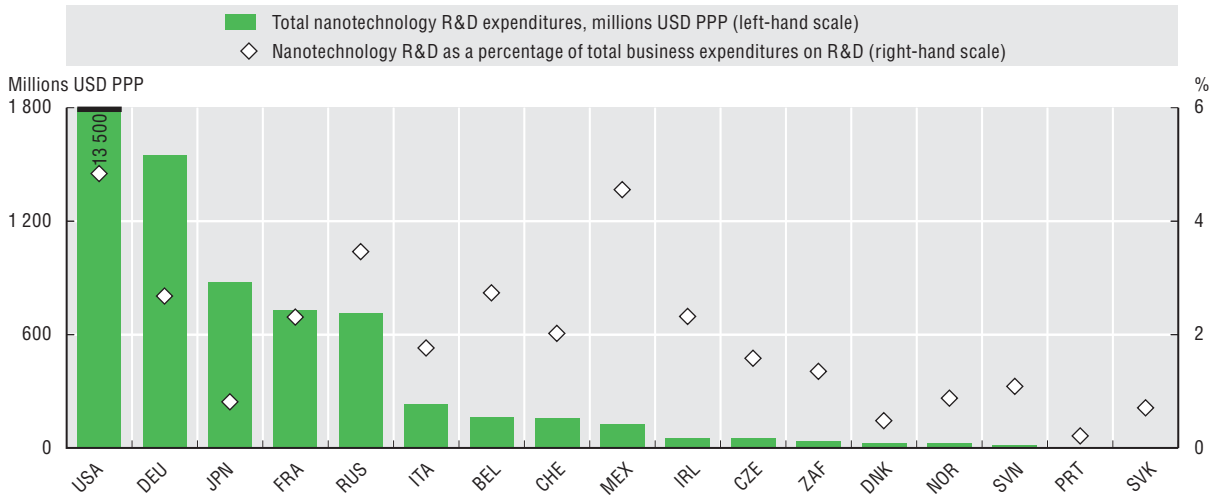
These data are partly reflected in government and higher education sector expenditures on nanotechnology R&D that are largest in the Russian Federation (USD 729 million PPP), followed by Japan (USD 542 million PPP) and Korea (USD 316 million PPP).

Definitions

There is no internationally agreed statistical definition of nanotechnology. The development of a range of comparable nanotechnology indicators depends on a uniform set of definitions.

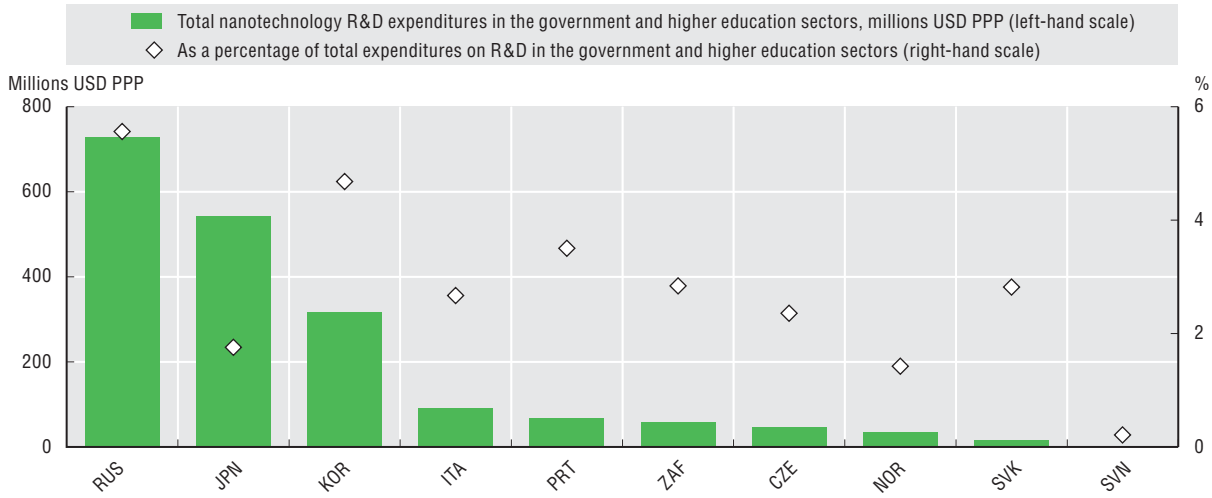
The International Organization for Standardization defines nanotechnology as: "Understanding and control of matter and processes at the nanoscale, typically, but not exclusively, below 100 nanometres in one or more dimensions, where the onset of size-dependent phenomena usually enables novel applications, by utilizing the properties of nanoscale materials that differ from the properties of individual atoms, molecules, and bulk matter to create improved materials, devices and systems that exploit these new properties."

Nanotechnology R&D in the business sector, 2011



Note: This is an experimental indicator. International comparability may be limited.
Source: OECD, Key Nanotechnology Indicators, *http://oe.cd/kni*; and OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.
StatLink *http://dx.doi.org/10.1787/888932892100*

Nanotechnology R&D in the government and higher education sectors, 2011



Note: This is an experimental indicator. International comparability may be limited.
Source: OECD, Key Nanotechnology Indicators, *http://oe.cd/kni*; and OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.
StatLink *http://dx.doi.org/10.1787/888932892119*

Measurability

Firms' nanotechnology activities can be measured by dedicated surveys of these firms, questions on nanotechnology added to national R&D surveys of firms and available secondary sources. Data comparability depends on how nanotechnology statistics are collected.

There are three types of nanotechnology firms:

1. A nanotechnology firm uses nanotechnology to produce goods or services and/or to perform nanotechnology R&D. These firms are captured by nanotechnology firm surveys.

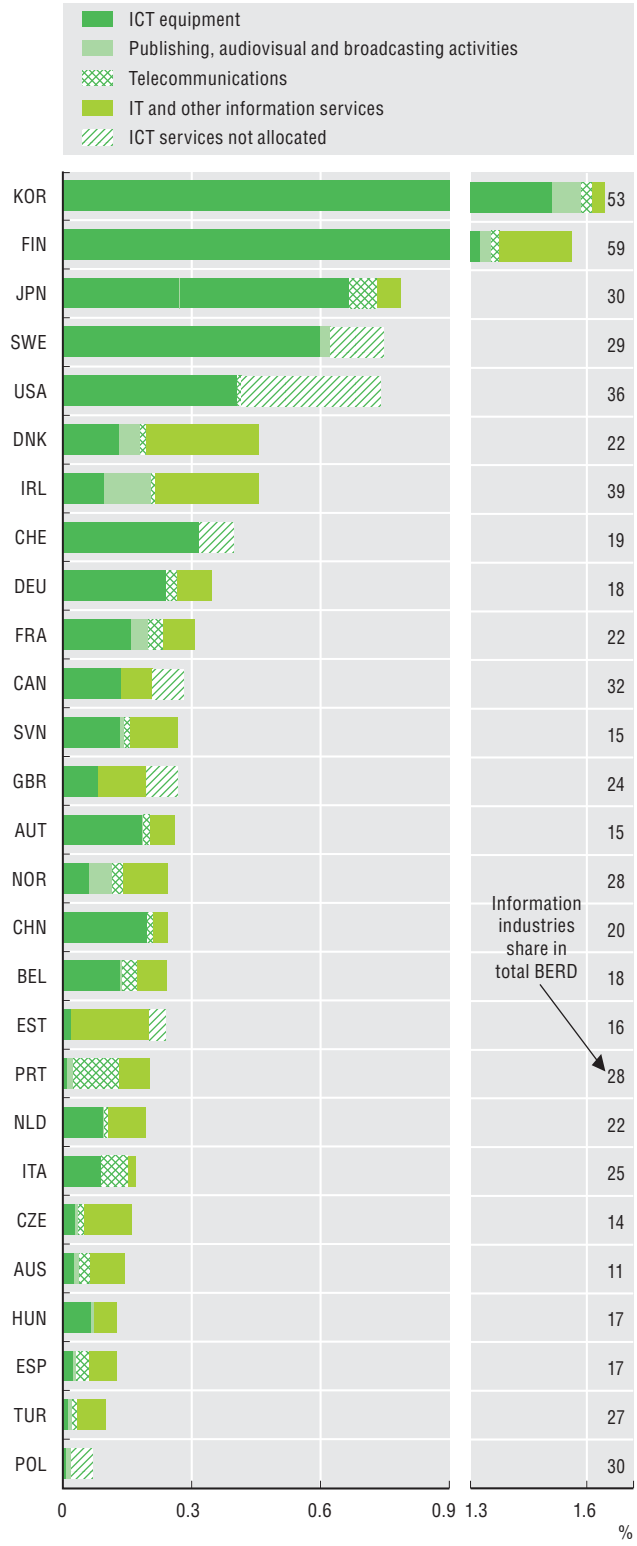
   Two subgroups of nanotechnology firms are largely defined by the method of data collection.

2. A dedicated nanotechnology firm devotes at least 75% of its production of goods and services, or R&D, to nanotechnology. These firms are captured by nanotechnology firm surveys.
3. A nanotechnology R&D firm performs nanotechnology R&D. Dedicated nanotechnology R&D firms, a subset of the group, devote 75% or more of their total R&D to nanotechnology. These firms are captured by R&D surveys.

6. ICT innovation

R&D expenditure in information industries, 2011

As a percentage of GDP



Source: OECD, ANBERD Database, *www.oecd.org/sti/anberd*; Research and Development Statistics Database, *www.oecd.org/sti/rds*; and national sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892138

Information and communication technologies (ICT) and related industries have been at the root of key changes in the global economy in recent decades. In 2011, business R&D expenditures (BERD) of information industries in many OECD countries accounted for 20-25% of BERD and for 0.2-0.3% of GDP. In Korea, Finland, Japan, the United States and Sweden, the share ranges from 30% to 50% or more of BERD and from 0.7% to 1.5% or more of GDP, owing to the high research intensity of these economies and of the sector itself.

In general, ICT R&D expenditures tend to be concentrated in the manufacturing sector, even when goods production is offshored. Telecommunication services remain minor performers of R&D, while IT services have gained ground in Ireland and Denmark, where R&D expenditure on publishing and audiovisuals (which includes some software development activities) is also substantial.

ICT BERD intensity is generally mirrored by the relative share of ICT-related patents. For the OECD as a whole, in 2009-11, ICT patents represented more than one-third of world patents filed under the Patent Cooperation Treaty (PCT), although this is 5% less than in 1999-2001. In contrast, the importance of ICT patents in BRIICS economies doubled, largely because of China. Overall, the share of computer patents is similar to that of other ICT-related technologies (a third each); telecommunication services remain slightly above 20% and are more important in economies with a higher share of ICT-related patents.

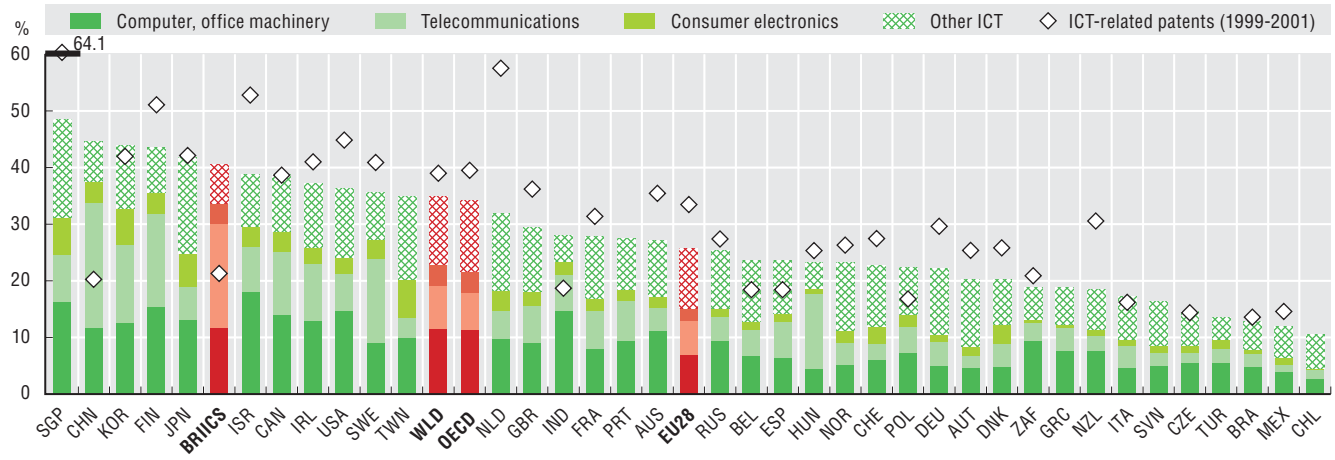
The pervasive presence of ICT is apparent in the spread of broadband connectivity in businesses, which was universal for larger enterprises in almost all OECD countries in 2012, and 90% or more even in smaller businesses with 10 to 49 employees.

Definitions

Information industries includes ISIC Rev.4 Division 26 (Manufacture of computer, electronic and optical products) and Section J (Information and communication), consisting of Divisions 58-60 (Publishing and broadcasting industries), 61 (Telecommunications) and 62-63 (Computer programming and information service activities). Hence, information industries encompass ICT industries (under Divisions 26, 61 and 62-63, plus a small component in 58), excluding trade and repair activities, and media and content industries (included in Divisions 58-60 and in the Group 639). BERD includes all expenditures performed by enterprises, irrespective of their funding. They are presented by main sector of activity of the enterprise in terms of turnover. The different types of ICT-related patents are identified following Schmoch's classification (2008, revised in 2013). Broadband connectivity refers to the availability of Internet access by the enterprise at a speed higher than 256 Kbit/s, for firms with 10 or more employees.

ICT-related patents, 1999-2001 and 2009-11

As a percentage of total PCT patent applications

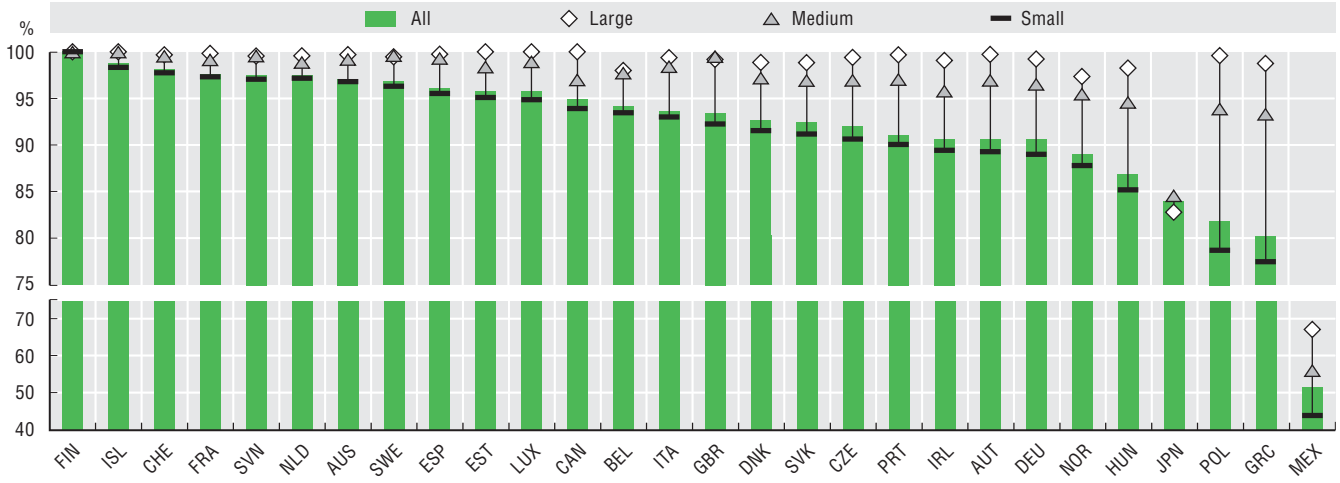


Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892157

Enterprises with broadband connection, by employment size, 2012

Fixed and mobile connections, as a percentage of all enterprises



Source: OECD, ICT Database, June 2013, and Eurostat, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892176

Measurability

Countries' statistics on BERD by industry are not always available at the same level of detail. The industry coding of enterprises is a major concern, owing to possible shifts in the main sector of activity of large R&D performers (e.g. physical production is outsourced), and to different corrections for R&D performed by specialised subsidiaries. Also, R&D figures generally do not include ICT-related R&D performed outside the sector.

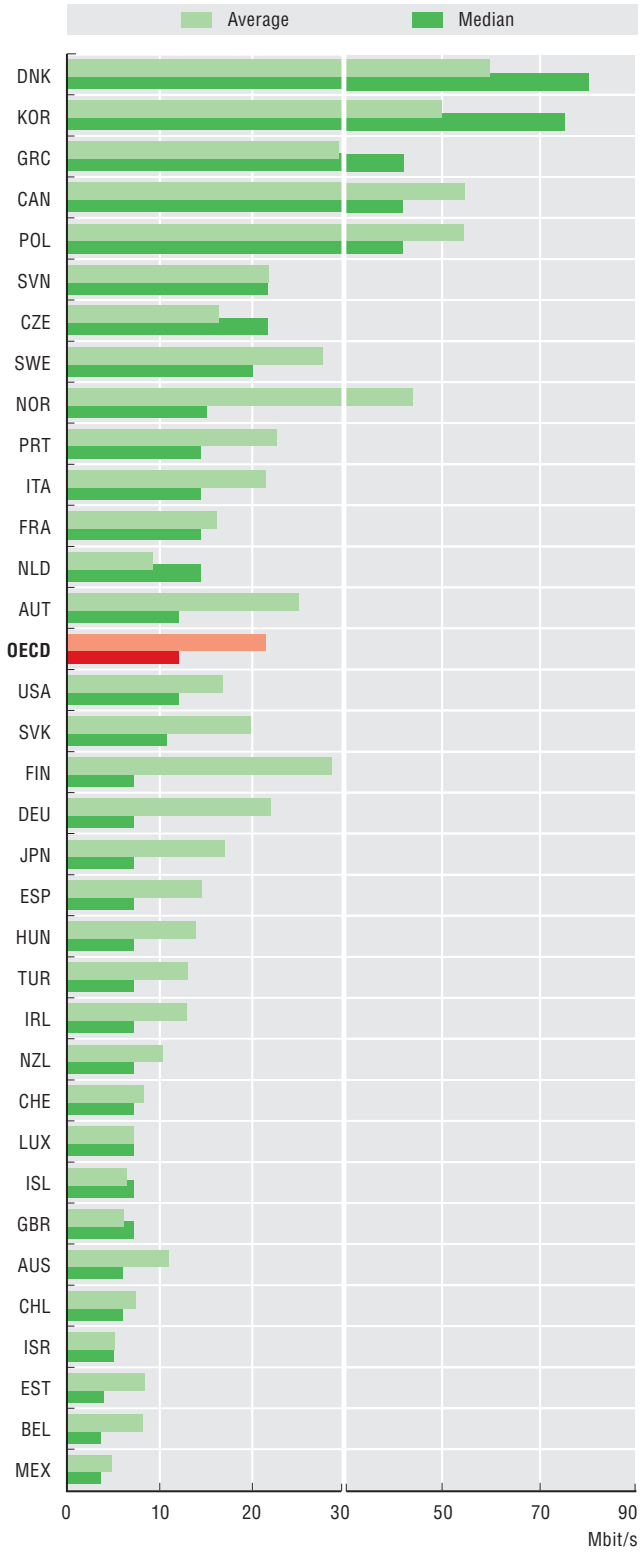
A higher share of patents in ICT-related classes with respect to industry's R&D expenditure may also reflect differences in the propensity to patent of different technological areas and economies.

Enterprises surveyed for ICT usage usually include small (10 to 49 employees), medium (50 to 249) and large (250 and more) enterprises in the non-agricultural business sector. Financial services are not considered. Differences in coverage across economies may affect results, and definitions may also require further harmonisation to achieve full comparability of broadband metrics.

7. Broadband price and quality

Internet connection speed, September 2012

Broadband median and average advertised download speeds, Mbits per second



Source: OECD (2013), *OECD Communications Outlook 2013*, OECD Publishing.

StatLink http://dx.doi.org/10.1787/888932892195

With faster Internet connection speed (bandwidth) and lower Internet service prices, new applications are becoming available for individuals and businesses. Internet users can now be "always-on", perform a growing number of tasks remotely and move seamlessly between different devices. Fast and affordable connections are thus an important driver of societal development and economic competitiveness alike.

OECD-area broadband speed levels, as measured by median and (usually higher) average advertised connection speeds for fixed line subscriptions, are relatively high overall but cross-country differences are still wide. Whereas OECD-wide median speeds in September 2012 stood at 12 Mbit/s (the average speed being above 20), leading countries were above 40 Mbit/s and lagging ones were at 4 Mbit/s or less. Despite lower income levels, some countries have been able to leapfrog and adopt the latest broadband technologies.

Internationally comparable price baskets, expressed in purchasing power parities (PPP), also range widely from USD 60 or more to less than USD 20 a month for a fixed-line subscription of 15+Mbit/s and up to 33 GB. For this relatively "high-end" basket, subscription prices tend to be lower in countries that offer more bandwidth. Past experience shows that in most countries monthly subscription prices tend to be relatively sticky, with offers that propose significant improvements in the quality of connections. Price setting is also strongly affected by network regulation policies.

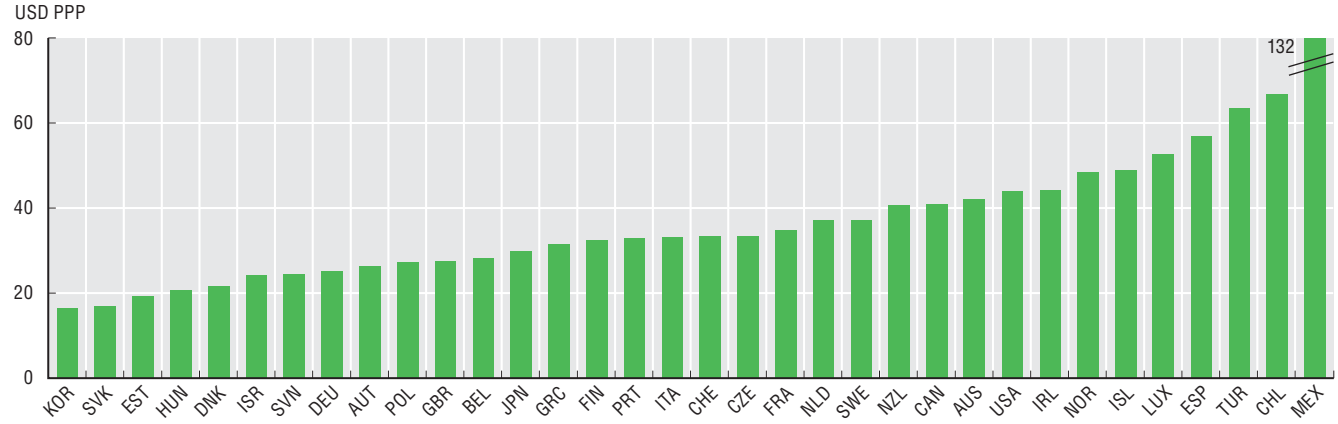
For mobile connectivity, all countries offer voice plus data packages that include a given volume of traffic (mobile voice traffic is still usually more costly than fixed-line). For a representative array of such offers, prices also range widely. A typical mid-range basket (100 calls/500 Mbit) is priced in most countries at USD 20 to USD 40 PPP a month; in a few it costs about USD 10 PPP and in others over USD 50 PPP. Prices of low- and high-end baskets tend to show a similar inter-country pattern. Mobile and fixed broadband offers show a mild positive correlation.

Definitions

The OECD methodology for measuring prices of communication services is based on consumption patterns or "baskets" of fixed, mobile and leased line communication services, collected from several operators with the largest market shares in each country. USD PPP is used to facilitate international comparisons. For the purpose of this data collection, speeds are those advertised by three operators and are not likely to correspond to typical throughput. When not explicitly stated, maximum speeds were imputed based on the bandwidth typically associated with the technology considered.

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

USD PPP

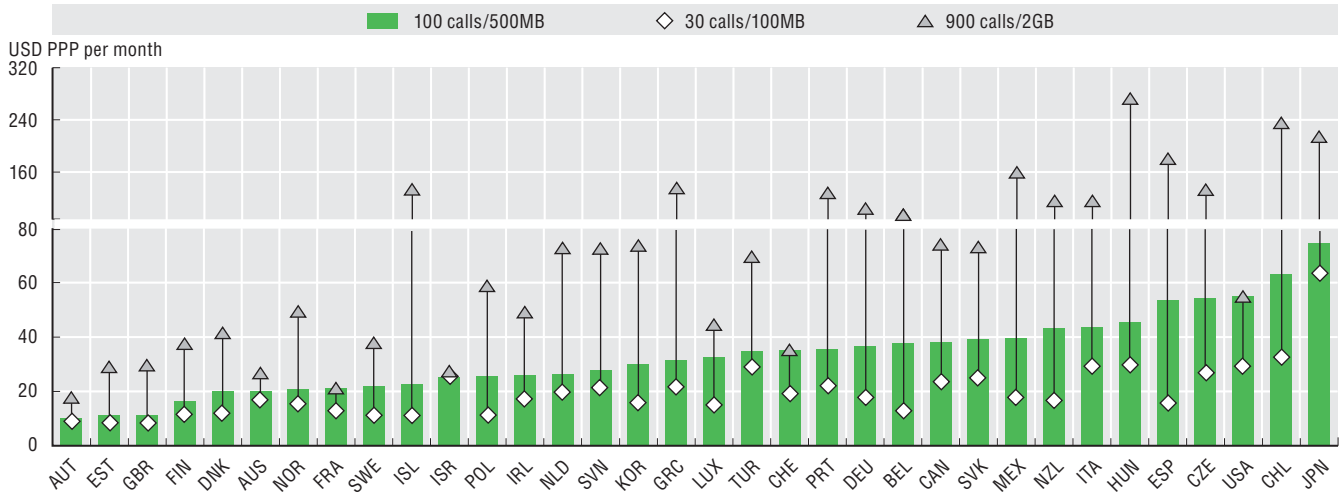


Source: OECD and Teligen, September 2012. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892214

Prices of mobile voice calls plus data traffic reference baskets, August 2012

USD PPP per month



Source: OECD and Teligen, September 2012. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892233

Measurability

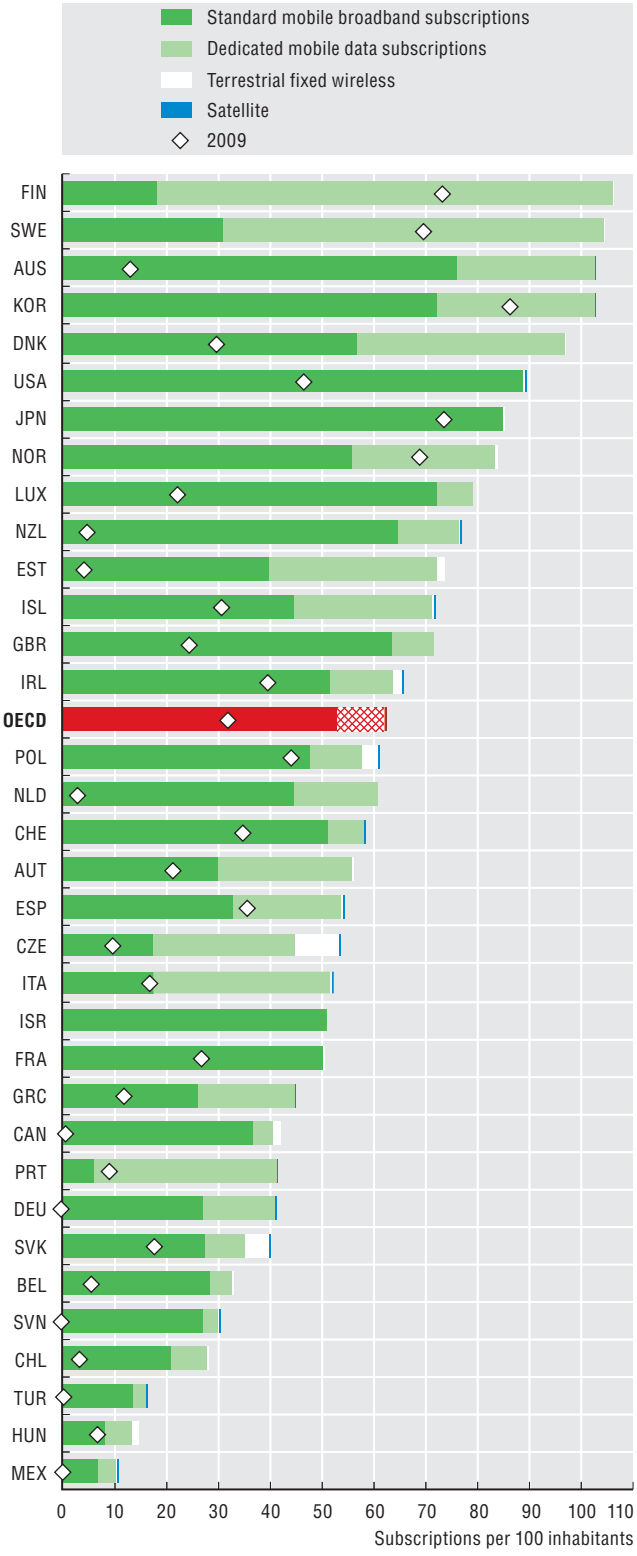
To collect broadband price and speed data, 1 950 stand-alone fixed broadband offers from 102 operators and 1 300 mobile voice plus data offers from 74 operators in the 34 OECD countries were surveyed for the *OECD Communications Outlook 2013*.

For fixed broadband, a set of three operators per country was chosen (with an average of 19 offers per operator): the incumbent telecommunications operator, the largest cable provider (if cable exists) and one alternative provider, if available, over DSL, cable or fibre. Offers had to be advertised clearly on the operator's website; all DSL, cable and fibre offers were recorded but not used in calculations when speed was lower than 256 Kbit/s; offers considered were for month-to-month service and had to be available in the country's largest city or in the largest regional city for firms with only regional coverage. Mobile baskets were based on consumers' profiles and offers available from the largest operators in each country.

8. Fixed and wireless broadband

Wireless broadband penetration by technology, December 2009 and 2012

Subscriptions per 100 inhabitants



Source: OECD Broadband Portal, July 2013. Standard mobile broadband subscriptions may include dedicated mobile data subscriptions when breakdowns are not available. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892252

Broadband diffusion remains uneven across OECD economies but continues to increase everywhere. Progress has been particularly swift in mobile (terrestrial wireless) broadband, with the OECD area penetration rate doubling in three years to more than 60% at the end of 2012. Subscriptions reached over 100% in Korea, Australia and some Nordic countries, but stood at 30% or less in Slovenia, Chile, Turkey, Hungary and Mexico. However, as the main channel of uptake is standard mobile subscriptions (with nearly universal diffusion in all OECD economies) and considering progress to date, mobile broadband appears to have great catch-up potential in lagging economies.

The penetration of fixed (wired) broadband also varies; over 35% of residents have subscriptions in six out of 34 OECD countries but less than 20% in six others. Here the digital divide is smaller, and take-up has increased smoothly in recent years; countries at the lower end of the distribution also show a significant deficit in the diffusion of faster connections, a sign of an infrastructure problem.

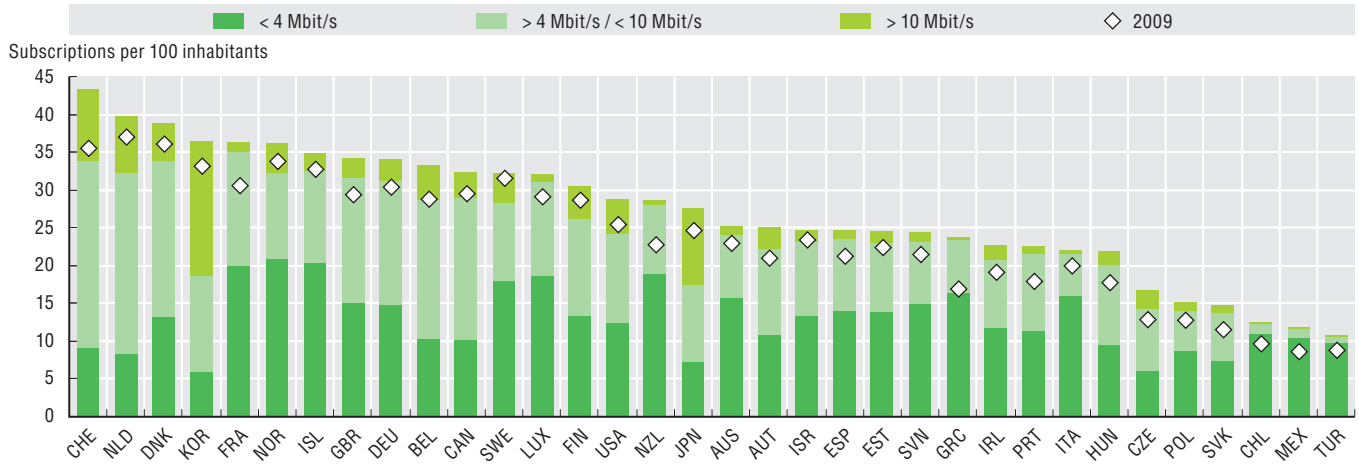
Broadband subscriptions and speeds generally reflect countries' relative income levels. This can be fully appreciated when considering Internet access within countries; in 2012 households in the top income quartile had access rates above 90% in nearly all countries, while those in the bottom quartile had rates of 60-70% in leading (and relatively wealthier) countries and down to 10-20% in lagging ones. In recent years, however, the gap in access between high- and low-income households has closed almost everywhere, as the Internet has become more affordable and gained higher priority among consumers' choices.

Definitions

The broadband indicator is composed of two categories: fixed wired and wireless broadband, which are presented separately. Fixed wired broadband includes DSL, cable, FTTH and other fixed broadband connections based on wired technology. Wireless broadband includes satellite and terrestrial fixed and mobile wireless. Depending on data availability, this last is divided into standard mobile (with active use) and dedicated data subscriptions. All components include only connections with advertised data speeds of 256kbit/s or more. Statistics on Internet access by households consider the possibility of connecting to the Internet from the premises of the household, irrespective of the technology used (wired or wireless) and of advertised speed. A standard mobile subscription is counted as an active broadband subscription only when it allows for full access to the Internet via HTTP (subscriptions that only offer walled gardens or email access are not counted) and when content or services were accessed using the Internet Protocol (IP) during the previous three months.

Fixed wired broadband penetration by speed tiers, December 2009 and 2012

Subscriptions per 100 inhabitants and actual speed in Mbits per second

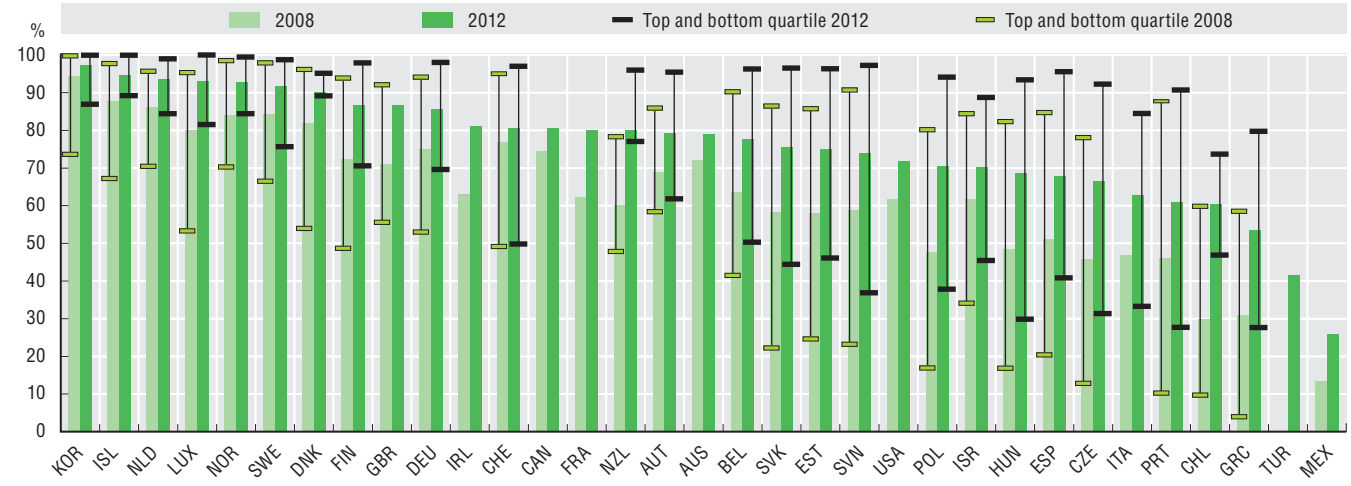


Source: OECD and Akamai, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892271

Household Internet access by income quartile, 2008 and 2012

As a percentage of all households



Source: OECD, ICT Database and Eurostat, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892290

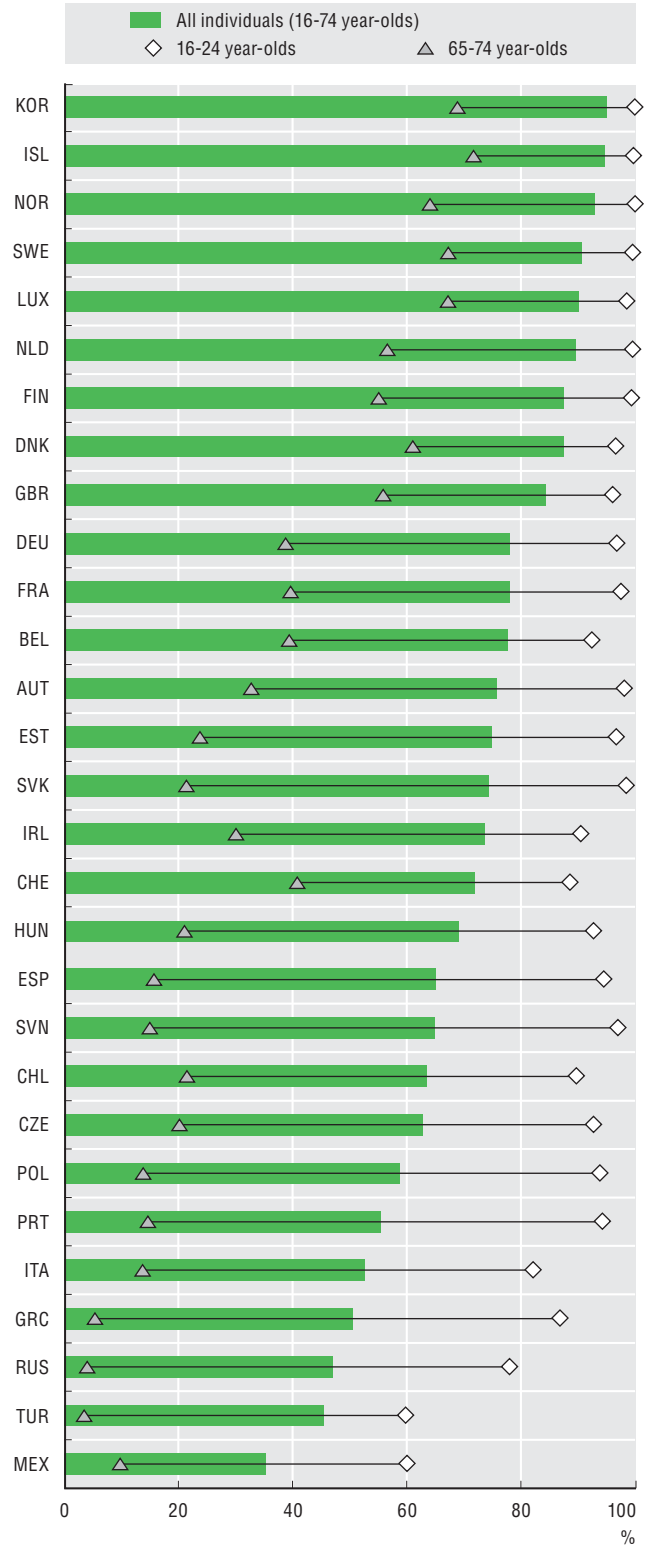
Measurability

Information on residential vs. nomadic usage and real speed is difficult to ascertain from connectivity information. Besides some overlaps in definitions (with fixed wireless and satellite connections referring mainly to fixed usage), frontiers in the use of devices and connections are increasingly blurred. For instance, many people disposing of a wireless subscription mostly use their domestic wi-fi for their smartphones and tablets at home. The relevance of free-of-charge hotspots (based on wired technology) is potentially huge; for example in France, some operators allow their fixed-line subscribers to use mobile connections by relying on the network of other wired subscribers' wi-fi enabled modem-routers. Household access statistics are also far from homogeneous. For income, differences in definitions and data quality may raise comparability issues. Income is usually assessed in terms of thresholds and then converted. Nearly all countries in the European Statistical System do not correct income data for the size of the household, while Korea does not operate a conversion to quartiles.

9. Internet users

Regular Internet users, by age, 2012

As a percentage of the population in each age group



Source: OECD, ICT Database, and Eurostat, June 2013; national sources, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892309

The diffusion of the Internet still differs widely among OECD countries: 90% and more of the adult population in Korea and some northern European countries are regular users (which is lower overall than all users by 5% to 10%), but this ratio is less than 60% in some southern and eastern European countries and in Mexico. The differences are primarily linked to age, income and educational factors, which are often intertwined.

In most countries, uptake by young people is nearly universal, but there are wide differences for older generations (notably seniors), and these shape the overall ranking of countries. The role of education appears to be much more relevant for determining Internet usage by these groups than for young people. The share of regular users among 65-74 year-olds with tertiary education is in line with that of the overall population and, in leading countries, approaches that of 16-24 year-olds. Older people, particularly those with less education, are thus a potential focus of strategies to reduce the digital divide.

Purchasing of goods and services over the Internet requires familiarity and trust. The share of Internet users buying products on line ranges from 20% to 70% of adults in reporting countries: the country ranking is similar to that of regular Internet usage, but with important changes over time owing to swift progress in some countries. The impact of income on this activity is reflected in the leading role of 25-44 year-olds compared to younger generations (everywhere but Korea), as well as in the reduction of the gap for 65-74 year-olds in many countries.

Definitions

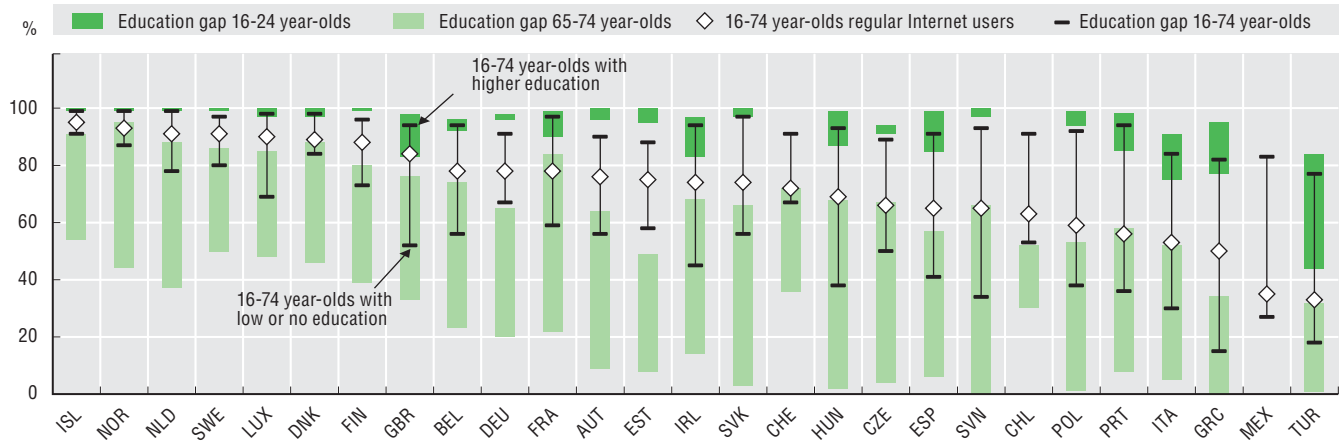
Regular users of the Internet are defined as individuals having used the Internet at least once a week during the last three months.

The *education gap* corresponds to the percentage difference between the proportions of regular users of the Internet with tertiary education (ISCED level 5 or 6) and with at most lower-secondary education (ISCED levels 0, 1 and 2). This can also take account of specific characteristics of individuals, such as their age.

Online purchases are a component of electronic commerce (e-commerce). This includes transactions of goods and services "conducted over computer networks by methods specifically designed for the purpose of receiving or placing orders" (OECD, *Measuring the Information Society*, 2011). For individuals (whether sellers or purchasers), such transactions typically occur over the Internet, while most business-to-business (B2B) e-commerce takes place using other means, such as electronic data interchange (EDI) systems.

Regular Internet users by educational attainment and age, 2012

As a percentage of the population with the same educational attainment in each age group

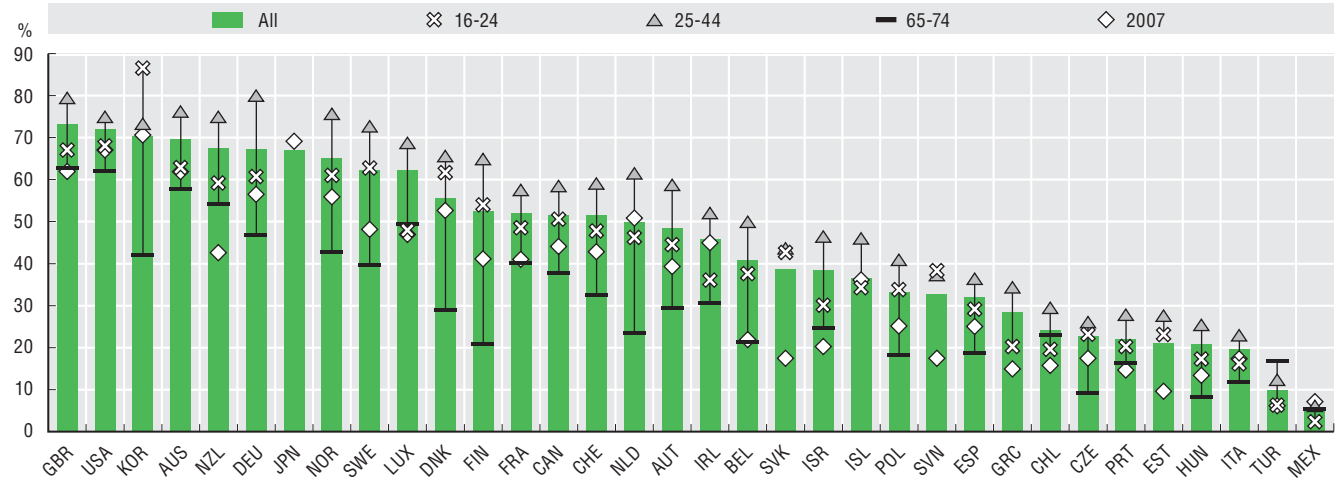


Source: OECD, ICT Database, and Eurostat, June 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892328

Individuals who purchased on line in the last three months, by age class, 2012

As a percentage of Internet users



Source: OECD, ICT Database, and Eurostat, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892347

Measurability

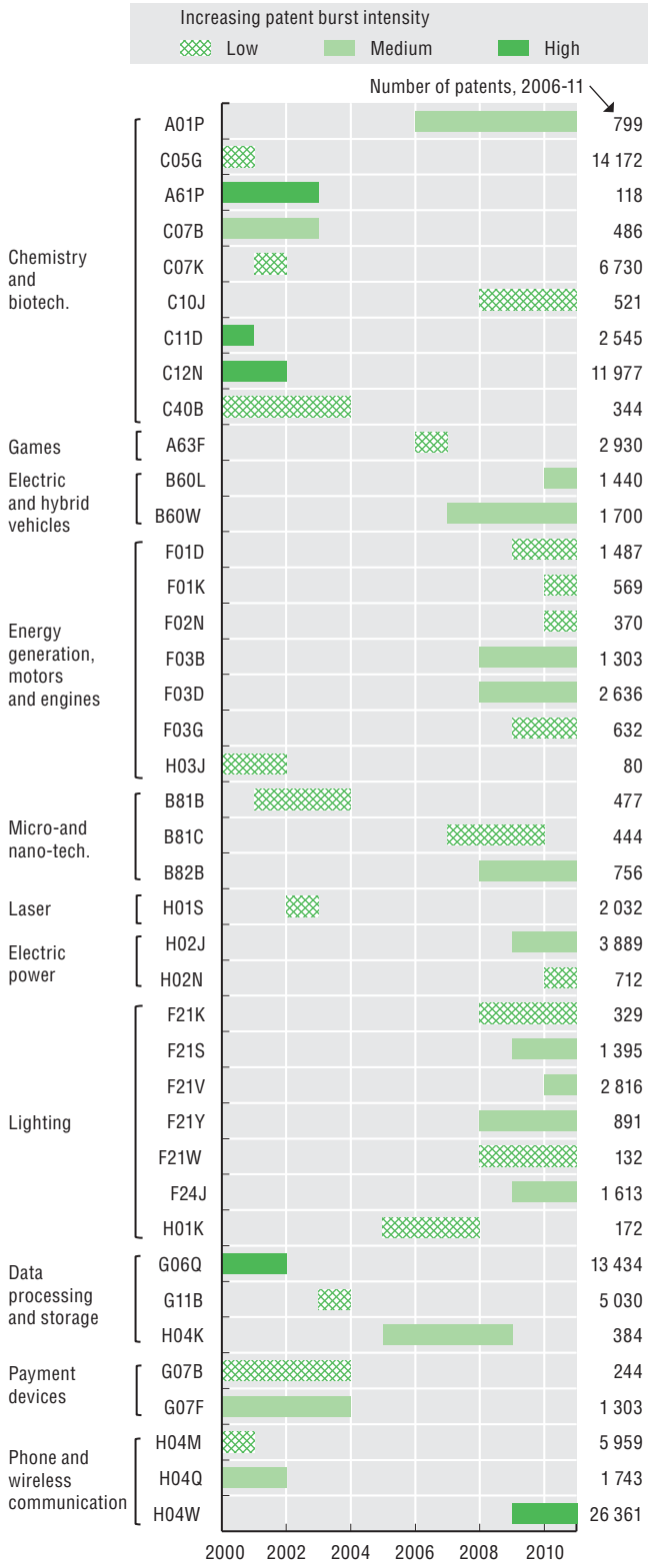
Not all OECD countries survey ICT usage by households and individuals. The collection of information and data availability for specific indicators also vary: in Australia, Canada, Chile, Israel and New Zealand, surveys are on a multi-year or occasional basis, while in other countries they are annual. For European countries, they also involve fully harmonised indicators, but even here data collection practices differ: for instance, ICT usage is generally monitored with a dedicated survey, but in Austria, Belgium, the Czech Republic, Estonia and Ireland data are collected within the Labour Force Survey, and in Italy and the United Kingdom within a general survey on living conditions.

Another source of diversity is the compulsory or voluntary nature of responses (e.g. in the European Union, the survey is only compulsory in eight countries). Also, for online purchases in European countries the recall period is the last three months, while most other countries use the last 12 months. Data on usage with respect to educational attainment of different age groups may also raise issues of the robustness of the information, especially for smaller countries, owing to sampling size and survey design.

10. Emerging technologies

Acceleration in the development of patented technologies, 2000-11

Top 40 technologies, international patent classification classes and their development speed over time



Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892366

New technologies and new fields emerging from the combination of different technologies take time to develop and mature. Experimentation, in the form of R&D or inventive activity over several years, is sometimes followed by a sudden and marked increase in innovative activity that is typical of the development of successful new technologies. The accelerated development of these technologies, i.e. their "burst", can be identified with an experimental methodology that detects sharp rises in the frequency of patent filings in different areas. This methodology also indicates which technologies are likely to continue booming over the next few years.

The timing and intensity of patent bursts in technology areas show that early developments generally occur in patent classes that are later abandoned in favour of new technological solutions in different patent classes. Depending on the field, the move from one technology to another may take place in a continuous fashion (e.g. in data processing and storage) or as simultaneous bursts followed by relatively flat patenting activity and then by later bursts as different technologies emerge (e.g. in chemistry and biotechnology, phone and wireless communication).

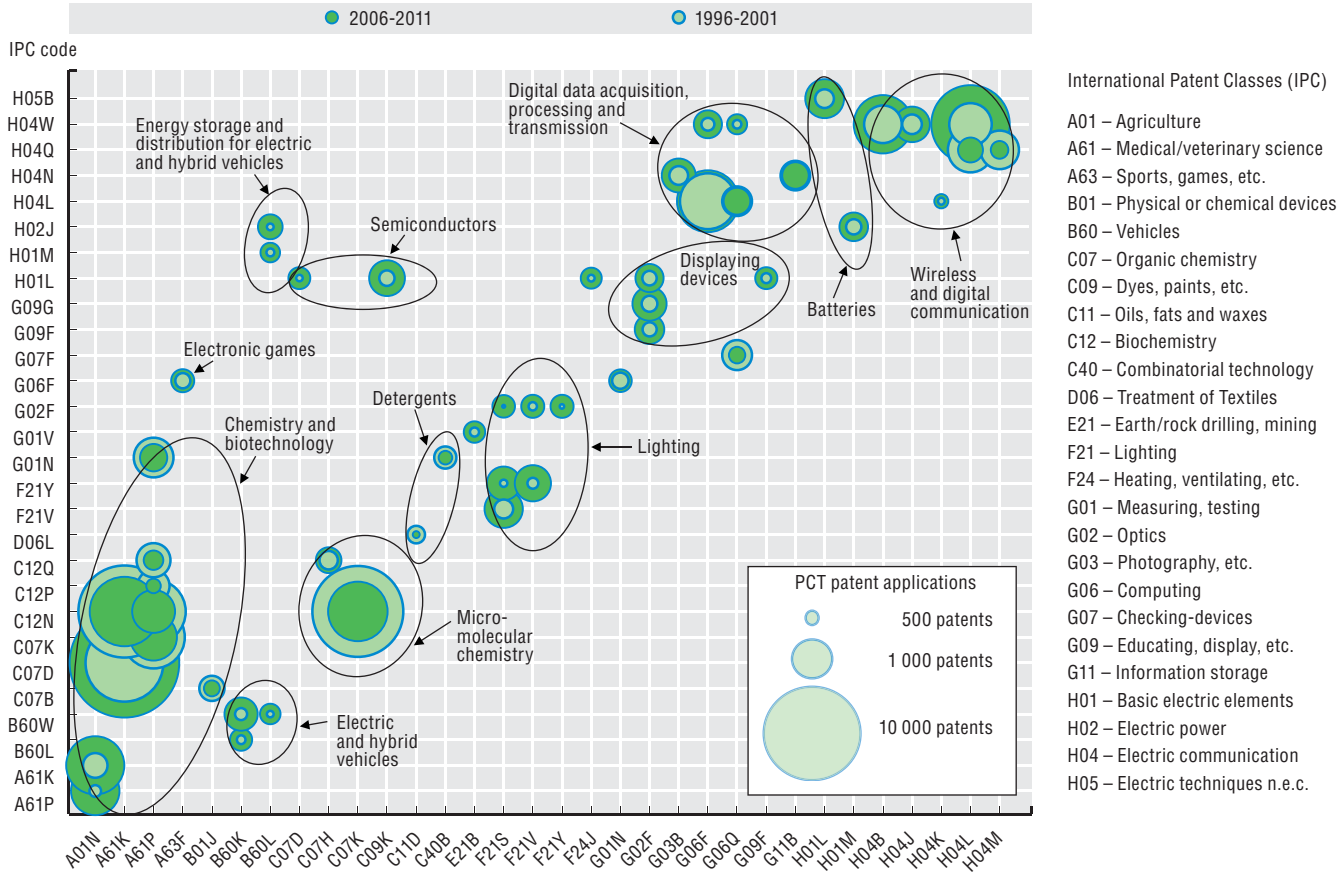
The acceleration of the co-development of pairs of patent classes over time shows the extent to which new fields arise from the cross-fertilisation of different technologies. New display devices, for instance, resulting from co-innovations in basic electric elements (IPC class H01), displaying devices (G09) and optics (G02), underwent a burgeoning development phase in 1996-2001 followed by a less intense activity in 2006-11. Conversely, a growing number of co-developments have been occurring between medical and veterinary science (IPC class A61) and biochemistry (IPC class C12), and between measuring and testing (IPC class G01) and medical and veterinary science.

Definitions

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

Acceleration in the co-development of patented technologies, 1996-2001 and 2006-11

Top 50 co-developments of IPC classes by development speed observed in the 2000s



Note: The technologies experiencing an acceleration in co-development can be identified at the intersection of the x and y axes (e.g. electronic games arise from the combination of A63F, sports, games etc., and G06F, computing). Co-developments that have increased in importance over time are characterised by dark bubbles that are bigger than light bubbles (e.g. biotechnologies arising from the combination of A61P, medical/veterinary science, and A01N, agriculture). Co-development for which the intensity has been fading is characterised by light bubbles that are bigger than dark bubbles (e.g. micro-molecular chemistry, at the intersection of C07K, organic chemistry, and C12N, biochemistry).

Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892385

Measurability

The patent burst experimental methodology is based on work done by Kleinberg (2003). Bursts are evaluated in relative terms, i.e. in comparison with the patent application patterns typically observed in previous years in the technology fields considered and with what occurs in other fields. This is done to distinguish technology- or field-specific increases from generalised increases in overall patenting activity. Only IPC combinations with positive burst intensities are included. Applying the burst methodology to detect sudden and persistent decreases in patenting activity may provide insights into technologies and technology fields that are abandoned or become obsolete. Data relate to patent applications filed through the Patent Cooperation Treaty (PCT) system. Using data from different patenting authorities, especially national offices, may shed light on the technology specialisation of economies and the different development trajectories of technologies across countries and over time. Tracking patent bursts over time, especially those characterised by an initially small number of patent applications, might help uncover new technological trajectories.

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 recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'."

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

"The Republic of Cyprus is 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. R&D funding and specialisation

R&D specialisation, top three performing industries, 2011

For comparability reasons, estimates are only calculated for countries with data available by main economic activity based on ISIC Rev.4 or an analogous classification.

ISIC Rev.4 Divisions as follows: Agriculture, mining, utilities and construction: 01-03, 05-09, 35-39 and 41-43; Chemicals and minerals: 19-23; 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 excluding 72; R&D services: 72; Wholesale, retail and transport services: 45-47, 49-53, 55-56.

For Australia, Denmark, France, Germany, Italy, the Netherlands, Portugal, Spain and the United Kingdom, data refer to 2010.

For Austria, Belgium, Sweden and the United States, data refer to 2009.

For Switzerland, data refer to 2008.

Data are drawn from national sources for Canada and Switzerland.

For Estonia, "Chemicals and minerals" includes a significant investment in new technology in the oil industry (ISIC Rev.4 Division 19) in 2011.

R&D budgets by socio-economic objectives, 2012

"Other" includes support for research on education and society, exploration and exploitation of space, and budgets not elsewhere classified.

For Chile, EU28, France, Israel, Korea, Mexico, Spain, Sweden and the United Kingdom, data refer to 2011.

For Canada, OECD and Switzerland, data refer to 2010.

For Poland, data refer to 2008.

For Israel, a substantial part of defence R&D is not included in estimates reported to the OECD.

For Japan, military procurement contracts are excluded from defence in government budget appropriations or outlays for R&D (GBAORD).

For Korea, general university funds (GUF) cannot be identified separately from general advancement of knowledge; both categories are reported under non-oriented research.

For Mexico, GUF cannot be identified separately from general advancement of knowledge; both categories are reported under the former heading.

For the United States, GUF is not estimated and is therefore not included in total reported GBAORD. General support for universities is the responsibility of state governments.

Top two technologies patented by countries, 2009-11

Data relate to patent applications filed under the Patent Cooperation Treaty (PCT). Patent counts are based on the priority date, the inventor's residence country and fractional counts. Patents are allocated to technology fields using International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised in 2013).

4.2. Green innovation

R&D budgets for energy and the environment, 2002 and 2012

Data refer to 2002 and 2012 except for Canada (2010), Chile (2011), EU28 (2011), France (2011), Israel (2011), Italy (2001), Korea (2011), Mexico (2002), the OECD (2010), Poland (2008), the Russian Federation (2001, 2009), Spain (2011), Sweden (2011), Switzerland (2010) and the United Kingdom (2011).

General notes:

Patents in selected environmental technologies, 1998-2000 and 2008-10 and;
Countries' share in selected environmental technologies, 2008-10

Data relate to patent applications filed under the Patent Cooperation Treaty (PCT). Patent counts are based on the priority date, the inventor's residence and fractional counts. Patents in environment-related technologies are defined using combinations of IPC classes and codes Y02 of the European Classification (ECLA), as detailed in *www.oecd.org/env/consumption-innovation/indicator.htm*.

Additional note:

Patents in selected environmental technologies, 1998-2000 and 2008-10

Only economies that applied for more than 250 patents in 2008-10 are included. For technology fields based on ECLA codes, data for 2008-10 are underestimated.

4.3. Health innovation

Government funding of health-related R&D, 2012

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.

Funds for the general objective of "Advancement of knowledge", comprising non-oriented research funds and general university funds, the estimated R&D content of government block grants to universities, have been included as health-related on the basis of available data attributing a fraction of R&D funds in this category to the field of medical sciences. The "Other" category represents *ad hoc* OECD estimates based on available national sources covering general support for R&D in hospitals and related areas that is excluded from GBAORD estimates.

For Chile, Denmark, Estonia, Finland, Israel, Italy, Korea, Mexico, Slovenia, Spain, Sweden and the United Kingdom, data refer to 2011.

For Canada and Switzerland, data refer to 2010.

For the Russian Federation, data refer to 2009.

For Poland, data refer to 2008.

General notes:

Health-related patents, 1999-2001 and 2009-11 and;
Countries'share in pharmaceutical patents, 2009-11

Data relate to patent applications filed under the Patent Cooperation Treaty (PCT). Patent counts are based on the priority date, the inventor's residence and fractional counts. Health-related patents are defined using International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised in 2013).

Additional note:

Health-related patents, 1999-2001 and 2009-11:

Only economies that applied for more than 250 patents in 2009-11 are included.

4.4. Biotechnology R&D

General notes:

Number of firms active in biotechnology, 2011 and;
Biotechnology R&D in the business sector, 2011

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 Denmark and Slovenia data are preliminary.

For the Russian Federation, a proxy indicator is used: R&D expenditure by priority areas of S&T (Life sciences). These include: Bioengineering; Biocatalysis, biosynthesis and biosensor technologies; Biomedical and veterinary technologies; Genomics and pharmaco-genetics; Living cell technologies.

Additional notes:

Number of firms active in biotechnology, 2011

For Mexico, data include firms with some biotechnology activity over 2010-11. The data are overestimated as they cover two years and therefore exclude firm exit. Data are for firms with 20 or more employees only.

For the Netherlands and Sweden, firms with 10 or more employees only.

For the United Kingdom, an estimated 66% of biotechnology firms (for most of which biotechnology, as defined by the OECD, is the main activity) undertake R&D.

Biotechnology R&D in the business sector, 2011

For Germany, 2011 business expenditures on R&D (BERD) were used to calculate biotechnology R&D intensity, as 2012 BERD was not available.

For Mexico, with 20 or more employees only. 2010 BERD was used to calculate biotechnology R&D intensity, as 2011 BERD was not available.

For the Netherlands and Sweden, firms with 10 or more employees only.

Biotechnology R&D in the government and higher education sectors, 2011

Government expenditure on R&D (GOVERD); higher education expenditure on R&D (HERD).

For Italy, the higher education sector is excluded.

For the Netherlands, provisional data; the higher education sector is excluded. Public-sector firms or institutes 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). These include: Bioengineering; Biocatalysis, biosynthesis and biosensor technologies; Biomedical and veterinary technologies; Genomics and pharmaco-genetics; Living cell technologies.

For Slovenia, data are provisional.

4.5. Nanotechnology R&D

General notes:

Number of firms active in nanotechnology, 2011 and;
Nanotechnology R&D in the business sector, 2011

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 Japan, number of business enterprises with a paid-in capital of JPY 100 million or more.

Additional notes:

Number of firms active in nanotechnology, 2011

For Mexico, data include firms with some nanotechnology activity over 2010-11. The data are overestimated as they cover two years and therefore exclude firm exit. Data are for firms with 20 or more employees only.

Nanotechnology R&D in the business sector, 2011

For Japan and Mexico, 2010 business expenditures on R&D (BERD) were used to calculate nanotechnology R&D intensity, as 2011 BERD was not available.

For the Russian Federation, preliminary estimates based on data gathered in the R&D survey.

Nanotechnology R&D in the government and higher education sectors, 2011

Government expenditure on R&D (GOVERD); higher education expenditure on R&D (HERD).

For Italy and Korea, the higher education sector is excluded.

For Japan, 2010 GOVERD and 2010 HERD were used to calculate nanotechnology R&D intensity, as 2011 data were not available.

For Korea, 2011 GOVERD and 2011 HERD were used to calculate nanotechnology R&D intensity, as 2012 data were not available.

4.6. ICT innovation

R&D expenditure in information industries, 2011

The "information industries" aggregate comprises ISIC Rev.4 Divisions 26 and 58-63. The terms "ICT equipment", "Publishing, audiovisual and broadcasting activities", "Telecommunications" and "IT and other information services" refer to ISIC Rev.4 Divisions 26, 58-60, 61 and 62-63, respectively. "ICT services not allocated" refers to industries within Divisions 58-63 that cannot be separated.

For Australia, Denmark, France, Germany, Italy, the Netherlands, Portugal, Spain and the United Kingdom, data refer to 2010.

For Austria, Belgium, China, Sweden and the United States, data refer to 2009.

For Switzerland data refer to 2008.

Data from national sources for Canada and Switzerland.

ICT-related patents, 1999-2001 and 2009-11

Data relate to patent applications filed under the Patent Cooperation Treaty (PCT). Patent counts are based on the priority date, the inventor's residence and fractional counts. ICT-related patents are defined using International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised 2013). Only economies that applied for more than 250 patents in 2009-11 are included.

Enterprises with broadband connection, by employment size, 2012

For Australia, data refer to 2010/11 (fiscal year ending 30 June 2011) instead of 2012.

For Canada, medium-sized enterprises have 50-299 employees instead of 50-249 persons employed. Large enterprises have 300 or more employees instead of 250 or more persons employed.

For Japan, all businesses with 100 or more persons employed instead of 10 or more, 100-299 instead of 50-249, and 300 or more instead of 250 or more.

For Mexico, data refer to 2008 instead of 2012 and to businesses with 20 or more persons employed instead of 10 or more.

For Switzerland, data refer to 2011 instead of 2012.

4.7. Broadband price and quality

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

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

Prices of mobile voice calls plus data traffic reference baskets, August 2012

The OECD methodology for measuring prices for communication services is based on consumption patterns or "baskets" of fixed, mobile and leased line communication services prices, collected from multiple operators with the largest market shares in each country. The current presentation of the price benchmarking results for mobile broadband services covers services provided over a handset or smartphone.

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

4.8. Fixed and wireless broadband

Wireless broadband penetration by technology, December 2009 and 2012

Wireless terrestrial broadband includes standard (voice plus data) and dedicated mobile data subscriptions, as well as terrestrial fixed wireless and satellite broadband. The latter two categories in the family of wireless technologies are widespread in only a few countries and, from the usage perspective, correspond to fixed broadband connections.

Standard mobile broadband subscriptions may include dedicated mobile data subscriptions when breakdowns are not available.

Data for Israel, Mexico, Switzerland and the United States are estimates.

Fixed wired broadband penetration by speed tiers, December 2009 and 2012

OECD subscription data (December 2012) merged with Akamai's actual speed data (2nd quarter, 2012).

Figures on fixed wired broadband subscriptions exclude fixed terrestrial wireless and satellite broadband technologies, which are typically used in fixed locations. These are grouped with other wireless subscriptions, and are relevant for only a few countries, and in particular, the Czech Republic (with a penetration rate of 8.6%) and the Slovak Republic (4.8%).

Data for Mexico, Switzerland and the United States are OECD estimates.

Household Internet access by income quartile, 2008 and 2012

For Australia, data refer to 2010/11 (fiscal year ending 30 June 2011) instead of 2012.

For Canada, the Czech Republic, Denmark, Israel, the Netherlands and the United States, data refer to 2011 instead of 2012.

For Chile, data refer to 2009 instead of 2008.

For Korea, data are not available by income quartiles but by thresholds. The bottom quartile was made equivalent to an income of less than KRW 100 million and the top quartile to an income of more than KRW 300 million.

For New Zealand, data refer to 2006 instead of 2008.

For Switzerland and Turkey, data refer to 2010 instead of 2012.

For the United States, data refer to 2007 instead of 2008.

For Australia, Canada, France, Ireland, Mexico, Turkey and the United Kingdom, data by quartile are not available.

4.9. Internet users

Regular Internet users by age, 2012

National source for the Russian Federation is the Institute for Statistical Studies and Economics of Knowledge, Higher School of Economics (HSE) of the National Research University, May 2013.

For the Czech Republic, Denmark and the Netherlands, data refer to 2011.

For Korea and Mexico, Internet users are defined for a recall period of 12 months.

For Switzerland, data refer to daily Internet users. Internet users are defined for a recall period of 6 months.

Regular Internet users by educational attainment and age, 2012

For EU countries and Turkey, data by educational attainment for 16-24 and 65-74 year-olds are OECD estimates based on Eurostat; for 16-24 year-olds, they are a 2010-12 average.

For the Czech Republic, Denmark and the Netherlands, data by educational attainment for 65-74 year-olds refer to 2011.

For Turkey, data refer to 2010.

For Switzerland, Internet users are defined for a recall period of 6 months.

For Mexico data refer to all Internet users defined for a recall period of 12 months.

For Chile and Switzerland, data for the lower educational level include all individuals without tertiary education.

Individuals who purchased on line in the last three months, by age class, 2012

For Australia, Canada, Chile, Mexico, New Zealand and Switzerland the reference period is the last 12 months.

For Australia, data refer to the financial year ending 30 June 2010 (2009/10) instead of 2012.

For Canada, the question refers to "ordering goods or services over the Internet from any location (for personal or household use, not business use)".

For the Czech Republic, Denmark and the Netherlands data refer to 2011 instead of 2012.

For Chile, data refer to 2009 instead of 2007. In 2009, no time period is specified, instead of last 12 months.

For Israel, data refer to all individuals aged 20 and over instead of individuals aged 16-74 and to 2006 instead of 2007.

For Japan, details by age are not available. Data refer to all individuals aged 6 and over instead of 16-74.

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

For Switzerland, data refer to 2005 instead of 2007.

For Turkey, data refer to 2010 instead of 2012.

For the United States, data are drawn from the PEW Research Center and cover all individuals aged 18 and over, instead of 16-74, who ever purchased a product on line. Data refer to September 2007 and May 2011.

4.10. Emerging technologies

Acceleration in the development of patented technologies, 2000-11

Data relate to patent applications filed under the Patent Cooperation Treaty (PCT). Patent counts are based on the application date, the International Patent Classification (IPC) codes and fractional counts. Patent "bursts" correspond to periods characterised by the sudden and persistent increase in the number of patents filed at the 4-digit IPC class level. Top patent bursts are identified by comparing the filing patterns of all 4-digit IPC classes. The intensity of a patent burst refers to the relative strength of the observed increase in filing patterns. Only IPC classes featuring a positive burst intensity in the 2000s are included.

Descriptions of IPC codes are available at: *www.wipo.int/classifications/ipc/en*.

Acceleration in the co-development of patented technologies, 1996-2001 and 2006-11

Data relate to patent applications filed under the Patent Cooperation Treaty (PCT). Patent counts are based on the application date and the co-occurrence of IPC codes in patents, using fractional counts. Patent "bursts" correspond to periods characterised by the sudden and persistent increase in the number of patents filed in the pairs of 4-digit IPC classes considered. Top patent bursts are identified by comparing the filing patterns of all possible pairs of 4-digit IPC classes. The intensity of a patent burst refers to the relative strength of the observed increases in the filing patterns. Technology domains have been identified through text analysis of the combinations of IPC codes considered. Only IPC combinations with a positive burst intensity in the 2000s (either starting or ending burst) are included.

Descriptions of IPC codes are available at: *www.wipo.int/classifications/ipc/en*.

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man
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future
ecology
lamp
image
hand
isolated
green
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business
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symbo
environment
blue
renewable
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5. UNLEASHING INNOVATION IN FIRMS

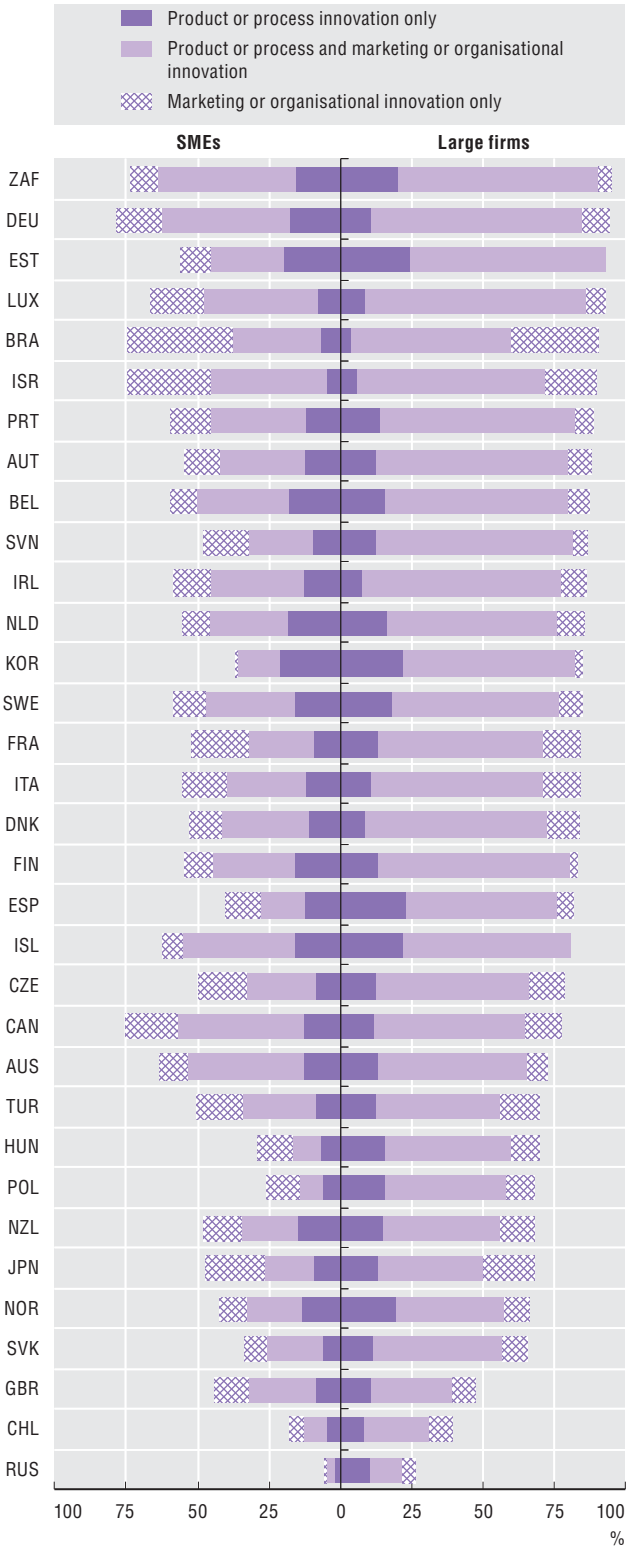
1. Mixed modes of innovation
2. Broader innovation
3. Public support to innovation
4. The IP bundle
5. Trademarks
6. Knowledge-asset-related trademarks
7. Registered designs
8. Trademarks and patents
9. Entry, exit and survival
10. Firm employment dynamics
11. Access to capital
12. Policy environment
Notes and References

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 much innovation is not R&D-based, the propensity to innovate among firms doing R&D is consistently higher. For their part, governments play an important role in promoting investment in innovation. Also critical for innovative firms is the ability to appropriate, exploit and protect the results of their creative activities. A new indicator on the intellectual property (IP) bundle points to the joint use of patents, trademarks and industrial designs by firms worldwide. For the first time patents and trademarks are matched to company data to describe the IP bundle of firms in different countries and sectors. A novel use of trademark data is also proposed to help track intermediaries in IP-related transactions. New data on registered designs provide information on how creativity is protected in countries. Indicators of firms' birth and death rates reflect the dynamism of the business sector. Evidence from a new project based on microdata shows the strong contribution of young firms to job creation. Policy areas for particular attention are the financing of innovative efforts and fostering the start-up and growth of new firms. Selected indicators reflect the availability of debt financing and venture capital; regulatory and taxation indicators are also important as these areas affect entrepreneurial activities.

1. Mixed modes of innovation

Innovation types by firm size, 2008-10

As a percentage of all SMEs and large firms



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892404

Firm-level data reveal innovation strategies that combine different types ("mixed modes") of innovation: most innovative firms introduce new marketing or organisational methods alongside product or process innovations since these are often complementary. In fact, new organisational methods may facilitate the introduction of a new production process or the new process may even require them. This holds true for both large firms and SMEs in both manufacturing and services.

Brazil, Israel, Luxembourg and Germany have the largest share of organisational and marketing innovators: more than 80% of large firms and more than half of all SMEs introduced such innovations in 2008-10. In the Russian Federation, Chile and Poland, fewer than 20% of all SMEs introduced organisational or marketing innovations. A significantly higher share of large firms than of SMEs introduced product and process innovations in all countries, and particularly in Slovenia, Spain and Estonia.

In most countries, the shares of organisational and marketing innovating firms are relatively similar across broad sectors, although in Iceland and Portugal, the share is significantly higher in services (by 19.2 and 13.4 percentage points, respectively). In Israel and Brazil, more than 20% of all firms in manufacturing and 30% in services introduced organisational or marketing innovations only.

Definitions

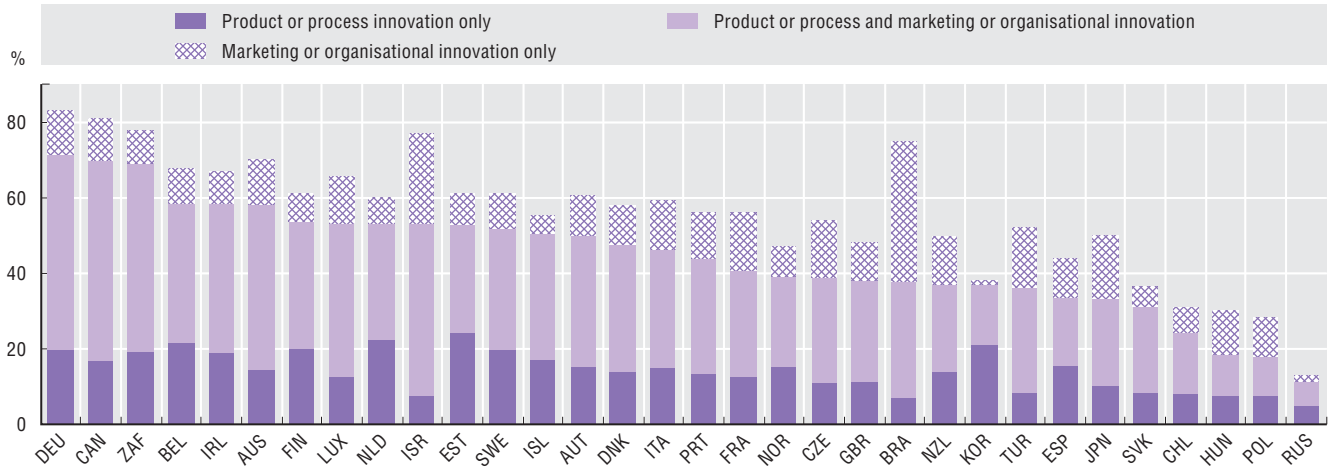
The current edition of the *Oslo Manual* identifies four types of innovation:

- *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 (see chapter notes).

Innovation in the manufacturing sector, 2008-10

As a percentage of all manufacturing firms



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

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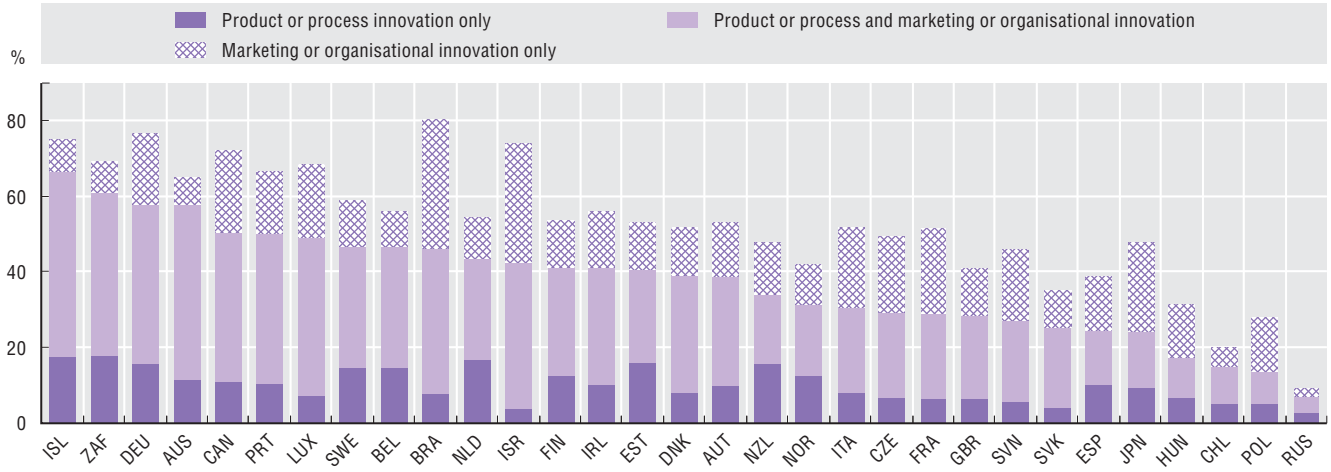
Innovation in the services sector, 2008-10

As a percentage of all services firms



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892442

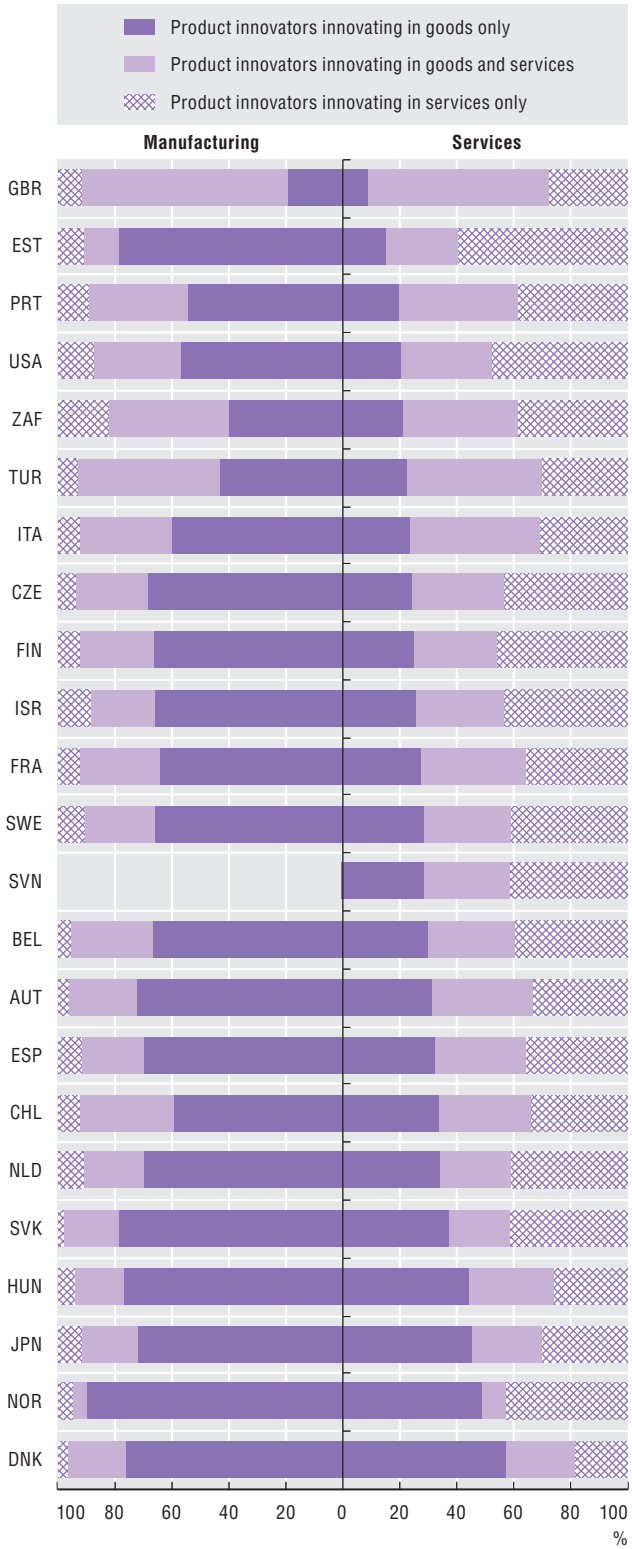
Measurability

These indicators may be affected by differences in the sectoral coverage of innovation surveys across countries. Although an effort was made to align the data for non-European countries with the "core" coverage of the Community Innovation Survey (CIS), this is not always possible owing to survey and sample design. In Korea, these data only cover the manufacturing sector. Similarly, differences in sectoral coverage in Brazil, Canada, Chile, New Zealand and South Africa may affect the comparability of some indicators. Finally, some countries do not identify firms with ongoing/abandoned innovation activities, so that (contrary to the CIS data) these are not included in the figures for product and/or process innovative firms and may also affect comparability.

2. Broader innovation

Firms innovating in goods and services, manufacturing and services, 2008-10

As a percentage of product innovative firms in each sector



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892461

The boundaries between services and manufacturing are increasingly blurred: a significant share of product innovative firms in manufacturing introduces new services alongside new goods. However, in Denmark, Norway and Japan, more than 45% of product innovators in the services sector only had goods innovations during the period 2008-10. Part of this apparent blurring of sectoral boundaries may be due to the fact that some large enterprises are involved in both manufacturing and service activities (and so would introduce both goods and service innovations), but are classified in a single industry.

Product innovation is often associated with R&D: in most countries, more than half of all product innovative firms are also R&D-active (i.e. they either carry out R&D in-house or purchase R&D services from others). Yet more than 60% of product innovators in Luxembourg, New Zealand, France and Turkey and almost 80% in Brazil do not engage in R&D. The propensity of firms to innovate in products is also consistently higher among R&D-active firms (between 65% and 85% in most countries) than among those do not engage in R&D, although there is much greater variability among the latter.

In most countries, the propensity of product and/or process innovative firms to be R&D-active is generally higher in manufacturing than in services. Estonia, Hungary, Portugal, the Russian Federation and Brazil are exceptions, but the difference is generally small. Not all innovation is based on R&D, particularly in services: in Australia and New Zealand less than 20% of product and/or process innovating firms in the services sector are R&D-active.

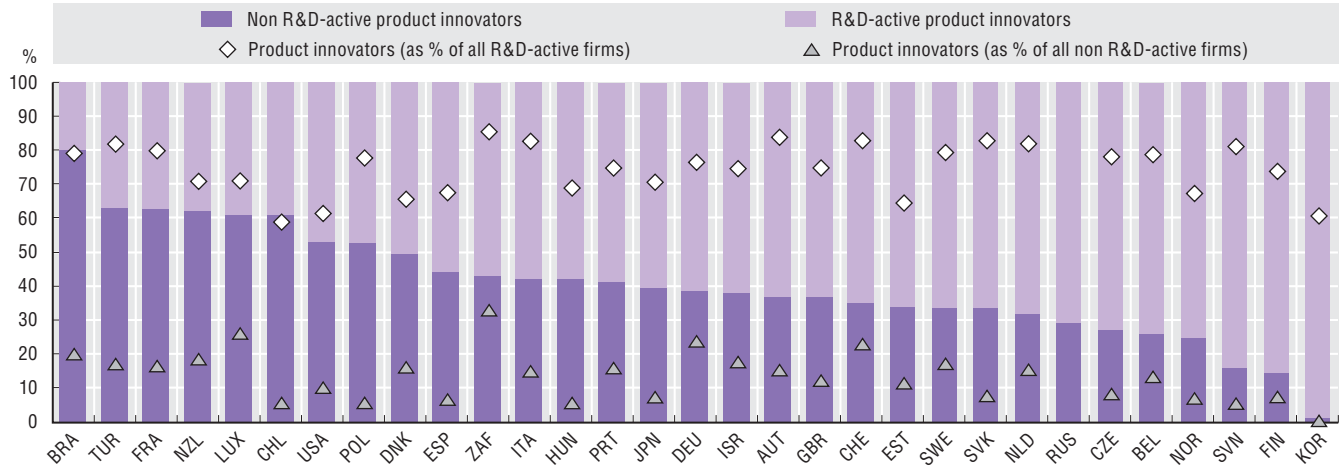
Definitions

The term "product" is used to cover both goods and services. *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.

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 (see chapter notes).

Product innovation, by R&D status, 2008-10



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

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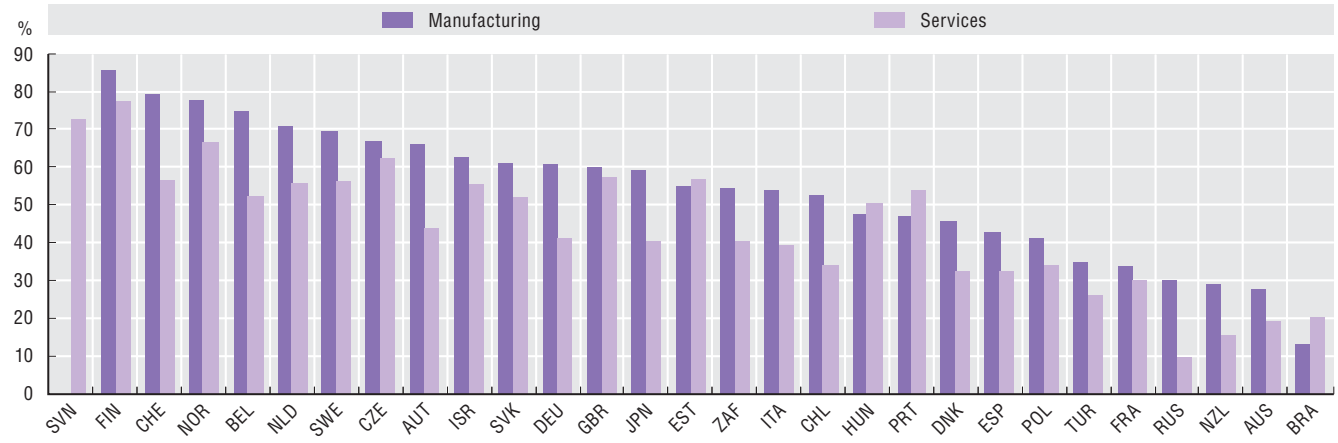
R&D-active firms, manufacturing and services, 2008-10

As a percentage of product and/or process innovative firms in each sector



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

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Measurability

Because R&D and innovation are related phenomena, some countries collect information on innovation as part of business R&D surveys. Given that R&D surveys target R&D performers while innovation surveys have a much wider target population, these differences may affect the comparability of R&D-related data collected from different instruments.

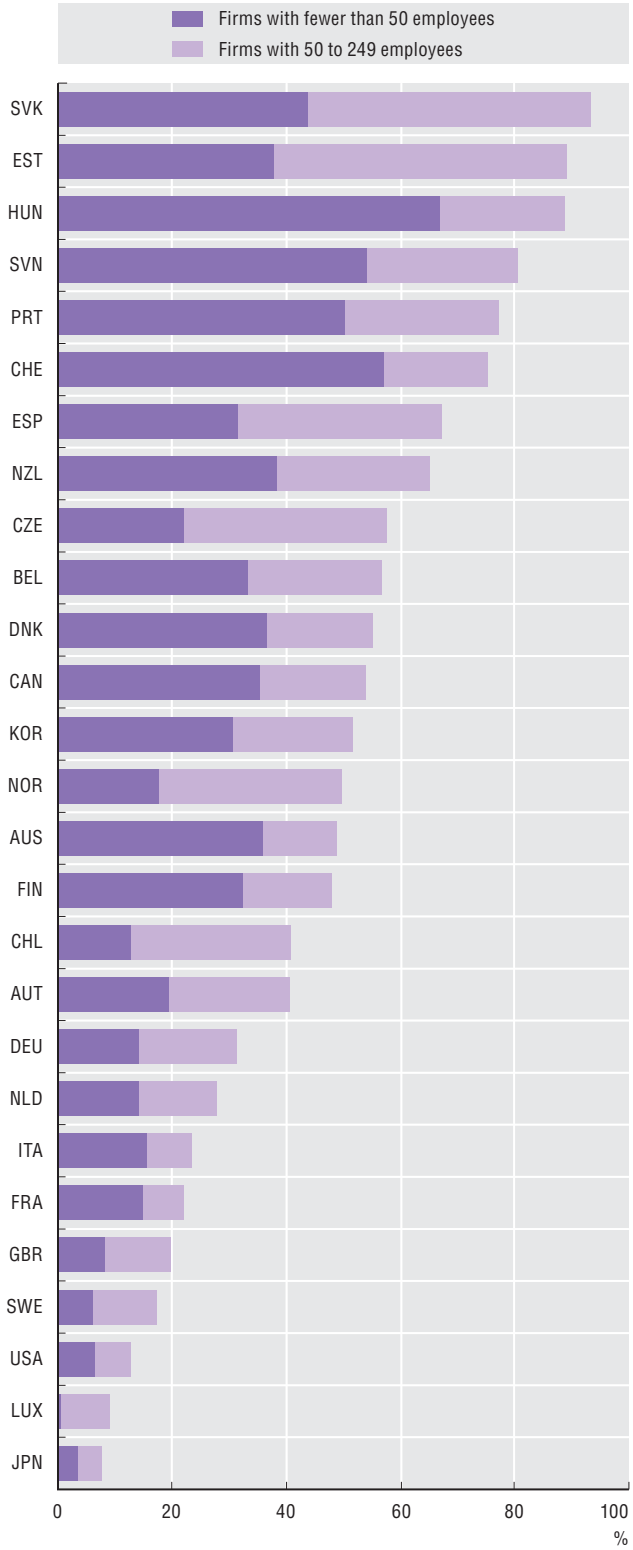
In dedicated surveys that adopt the Community Innovation Survey (CIS) model, firms are typically identified as being R&D-active when they report carrying out internal or external R&D as part of their product and/or process innovation activities. The innovation surveys of Australia and New Zealand request this information of all innovative firms (including those with only organisational or marketing innovations).

Differences in surveys' sectoral coverage affect the comparability of the data relating to R&D status since some non-CIS surveys cover less R&D-intensive industries much more extensively. Differences in the size thresholds used also affect comparability since very small firms are on average less likely to carry out or purchase R&D.

3. Public support to innovation

Government-financed R&D in the business sector, by firm size, 2011

As a percentage of government-financed BERD



Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892518

Public support, both direct and indirect, can play a key role in facilitating firms' investment in R&D and innovation, particularly by small and medium-sized enterprises (SMEs). In most countries, the share of government-financed business enterprise expenditures on R&D (BERD) to SMEs has increased in the last decade to between 40% and 80% and to over 85% in the Slovak Republic, Estonia and Hungary in 2011. However, in Japan, Luxembourg, the United States and Sweden, more than 80% of public support goes to firms with over 250 employees.

Many countries offer various financial incentives to encourage firms to engage in innovation activities (R&D and other), but uptake varies between 20% and 40% in most countries. In a large majority of countries, large firms tend to benefit more from such schemes than SMEs. In several cases for which earlier data are available, the rate of uptake among innovative firms seems to have increased from 2006-08 to 2008-10.

Public support for innovation is generally more prevalent in manufacturing than in services, although the difference is quite small in most countries. In Luxembourg, the Netherlands, Finland and Switzerland the share of manufacturing firms receiving public support for innovation exceeds that of services firms by 20 to 30 percentage points. Only in the Russian Federation is the uptake of public support for innovation higher in service firms, although this may include a significant number of firms whose main activity is R&D services for others.

Definitions

Government-financed BERD includes all forms of direct support such as grants, some types of loans and procurement contracts. It does not include R&D tax credits or other indirect support measures.

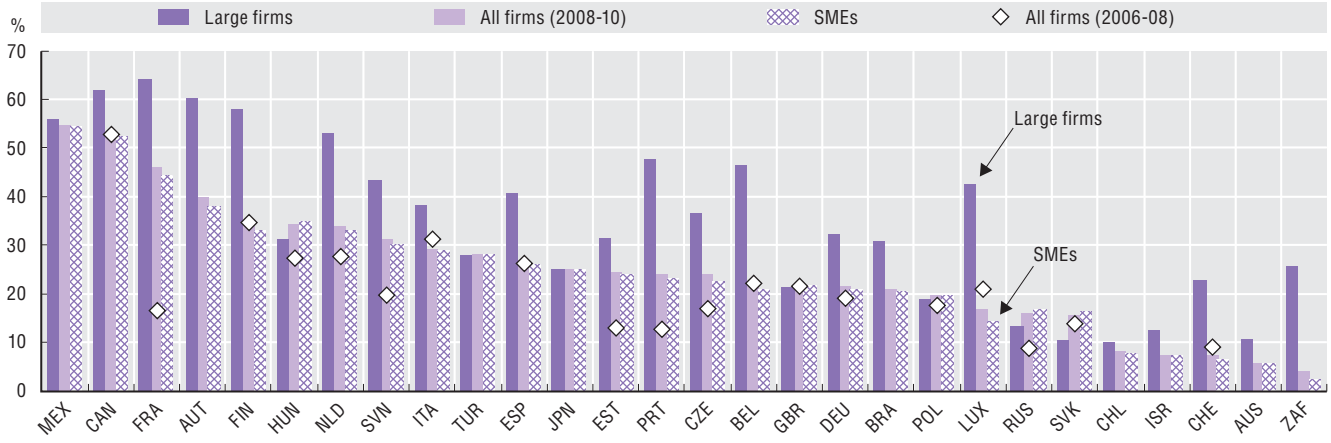
Public support for innovation includes financial support via tax credits or deductions, grants, subsidised loans, and loan guarantees. It excludes research and other innovation activities conducted entirely for the public sector under contract.

The classification of firms by size follows the recommendations of the *Oslo Manual*. In a majority of countries, it is calculated on the basis of the number of employees. SMEs are defined as firms with 10-250 employees, with some exceptions: New Zealand 6+; the Russian Federation 15+, Mexico 20+. For South Africa, firm size is based on turnover.

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 (see chapter notes).

Firms receiving public support for innovation, by firm size, 2006-08 and 2008-10

As a percentage of product and/or process innovative firms

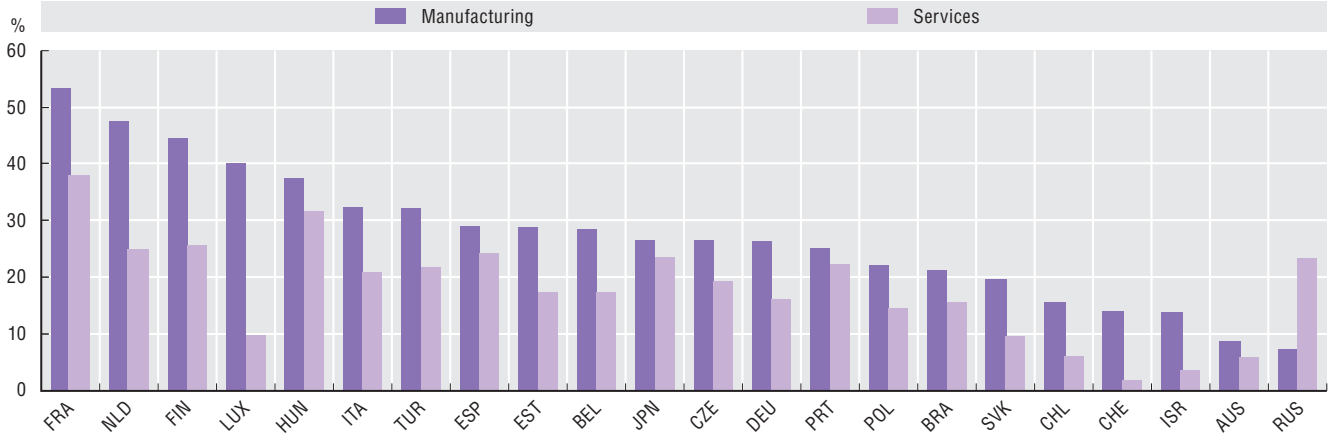


Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892537

Firms receiving public support for innovation, manufacturing and services, 2008-10

As a percentage of product and/or process innovative firms in each sector



Source: OECD, based on Eurostat (CIS-2010) and national data sources, June 2013. See chapter notes.

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Measurability

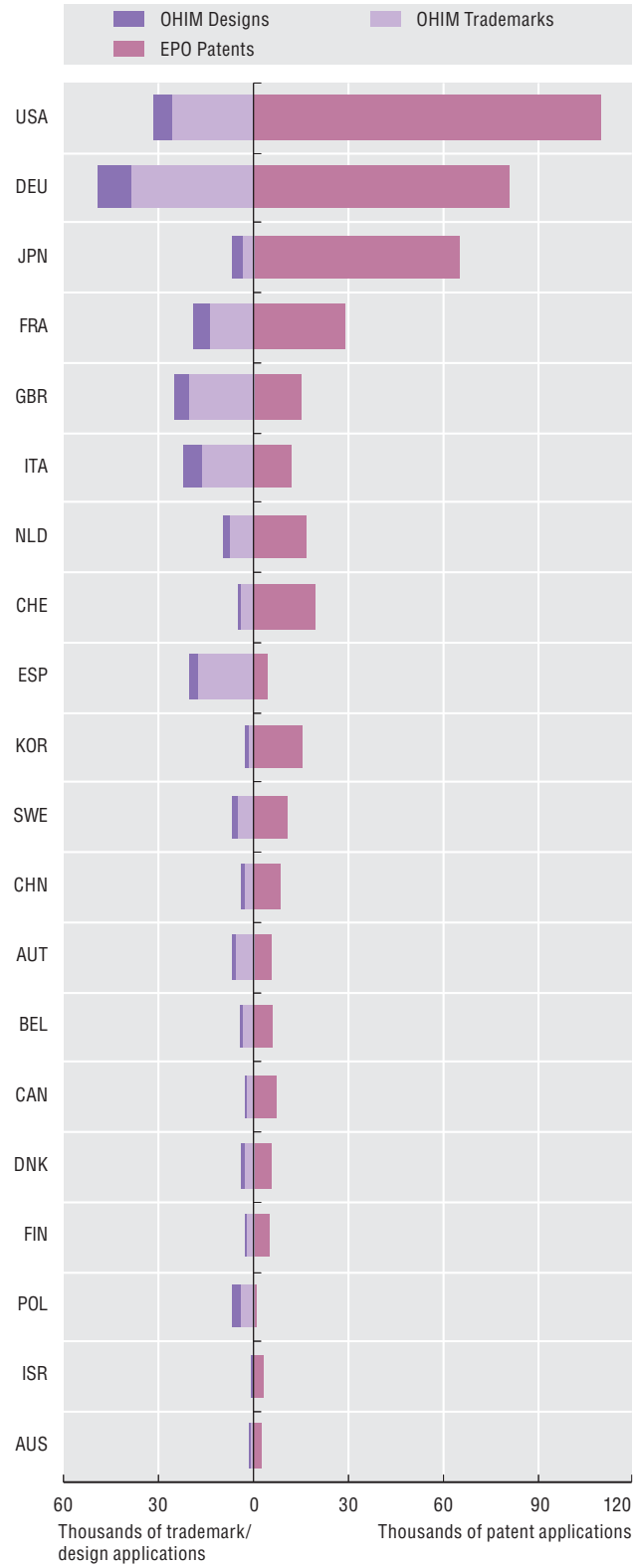
BERD data only cover direct support (grants as well as contracts) and should be complemented with additional information on indirect support (such as foregone revenue from R&D tax credits) to obtain a broader picture of public support to business R&D.

Data on public support by firm size do not distinguish between SMEs that are part of a group and those that are independent. The propensity of each of those types of firms to receive public support may differ significantly.

Data on public support for innovation refer to any kind of support scheme, but in the countries carrying out the Community Innovation Survey (CIS), this only includes support for product/process innovations. In other countries, public support can include support to other types of innovation, notably marketing and organisational. In the Canadian Survey of Innovation and Business Strategy (SIBS), public support for innovation only includes grants and tax credit programmes across all levels of government.

4. The IP "bundle"

IP bundle of top 20 applicants, 2010-12



Source: OECD calculations based on OECD, Patent Database, OHIM, Community Trademark Database, CTM Download, May 2013, and OHIM, Registered Community Design Database, RCD Download, April 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892575

Patents, trademarks and industrial designs can be used to appropriate, exploit or protect the results of innovative and creative activities. Evidence suggests that firms worldwide increasingly rely on the joint use of these intellectual property (IP) rights. The overall size and composition of the IP "bundle" relate to a country's industrial structure and to the main characteristics of its firms, their innovativeness, creativity and competitiveness, and to framework conditions such as trade openness and IP regimes.

The size and composition of the IP bundle vary notably across countries in terms of the proportion of patents filed at the European Patent Office (EPO), of Community trade marks (CTM) and of registered Community designs (RCD). In absolute terms, the United States, Germany and Japan are the countries that rely most on these knowledge-based assets. IP bundles registered at European offices generally have a majority of patents, followed by CTM and RCD. For Spain, Poland and the United Kingdom the IP bundles predominantly contain trademarks. In Poland and Italy designs dominate (37% and 16% respectively).

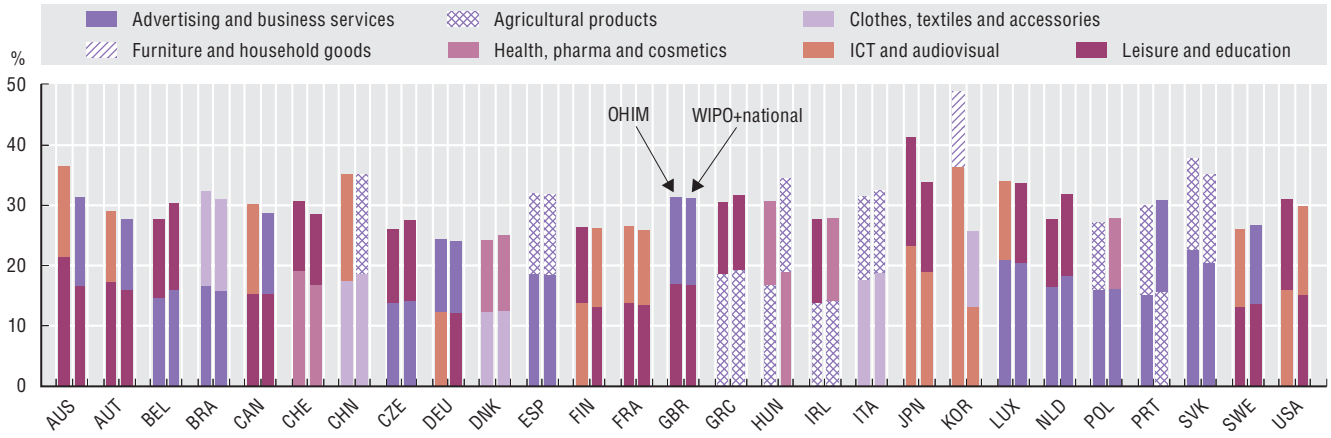
In general, registered trademarks and designs relate to the same categories of products at home and abroad, although there are differences in the share of registrations accounted for by the top two application fields. In the case of Korea, these account for almost 50% of CTM and for more than 60% of designs registered at home and abroad, with ICT and audiovisual trademarks and designs responsible for the biggest shares in both.

Definitions

The IP bundle refers to the joint use of patents, trademarks and industrial designs, each protecting a different type of knowledge-based asset. Patents are exclusive rights granted for inventions, i.e. products or processes providing new ways of doing something or offering new technical solutions to problems. Patents reward innovators but also require the disclosure of the relevant technical knowledge and may thus enable further technological developments. Trademarks are distinctive signs – i.e. words, symbols, images, etc., or a combination thereof – used to identify goods or services. These aim to help customers choose products or services that meet their needs and expectations, e.g. in terms of quality or price. Registered trademarks are often part of brand strategies, as brands can be legally protected in so far as (some of) their parts are protected by IP rights. Industrial designs protect new and/or original ornamental or aesthetic aspects of articles rather than their technical features. Designs render objects more appealing to consumers and increase their marketability or commercial value.

Top two trademark application fields, by country, 2009-11

As a percentage of total trademark applications

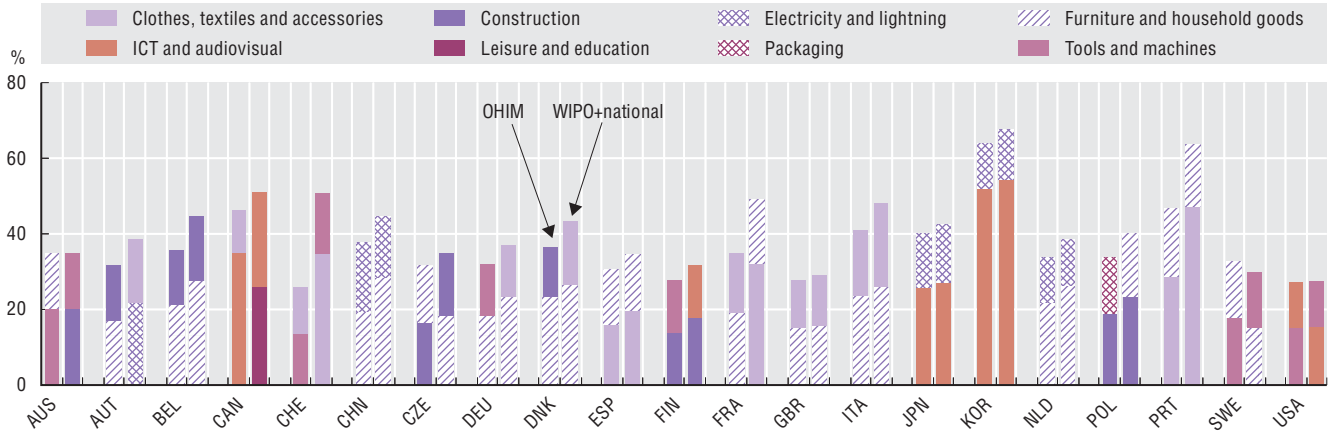


Source: OECD calculations based on OHIM, Community Trademark Database, CTM Download, May 2013; WIPO Statistics Database, November 2012. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892594

Top two design application fields, by country, 2009-11

As a percentage of total design applications



Source: OECD calculations based on OHIM, Registered Community Design Database, RCD Download, April 2013; WIPO Statistics Database, November 2012. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892613

Measurability

The initial focus on European IP offices is due to the extensive use that applicants worldwide make of them. The WIPO-administered Madrid System for the International Registration of Marks and the Hague System for the International Registration of Industrial Designs are relatively less exploited, with yearly trademark applications varying between 35 000 and 44 000 in 2006-12 (versus 63 000 to 84 000 CTM filed per year at OHIM), and designs registered under the Hague System of up to 3 000 a year during the period considered (but up to 22 000 RCD a year).

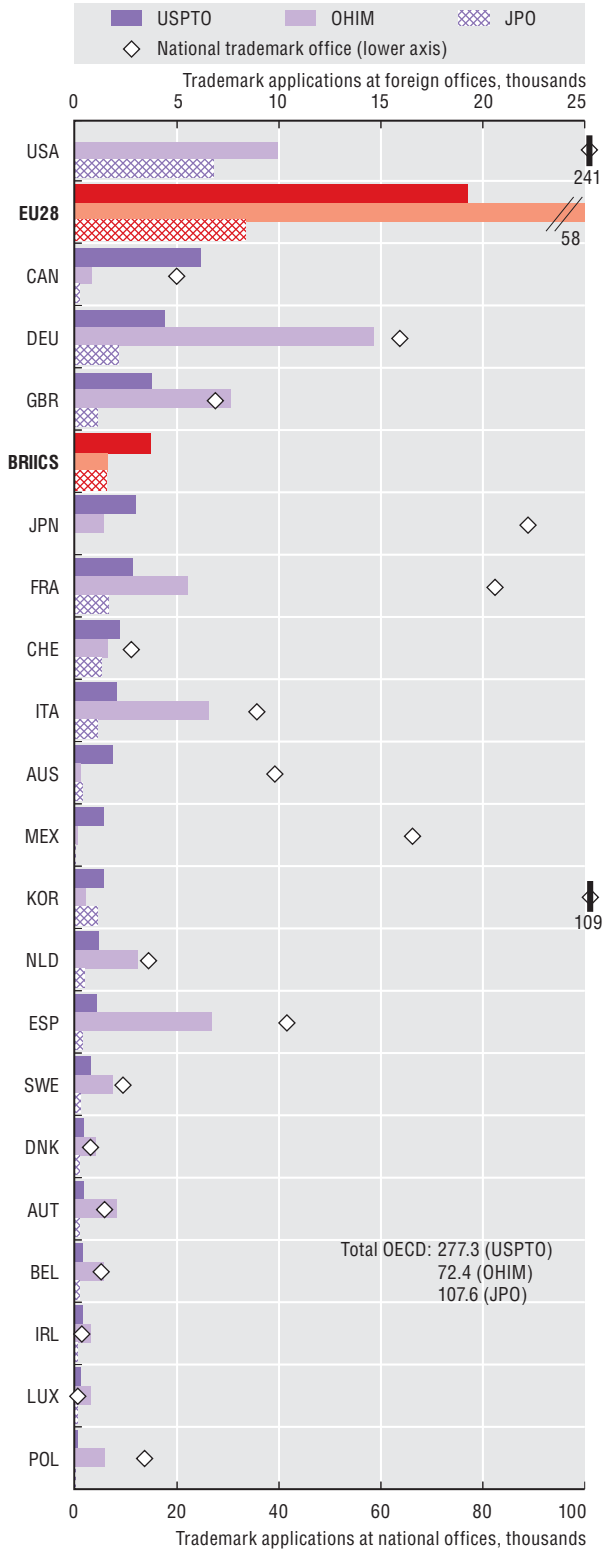
There are differences in the territorial coverage of EPO patents and of CTM and RCD. EPO patents may be requested for one or more contracting states (38 since 2010), whereas CTM and RCD have a unitary character and their geographic scope cannot be restricted (see chapter notes). Territorial coverage also varies for trademarks and designs registered through the WIPO-administered international system, depending on the contracting states.

In Germany and Spain, the proximity and accessibility of the EPO (Munich) and the OHIM (Alicante) may affect the statistics.

5. Trademarks

Top 20 trademark applicants, 2009-11 average

Trademark applications at USPTO, OHIM, JPO and national trademark offices, thousands



Source: US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google; OHIM Community Trademark Database CTM Download, May 2013; JPO Annual Reports 2001-12; WIPO statistics Database, March 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892632

Trademarks (TM) are distinctive signs identifying goods and services that are used by companies to distinguish their offerings from those of competitors. By endowing products with the unique characteristics associated with brand names, they help make their owners more competitive and thus ensure future earning streams. As TM registration often accompanies the launch of new products and services, it can serve as an indicator of innovative and marketing activity and can proxy non-technological innovation and innovation in services. TM registered by foreign firms provide information on market penetration by foreign companies and may help reveal firms' strategies in different markets.

Firms show different propensities to rely on TM and to penetrate foreign markets, as shown in TM applications at the United States Patent and Trademark Office (USPTO), the European Office for the Harmonization in the Internal Market (OHIM) and the Japan Patent Office (JPO). This may be due to factors such as the size of the target market, the presence and location of foreign affiliates, economies' industrial specialisation, trade agreements, and participation in global value chains. While BRIICS economies show a lower level of trademark activity abroad than OECD countries, their presence, especially that of China, has increased markedly in the United States, Japan and Europe over the past decade. BRIICS firms appear to target mainly the US market, followed by Europe. With the exception of the Russian Federation BRIICS' foreign market penetration has been paralleled by a marked rise in domestic TM registrations.

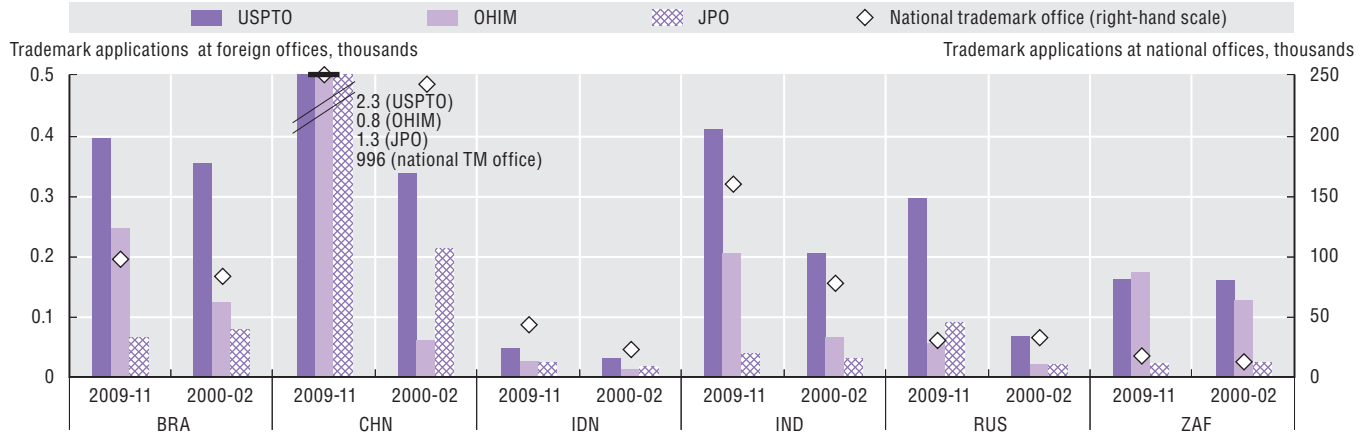
Most TM applications relate to goods in all markets considered, although the proportion varies among TM offices. The share of service TM applications is generally largest in the home market, i.e. at USPTO for US firms, at JPO for Japanese companies and at OHIM for European ones. A varying proportion of trademarks (up to 47% in the United Kingdom) covers both goods and services and is typically larger in Europe than in the United States and Japan. This may reflect the growing sophistication of company strategies for offering bundles of goods and services to clients.

Definitions

Registered TM are a form of intellectual property protection for goods and services that grant exclusive rights to their owners and help consumers choose products that meet their needs and expectations in terms of nature, quality and price. Protection is enforced by the courts, which in most systems can block infringements. A trademark's country of origin is defined according to the address of the firm or economic agent listed in the trademark document.

Trademark applications by BRIICS countries, 2000-02 and 2009-11 averages

Trademark applications at USPTO, OHIM, JPO and national trademark offices, thousands

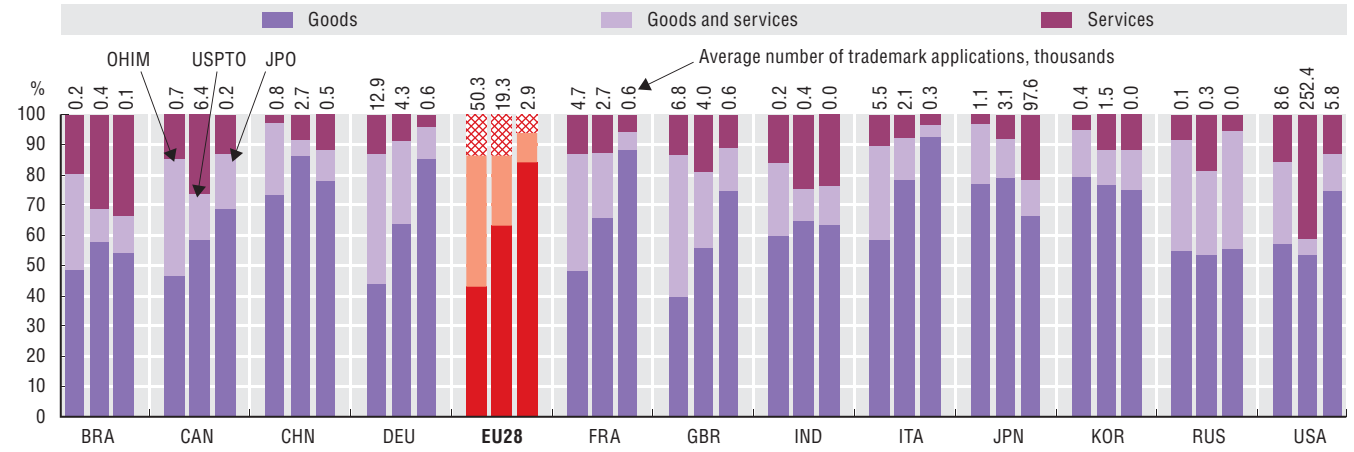


Source: US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google; OHIM Community Trademark Database CTM Download, May 2013; JPO *Annual Reports* 2001-12; WIPO statistics Database, March 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892651

Share of goods and services trademark applications at USPTO, OHIM and JPO, 2010-12

As a percentage of total trademark applications, selected OECD and non-OECD economies



Source: OECD calculations based on US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google; OHIM Community Trademark Database CTM Download, May 2013; and JPO Trademark Data, September 2012. StatLink contains more data. See chapter notes.

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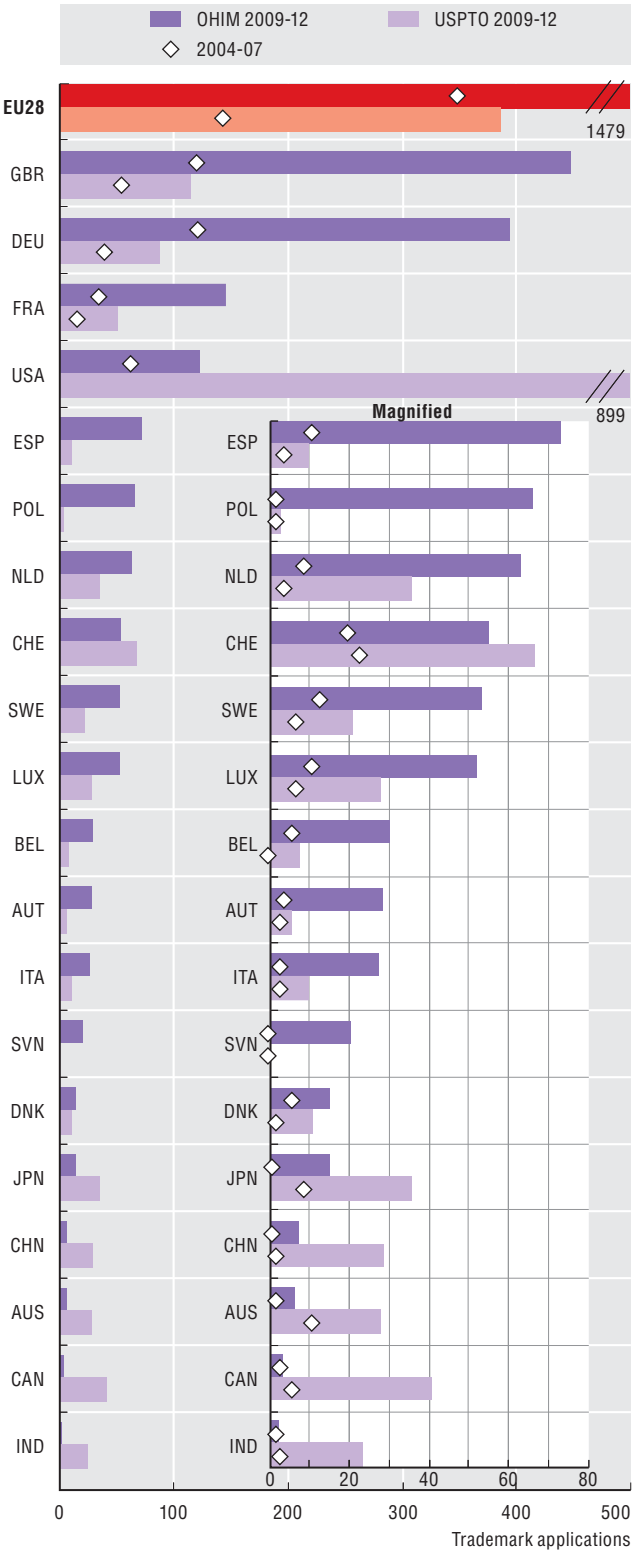
Measurability

Applications to register trademarks are filed with the relevant national or regional trademark offices and contain the list of goods or services (or both) to which the TM would apply. The current edition of the *International Classification of Goods and Services for the Purposes of the Registration of Marks*, known as the "Nice Classification" (tenth edition, entered into force on 1 January 2013) contains 34 classes of goods and 11 of services. Goods trademarks relate to classes 1-34; service trademarks correspond to classes 35-45. Most countries allow for multi-class filings; a few (e.g. China) allow only single-class applications. The period of TM protection may vary – it is typically ten years – and trademarks can be renewed indefinitely upon payment of fees. Registration and maintenance fees vary substantially. They are generally proportional to the number of designated classes, although OHIM, for example, allows up to three classes for the same initial fee. This may affect overall statistics and the observed proportions of goods and services TM.

6. Knowledge-asset-related trademarks

IP-transaction-related trademarks, 2004-07 and 2009-12

Trademark applications at OHIM and USPTO, top 20 applicants



Source: US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google; OHIM Community Trademark Database CTM Download, May 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892689

Data on the registration of trademarks (TM) can help shed light on the extent to which economic agents specialise in services and activities related to the generation and accumulation of knowledge-based capital (KBC). They also provide interesting information about market penetration by foreign firms in key markets and knowledge-related activities. The focus here is on trademarks related to R&D, which is essential for knowledge creation and long-term innovativeness, and on those related to intellectual property (IP) and to information and communication technologies (ICT), which have been increasing and are shaping the competitiveness of firms and economies alike.

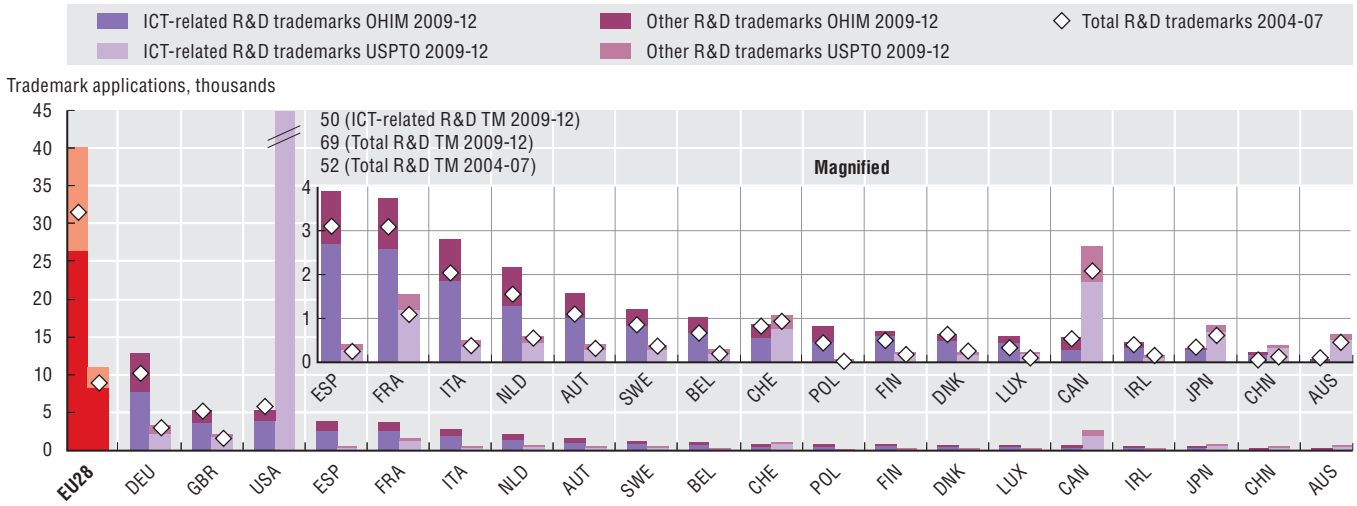
The registration of IP transaction-related TM increased substantially in both Europe and the United States from 2004-07 to 2009-12: it more than doubled in all economies considered. The increase in applications was less spectacular in R&D-related TM; they even decreased slightly in the United States, Denmark and Australia in some cases. R&D trademarks related to ICT account for between 54% and 93% of all R&D-related trademarks, an indication of the complementarity of R&D and ICT. Finally, ICT-related trademarks identified on the basis of a content analysis of the goods and services listed in the Nice Classification show that the United States and Japan have decreased the number of ICT-related trademarks applied for at OHIM in recent years, whereas almost all other economies have generally increased them. This may be due to the location of economic activities or to differences in branding strategies.

Definitions

Knowledge-asset-related TM correspond to TM registrations filed to protect services and activities related to the generation and accumulation of KBC. Three main KBC asset categories are considered: IP, R&D and ICT. *IP transaction-related TM* aim to capture activities explicitly related to the protection, management and commercialisation of IP rights, such as patent licensing services, IP consultation and legal mediation in the field of IP. These TM are identified on the basis of keyword searches in class 45 of the Nice Classification of trademarks. *R&D-related trademarks* correspond to class 42 of the Nice Classification and protect: scientific and technological services and related research and design services; industrial analysis and research services; and the design and development of computer hardware and software. This part of R&D TM overlaps with *ICT-related TM*, which are identified on the basis of keyword searches and concern both ICT goods and services. ICT-related TM have been found in classes 9, 28, 35, 38, 41 and 42 of the Nice Classification.

R&D-related trademarks, 2004-07 and 2009-12

Trademark applications at OHIM and USPTO, thousands, top 20 applicants



Source: US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google; OHIM Community Trademark Database CTM Download, May 2013. StatLink contains more data. See chapter notes.

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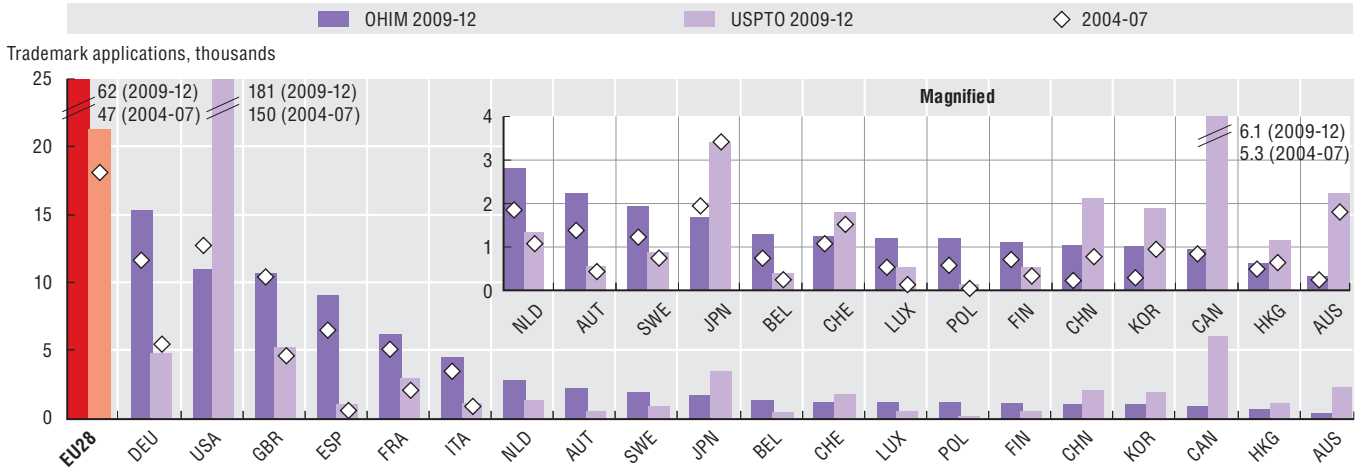
ICT-related trademarks, 2004-07 and 2009-12

Trademark applications at OHIM and USPTO, thousands, top 20 applicants



Source: US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google; OHIM Community Trademark Database CTM Download, May 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892727

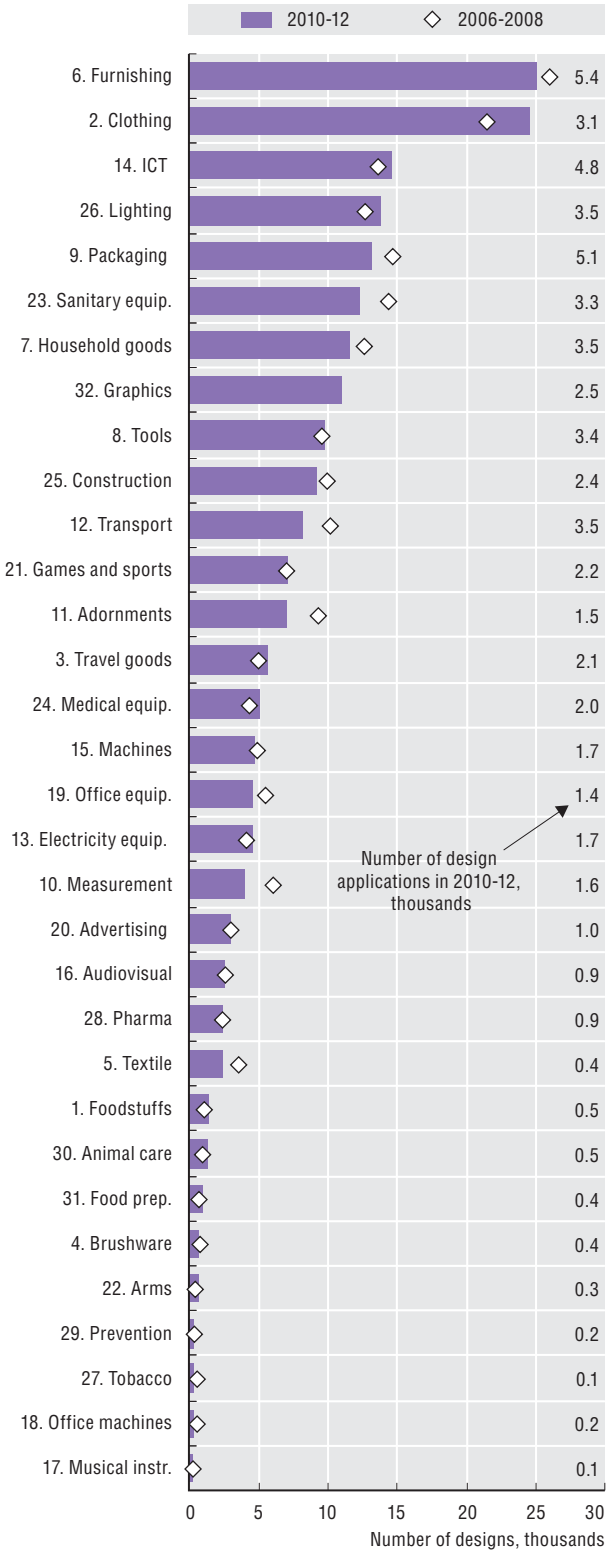
Measurability

TM are classified according to the Nice Classification, which has 34 classes of goods and 11 of services. Applications may be filed in one or more classes and must contain the list of goods and/or services for which TM protection is sought (the so called "goods and services description"). TM offices generally recommend selecting the goods and/or services from a list of terms previously validated by the office, as submitting non-validated terms may lead to delays in registration. Application, registration and renewal fees increase with the number of classes designated in the application. The list of keywords used to identify knowledge asset-related TM and ICT TM are chosen on the basis of a semantic analysis of all terms and expressions listed in the subclasses of the Nice Classification. Future work will aim to refine the goods and services considered in the present experimental work and to address the extent to which ICT-related R&D TM overlap with ICT TM chosen on the basis of the semantic analysis. Using data from different offices or related to different periods may give different results.

7. Registered designs

Number of designs by Locarno class, 2006-08 and 2010-12

Registered Community designs, thousands



Source: OECD calculations based on OHIM, Registered Community Design Database, RCD Download, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892746

The appearance of a good, i.e. its design, results from a creative process aimed at shaping one or more of its visual features to make the product appealing to consumers. Administrative data related to registered designs provide information on how creativity moulds the "look and feel" of articles, on the importance firms and customers attribute to the aesthetic features of goods, on product differentiation and customisation and, more generally, on the role of design in shaping competition on the marketplace.

The complexity of a product and the range of aesthetic features that may make it attractive to consumers can be better understood by looking at the number of distinct designs contained in design applications. On average, an application contains 3.5 individual designs, with the number of individual designs in each application varying between eight (in clothing) and two (in accident prevention devices). Over 2010-12, furnishing, clothing and ICT equipment account for 30% of all designs contained in design applications.

In transport-related registered Community designs (RCD), Germany and Japan play an important role in the field of cars, and France and the United States in the design of aircraft and space vehicles. Italy and France are very active in the design of ships and boats, and cycles and motorcycles account for the vast majority of RCD in the Netherlands and Denmark.

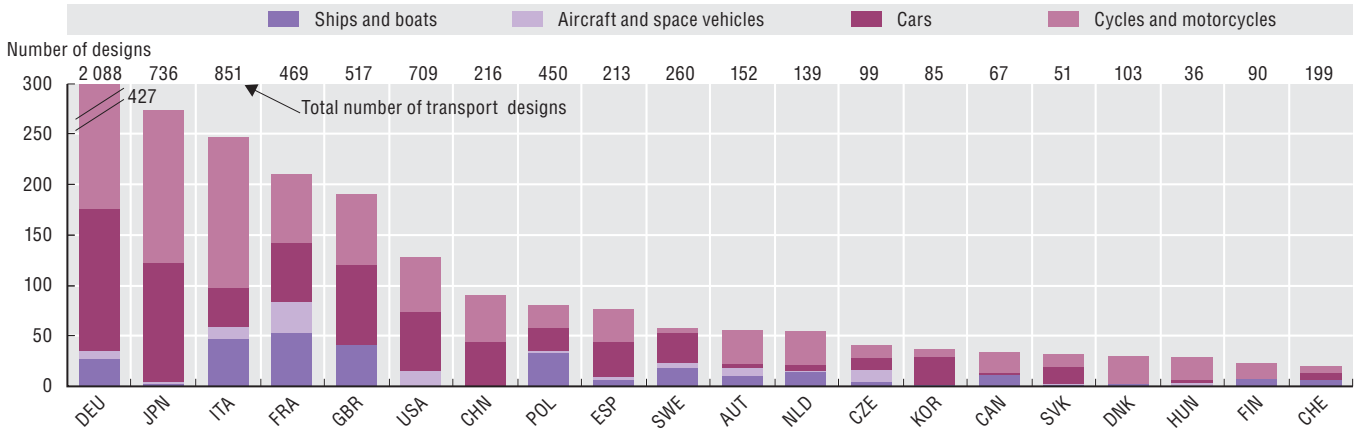
The United States, Japan, Germany and Korea are the most active in the design of ICT and audiovisual products. The United States is strong in data processing equipment and Korea in communication devices. France and Japan lead in the design of audiovisual devices.

Definitions

Registered Community designs are intellectual property (IP) rights granted to protect the ornamental or aesthetic aspects of an article or of its parts against copying or the independent development of similar designs. RCD are valid in the European Union as a whole, have an initial life of five years from filing, and can be renewed for subsequent five-year periods up to a maximum of 25 years. Only products or parts thereof can be legally protected, not functionalities or services. A single application can include several designs, e.g. for a whole range of similar products or different parts of the same product. Industrial designs follow the Locarno Classification (established in 1968). Its ninth edition, entered into force in 2009, contains 32 classes and 219 subclasses of goods. The classification has an administrative character and does not bind contracting countries with respect to the nature and protection afforded by the design. The owner of an RCD can act against infringement and request EU customs authorities to retain suspected counterfeit goods while under their control.

Transport-related designs, 2010-12

Registered Community designs, top 20 applicants

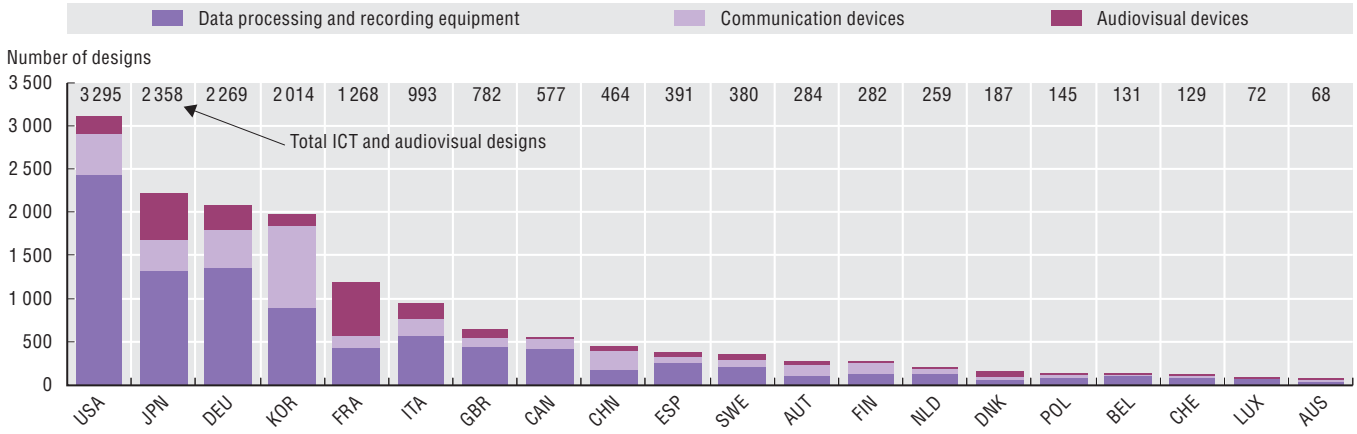


Source: OECD calculations based on OHIM, Registered Community Design Database, RCD Download, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892765

ICT and audiovisual-related designs, 2010-12

Registered Community designs, top 20 applicants



Source: OECD calculations based on OHIM, Registered Community Design Database, RCD Download, April 2013. See chapter notes.

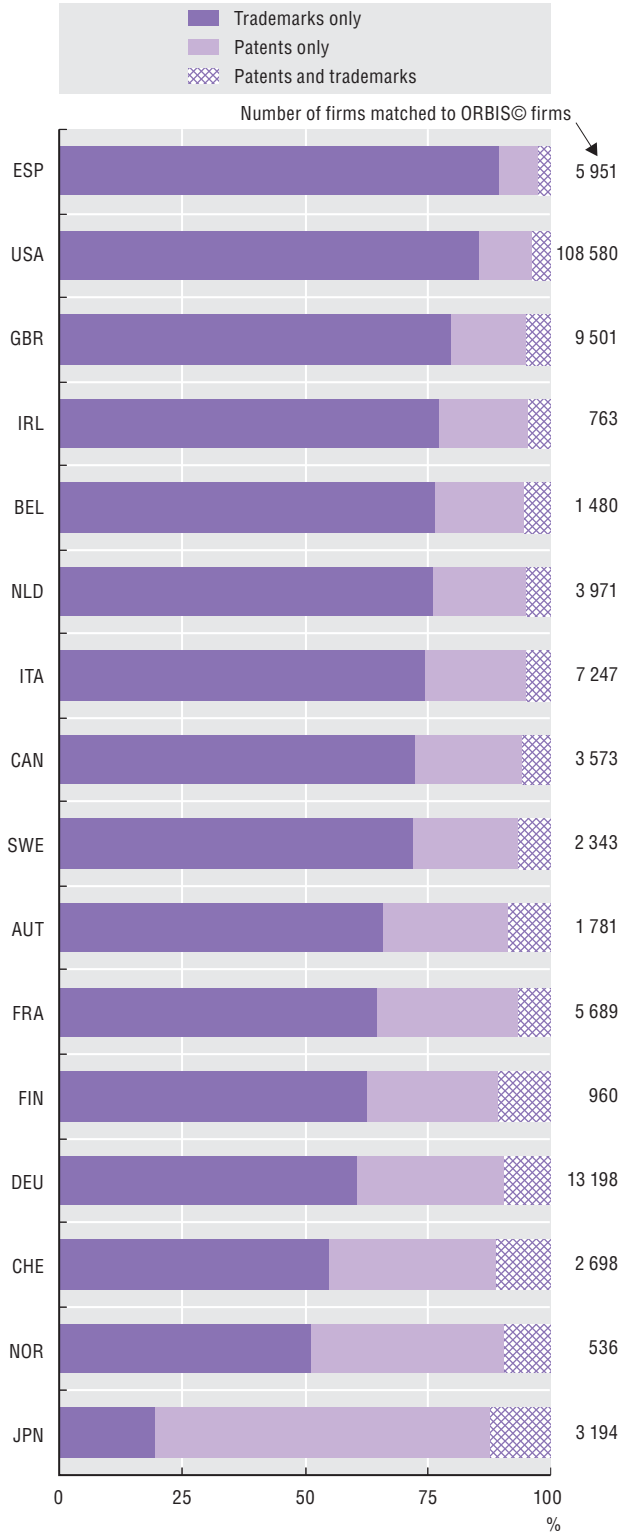
StatLink http://dx.doi.org/10.1787/888932892784

Measurability

Registered design data are used here for the first time to proxy the "creativity" that countries seek to protect on the European market. Such data are publicly available and provide a homogenous set of information related to e.g. ownership and the specific goods concerned. Like all proxies, design data suffer from drawbacks, including selectivity and truncation. Selectivity mainly stems from the fact that not all designs are registered – designers and owners may decide not to seek IP protection – or cannot be registered, e.g. if the designs are not novel or original or are exclusively dictated by the product's technical function. Also, industrial designs cannot be registered everywhere in the world. The United States is a notable exception, as industrial design is protected through the concurrent use of design patents, copyrights and trademarks. Finally, no information about the value of the asset is available in administrative data. Truncation mainly arises because of delays in making administrative data public and, in the case of RCD, because applicants have the right to keep the design confidential for up to 30 months from filing.

8. Trademarks and patents

Firms with trademarks and patents, 2009-11



Source: OECD calculations based on US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google, May 2013; OHIM Community Trademark Database CTM Download, May 2013; Worldwide Patent Statistical Database, EPO, April 2013; and ORBIS© Database, Bureau van Dijk Electronic Publishing, June 2011; matched using algorithms in the Imalinker system developed for the OECD by IDENER, Seville, 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892803

To be competitive, firms and industries rely on their innovativeness and their capacity to diversify their goods and services from those of their competitors. Administrative data on patent and trademark (TM) registrations provide important information about firms' ability to innovate technologically (patents) and to propose new services and implement non-technological innovations (like organisational or marketing) in order to add value that customers will recognise and be willing to pay for (TM).

In the different economies considered, firms' propensity to patent ranges from 8% to 68%. Between 20% and 90% tend to rely on trademarks. Only between 3% and 12% appear to use both patents and trademarks to compete in key markets such as Europe and the United States. These differences may depend on factors such as the structure of the economy, including the age and size distribution of firms, the propensity of enterprises to rely on intellectual property (IP) rights, and the economy's openness to trade, participation in global value chains, and industrial specialisation.

The top two industries in terms of number of firms account for 50% (the Netherlands) to 24% (Ireland) in the case of firms applying for TM, and between 37% (Ireland) and 19% (Canada) in the case of patent-filing enterprises. Wholesale, retail and trade stands out as the industry in which firms are most likely to register at least one TM application; patent-related patterns are less clear-cut and reflect the specialisation of the different economies.

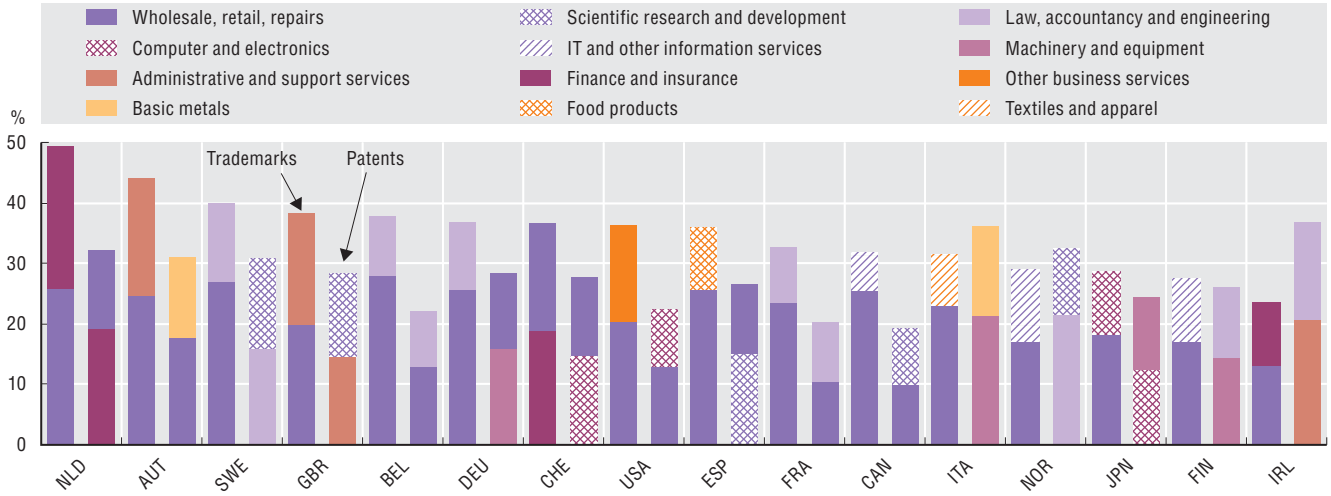
Excepting Japan and Finland, small firms with 20-49 employees are more likely to file TM applications than patents. Medium-sized and large firms account for between 69% and 92% of patenting firms.

Definitions

Data refer to patents filed at the European Patent Office (EPO) and at the US Patent and Trademark Office (USPTO), and to trademarks registered at the Office of Harmonization for the Internal Market (OHIM) and at the USPTO between 2009 and 2011. The names of patenting and trademarking firms were linked to names of firms in the ORBIS© database which contains structural and financial information about firms located worldwide. The linkages were established using combinations of string matching algorithms to optimise the precision of the match and minimise false positive and false negatives. The list of industries is based on ISIC Rev.4, and firms are allocated to sectors according to the information provided in ORBIS©. Size classes are based on the number of employees reported in ORBIS© for 2009 or nearest available year.

Top two industries with trademarks and patents by country, 2009-11

As a percentage of firms with patents and/or trademarks

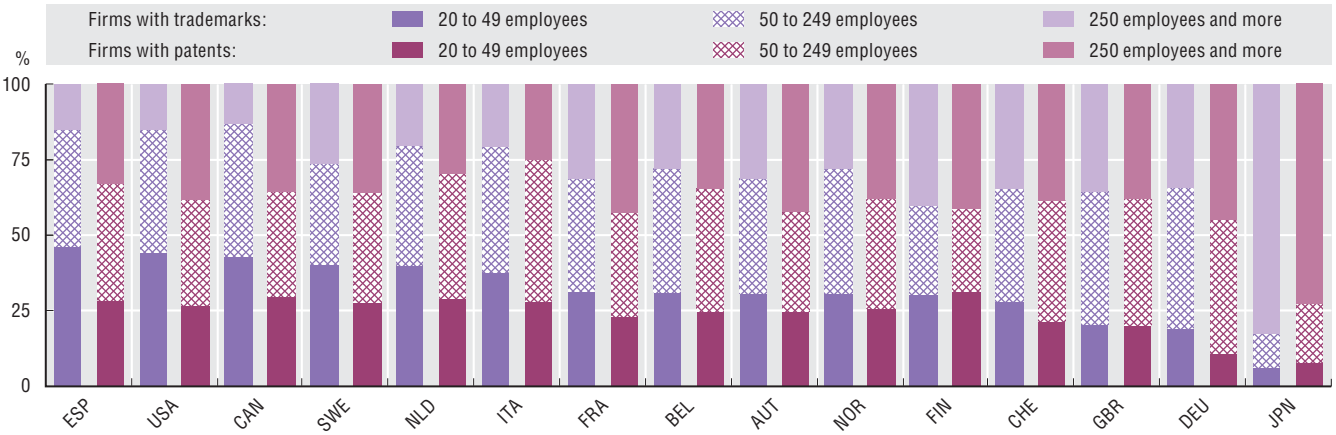


Source: OECD calculations based on US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google, May 2013; OHIM Community Trademark Database CTM Download, May 2013; Worldwide Patent Statistical Database, EPO, April 2013; and ORBIS© Database, Bureau van Dijk Electronic Publishing, June 2011; matched using algorithms in the Imalinker system developed for the OECD by IDENER, Seville, 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892822

Firms with trademarks and patents, by size, 2009-11

As a percentage of firms with more than 20 employees



Source: OECD calculations based on US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google, May 2013; OHIM Community Trademark Database CTM Download, May 2013; Worldwide Patent Statistical Database, EPO, April 2013; and ORBIS© Database, Bureau van Dijk Electronic Publishing, June 2011; matched using algorithms in the Imalinker system developed for the OECD by IDENER, Seville, 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892841

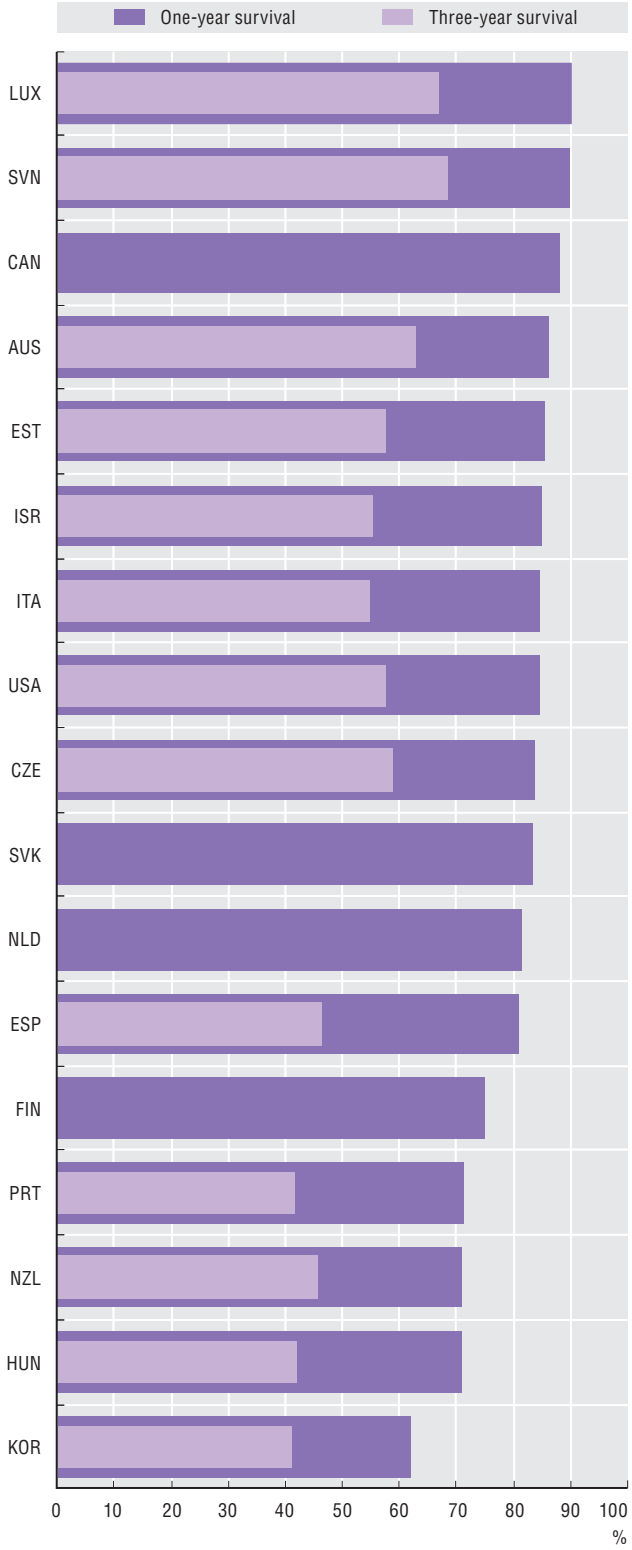
Measurability

Firms filing at least one patent or trademark application at the EPO, OHIM or USPTO were matched to enterprise data using name harmonisation procedures and string matching algorithms. As it was not possible to access economy-specific business register data, firm data were obtained from ORBIS©, a commercial dataset. However, the coverage of firms in ORBIS© is not exhaustive and the representativeness of the data appears to vary substantially among age and size classes, across economies and over time. To address the selection and consistency issues that such drawbacks may cause, the analysis was restricted to economies with matching rates above 80% of patent and trademark filings in the 2000s. The only exceptions are US and Canada trademark filings, for which matching rates are 76% and 70%, respectively. Owing to data shortages, firm data were not consolidated at the group level; this may affect the statistics on the number and size of firms filing both patents and trademarks. Where no employment data were available, size classes were imputed on the basis of complementary financial information (e.g. turnover), where available.

9. Entry, exit and survival

Employer enterprise survival rates, 2007 and 2009

As a percentage of all employer enterprises, 2006 reference cohort



Source: OECD (2013), *Entrepreneurship at a Glance 2013*, OECD Publishing. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892860

Entrepreneurship and entrepreneurial dynamics are at the heart of employment and productivity. The birth of new firms and the death of non-viable ones are essential to an economy's experimentation and creative destruction. As new, more productive firms appear on the market and grow, less productive ones are driven out of business. The rate at which firms are born reflects the ability of economies to create entirely new businesses and to experiment, while death rates, i.e. the rates at which firms exit the market, reveal the extent to which less competitive enterprises disappear. Birth, survival and death rates are shaped by framework conditions such as access to credit, employment protection legislation, bankruptcy law and administrative red tape, as well as by the dynamics of economic cycles and global value chains.

Economies and industries differ in the proportion of new firms that survive after one or more years of activity. Among new firms born in 2006, first-year survival rates in manufacturing vary between 62% (in Korea) and 90% (in Slovenia and Luxembourg). The figures are very similar for both manufacturers and service providers. After three years of activity, firms' survival rates range between 41% (in Korea) and 68% (in Slovenia). While survival rates of employer enterprises are generally higher in manufacturing than in services, manufacturing firms born in 2006 were equally hit by the crisis and in 2009 exhibit only slightly higher survival rates than those in services.

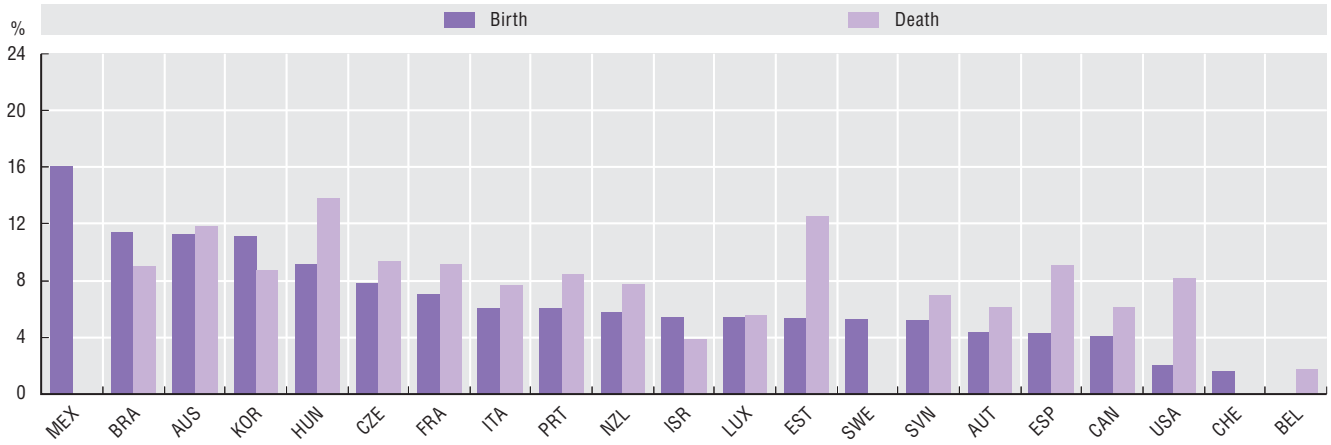
A breakdown by industry shows that there is more entry and exit in services than in manufacturing, with a net exit of both manufacturing and services enterprises in 2010 in most countries. In 2010 the percentage of active enterprises accounted for by new-born manufacturing firms varied between 2% and 16%, whereas the share of new-born services firms ranged between 3% and 22%. In the same year, the share of exiting firms varied between 2% and 14% in manufacturing, and between 3% and 19% in services.

Definitions

Survival rates correspond to the percentage of enterprises born in a certain year that survive for *n* years. *Employer enterprise births* consist of "new" enterprises reporting at least one employee in the birth year and of existing enterprises reporting for the first time one or more employees in the observation year. Births do not include entries due to e.g. mergers, break-ups or restructuring. *Birth rates* correspond to the ratios between the number of births and the population of active enterprises with at least one employee. *Death* occurs either when an enterprise closes down or when it shrinks below the one employee threshold for at least two years.

Employer enterprise birth and death rates in the manufacturing sector, 2010

As a percentage of the population of active enterprises with at least one employee

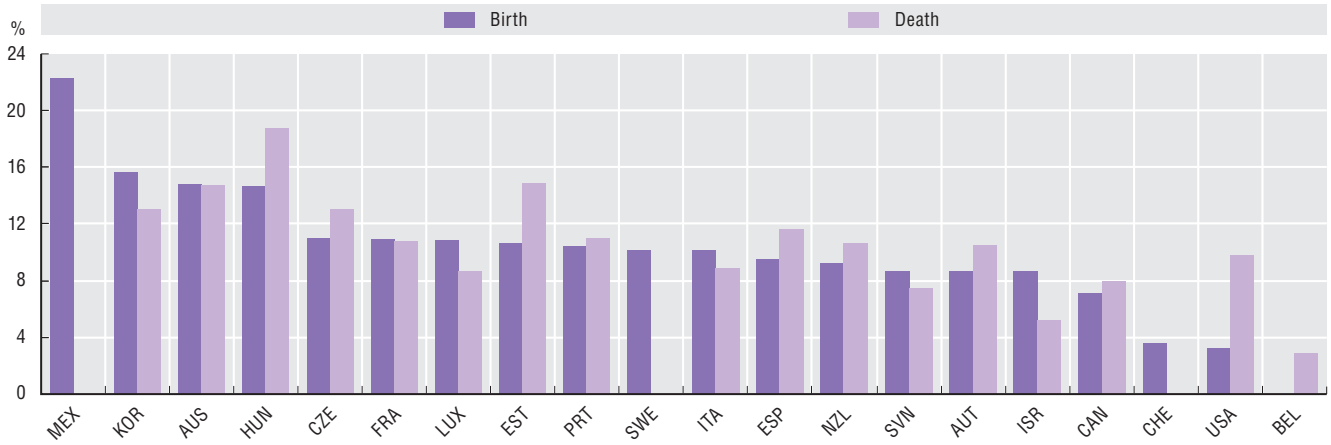


Source: OECD (2013), *Entrepreneurship at a Glance 2013*, OECD Publishing. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892879

Employer enterprise birth and death rates in the services sector, 2010

As a percentage of the population of active enterprises with at least one employee



Source: OECD (2013), *Entrepreneurship at a Glance 2013*, OECD Publishing. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892898

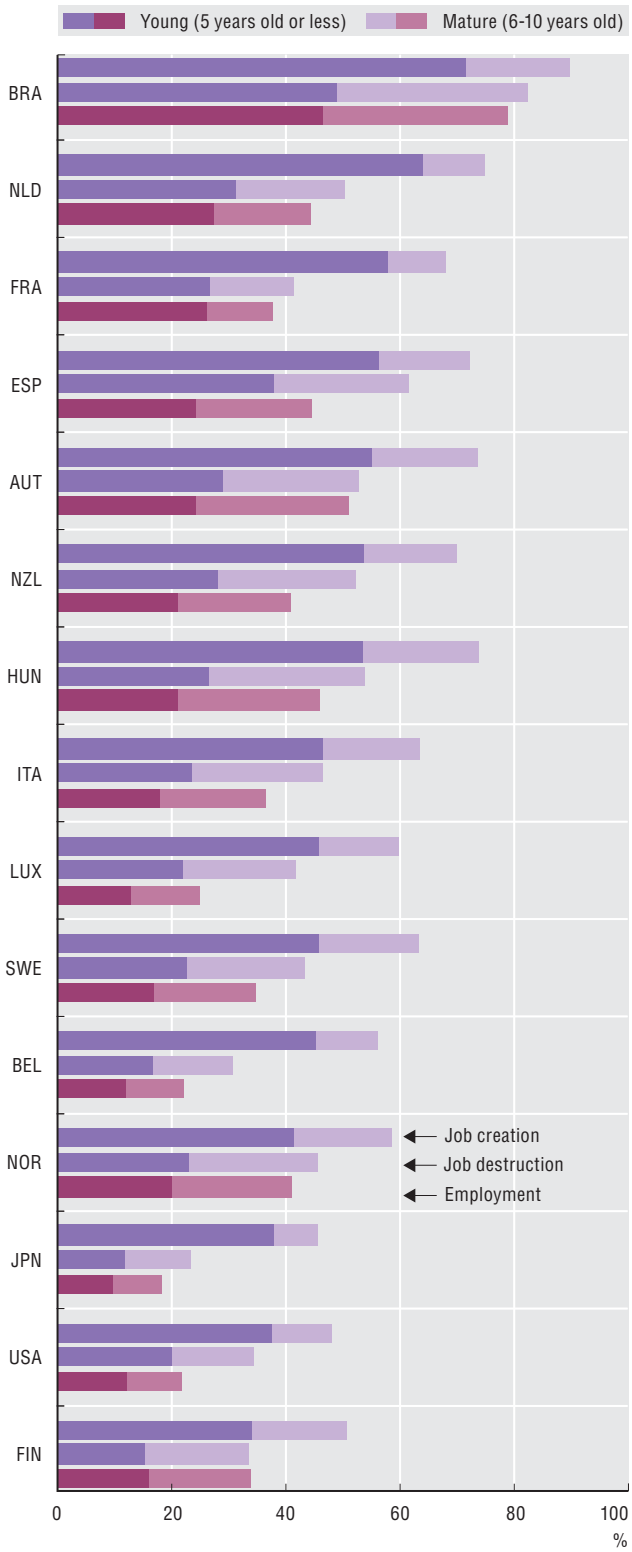
Measurability

Employer-related indicators are generally better for international comparisons than indicators covering all enterprises, as the latter are sensitive to the coverage of business registers (BR). In many countries, the main sources of data used in BR are administrative tax and employment registers, and capture only businesses above a certain turnover and/or employment threshold. Moreover, thresholds often change over time. The concept of employer enterprise is not without problems, however, as it excludes the self-employed. Compared to data on births of employer enterprises, information on enterprise deaths requires additional time because it needs ascertaining that the enterprise has not been reactivated (or had no employees) in the two years following its death.

10. Firm employment dynamics

Employment, job creation and job destruction in young and mature firms, 2001-11

Percentage shares, non-financial business sector



Source: OECD calculations based on the OECD DYNEMP data collection, July 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892917

Firm employment dynamics are at the heart of the process of creative destruction, of the reallocation of resources across firms, and of productivity growth. However, the data required for international comparative analysis over time are scarce and often difficult to access. To fill this gap, the OECD DYNEMP project has developed a new cross-country database of micro-aggregated firm-level data from administrative data sources, mainly national business registers.

Initial evidence shows that, on average, although young firms represent only 17% of total employment, they contribute more than proportionally to job creation across the OECD economies considered, i.e. for 45% of the total. For their part, mature businesses have approximately the same weight in terms of employment share and gross job creation, at 16% and 13%, respectively, while old businesses account on average for 60% of employment but only 35 % of gross job creation.

Differences in the magnitude of this phenomenon point to the importance of national policies and business environments in fostering the birth and growth of new firms. In some countries, young firms account for more than half of the economy's total gross job creation.

This general pattern also holds for the main sectors of the economy. The dynamism of young firms in the market services sector is accentuated by the fact that these firms have a higher share of total employment than in manufacturing. However, in the non-financial market services sector, the ratio of gross job creation to the share of employment for young firms is only 2.3 on average whereas in manufacturing it is almost 3.3.

Definitions

Employment refers to the total number of employees, typically headcounts. In each year, *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. The figures report the shares of employment, gross job creation and gross job destruction in young firms averaged over the period 2001-11 or nearest available years. Firm age corresponds to the difference between the reference year and a firm's year of birth. *Young firms* are five years old or less. *Mature businesses* are between six and ten years old. *Old businesses* are eleven years old or more. *Business registers* are administrative data sources that provide comprehensive coverage of firms' entry, exit, employment and/or turnover from social security records, tax records, censuses and/or other sources.

Employment, job creation and job destruction in young firms, manufacturing, 2001-11

Percentage shares

Source: OECD calculations based on the OECD DYNEMP data collection, July 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892936

Employment, job creation and job destruction in young firms, non-financial services, 2001-11

Percentage shares

Source: OECD calculations based on the OECD DYNEMP data collection, July 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892955

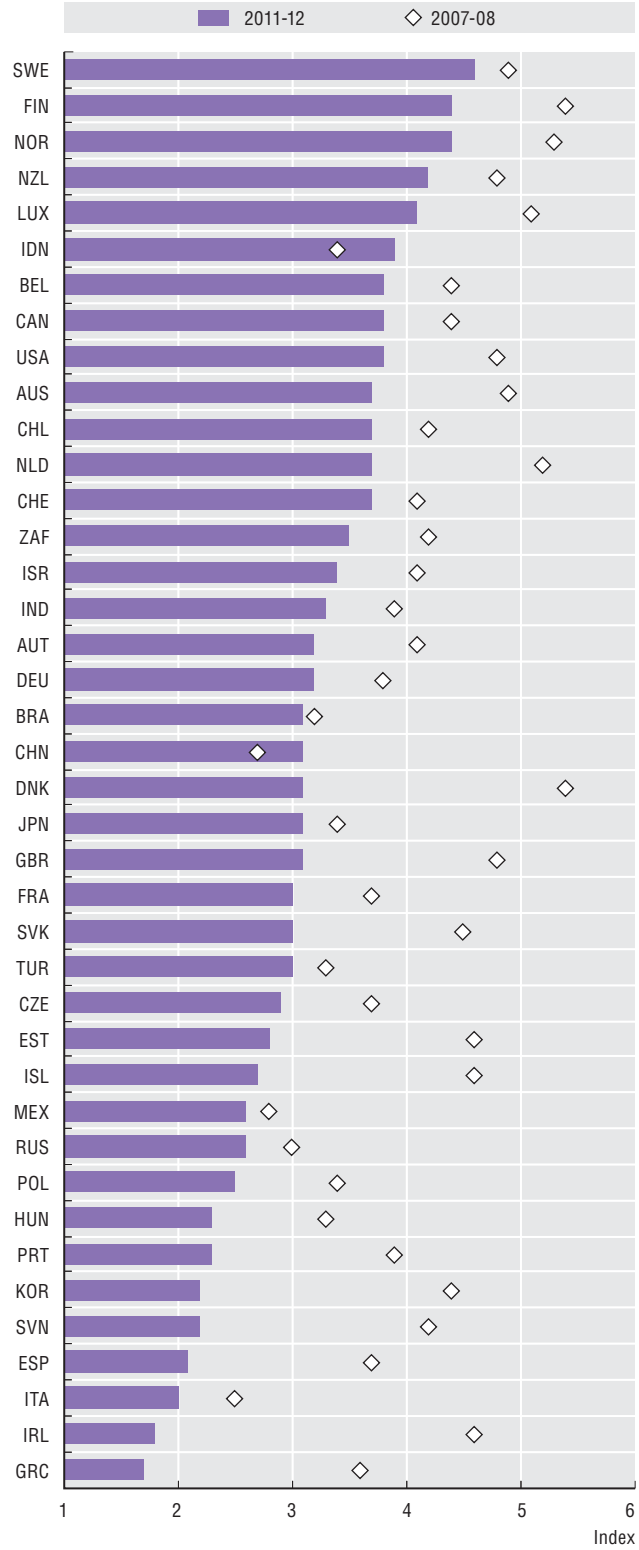
Measurability

Owing to the confidential nature of the information in business registers (BR), access is often restricted. Also, because national sources are generally not directly comparable, key concepts must be harmonised. To this end, the OECD has developed statistical routines for researchers to run on national-level data. The DYNEMP database currently contains non-confidential comparable statistics for 15 OECD economies and Brazil on employment, gross job creation and destruction by firm age, size and macro-sectors. The statistics are preliminary, e.g. mergers and acquisitions are not accounted for. Also, differences exist in the minimum threshold above which a unit is captured, as when a BR builds on tax records and filing is compulsory only above a given level of turnover or of employment (or both). Owing to methodological differences in constructing these indicators, DYNEMP statistics may deviate from official statistics published by national statistical offices. For instance, firms that enter and exit the data in the same year, and those that are never seen to employ more than one employee, are excluded from DYNEMP-based figures.

11. Access to capital

Ease of access to loans, 2007-08 and 2011-12

Scale from 1 to 7 from hardest to easiest, weighted averages



Source: World Economic Forum (2012), *The Global Competitiveness Report 2012-2013* and World Economic Forum (2008), *The Global Competitiveness Report 2008-2009*, World Economic Forum, Geneva.

StatLink http://dx.doi.org/10.1787/888932892974

Young innovative firms are essential to economic growth and job creation. However, they face many challenges when seeking financing as they generally lack collateral or a track record. While not all start-ups require (or deserve) external capital, they have difficulty accessing seed and early-stage financing. The seed and early-stage equity market has suffered over the past five years. Banks have been unable or unwilling to provide loans to young innovative start-ups as a result of the financial crisis, and venture capital firms have become more risk-adverse because of pressures on the industry and have focused on later-stage investments.

The World Economic Forum's *Global Competitiveness Report*, which collects data through executive opinion surveys, provides information on individuals' views on access to bank loans in different countries. The data show that bank financing became more difficult to obtain between 2007 and 2012 in all countries but Indonesia and China.

Venture capital differs significantly among countries and is very sensitive to market cycles in terms both of amounts invested and stages of investment. In today's financial environment, venture capital funds tend to invest in later stages, leaving gaps at the pre-seed and seed stages where profit expectations are less clear and risks much higher.

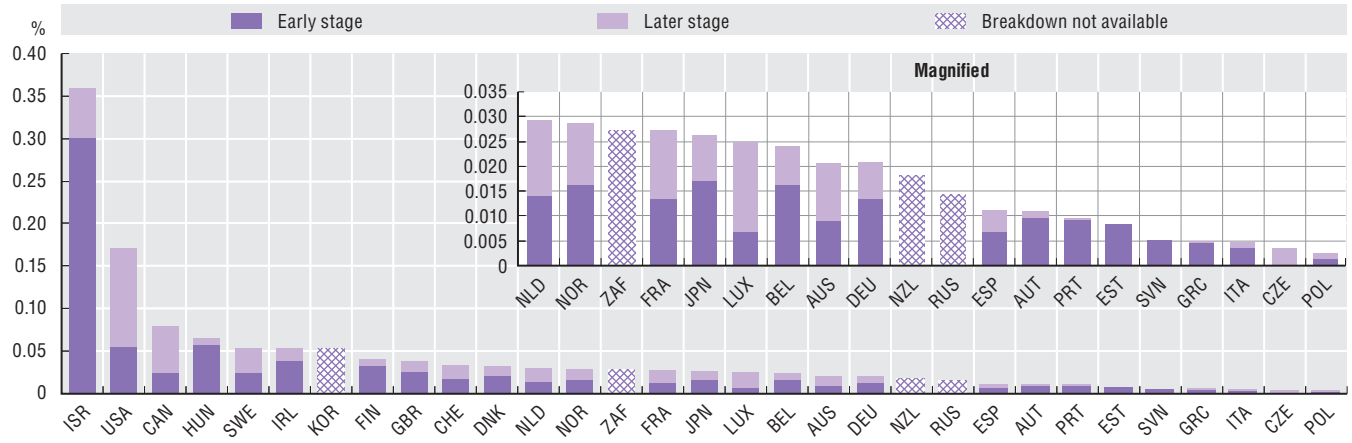
Access to finance is particularly difficult for small and medium-sized enterprises (SMEs). In 2011, SMEs' access to debt and equity finance, and the conditions at which these were granted, varied across countries. SME lending conditions deteriorated in most countries, particularly as a result of higher interest rates and greater demand for collateral. This was also generally accompanied by modest or no growth in credit volumes, except in a few countries. These diverging performances can be traced to the different degrees to which countries were hit by the crisis and subsequently recovered in 2009 and 2010.

Definitions

The *ease of access to loans* indicator measures how easy it is to obtain bank loans with only a good business plan and no collateral on a scale of one to seven; higher values suggest easier access. *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. *SME loans* are based on bank data collected by firm size or the availability of SME financial statements from tax authorities. In the absence of such data, business loans below a given threshold (EUR 1 million or USD 1 million) serve as a proxy for SME loans.

Venture capital investment, 2012

As a percentage of GDP

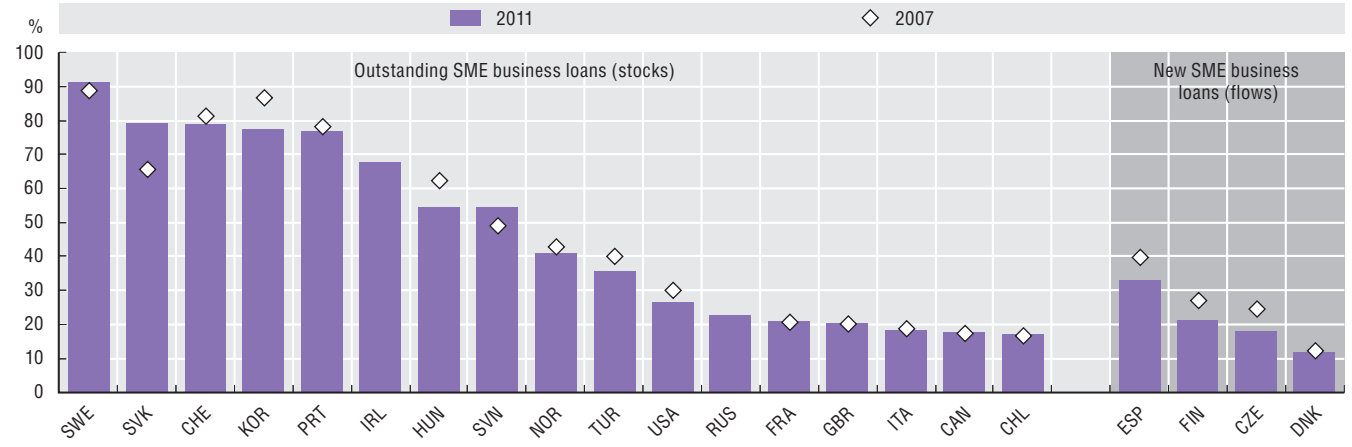


Source: OECD (2013), *Entrepreneurship at a Glance 2013*, OECD Publishing. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932892993

SME loans, 2007 and 2011

As a percentage of total business loans



Note: Differences in national sources may affect international comparability.

Source: OECD (2013), *Financing SMEs and Entrepreneurs 2013: An OECD Scoreboard*, OECD Publishing. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893012

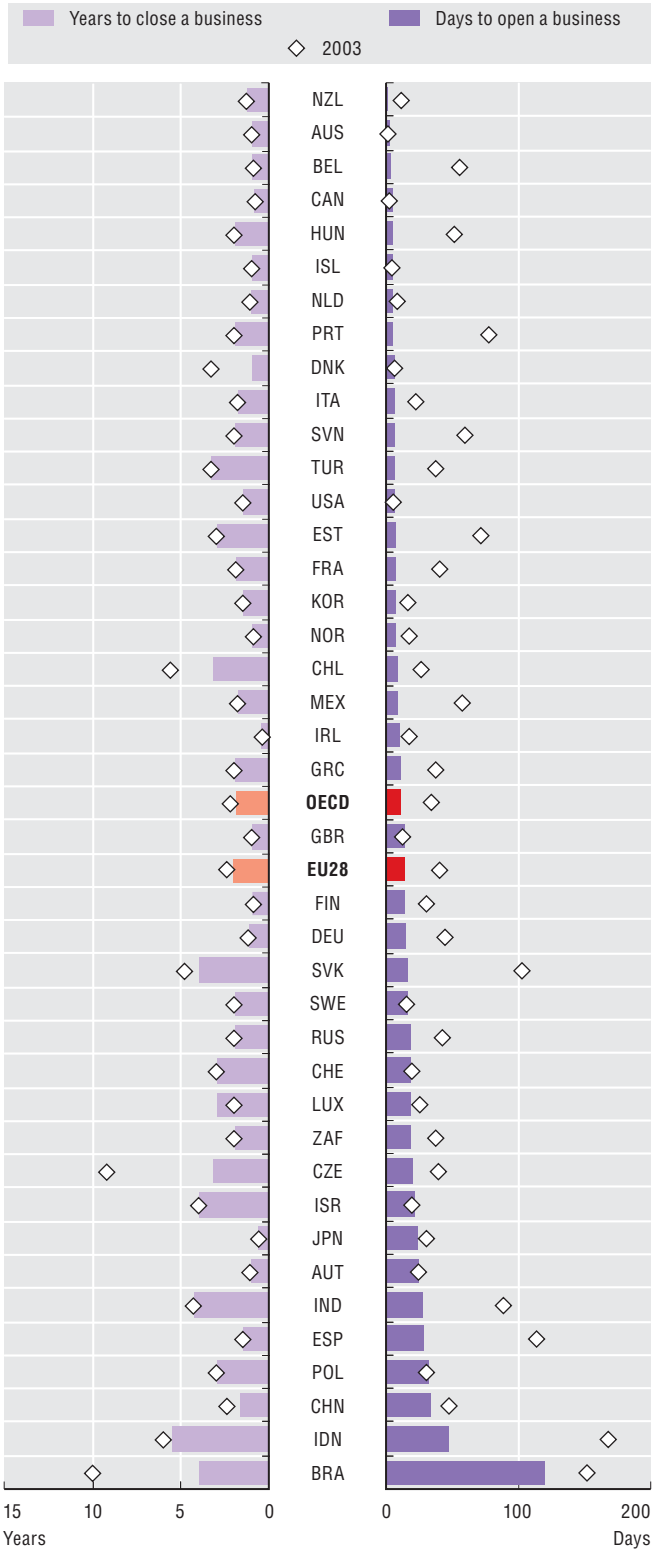
Measurability

The access to loan index is based on the World Economic Forum's Executive Opinion Survey of business executives' views of their operating environment. In collaboration with more than 150 partner institutes in 144 countries, 14 059 surveys were conducted in 2012 with an average of 100 respondents per country. Data on venture capital are drawn mainly from national or regional venture capital associations, in some cases in collaboration with commercial data providers. There are no standard international definitions of venture capital or of the breakdown of venture capital investments by stage of development. In the *OECD Entrepreneurship Financing Database* original data are aggregated to fit the OECD classification of venture capital by stages (OECD, *Entrepreneurship at a Glance 2013*).

In terms of measuring SMEs' access to finance, countries' differences in definition and coverage hinder international comparability. The biggest challenge to comparability remains the lack of harmonisation in the statistical definition of SMEs. This continues to prove difficult owing to the different economic, social and political concerns of individual countries in their approach to SMEs.

12. Policy environment

Time needed to open and close a business, 2003 and 2012



Source: World Bank, Doing Business Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893031

The policy environment plays an important role in keeping efficient firms in existence, encouraging the creation of new firms and promoting healthy competition in the economy. The entry and growth of new firms are important for an economy, as is their adaptability to changes in the economy and their ability to exit when necessary. Less red tape facilitates business creation and good insolvency regimes reduce the stigma of bankruptcy for firms and individuals and encourage entrepreneurs to take risks and innovate. A proxy measure of such policy settings is the time required to open and close a business. Days needed to open a business have decreased in most countries since 2003, while the years required to close a business remained rather stable.

A high-quality regulatory framework allows businesses to enter the market and grow. During the last decade, most OECD countries have lowered barriers to entrepreneurship.

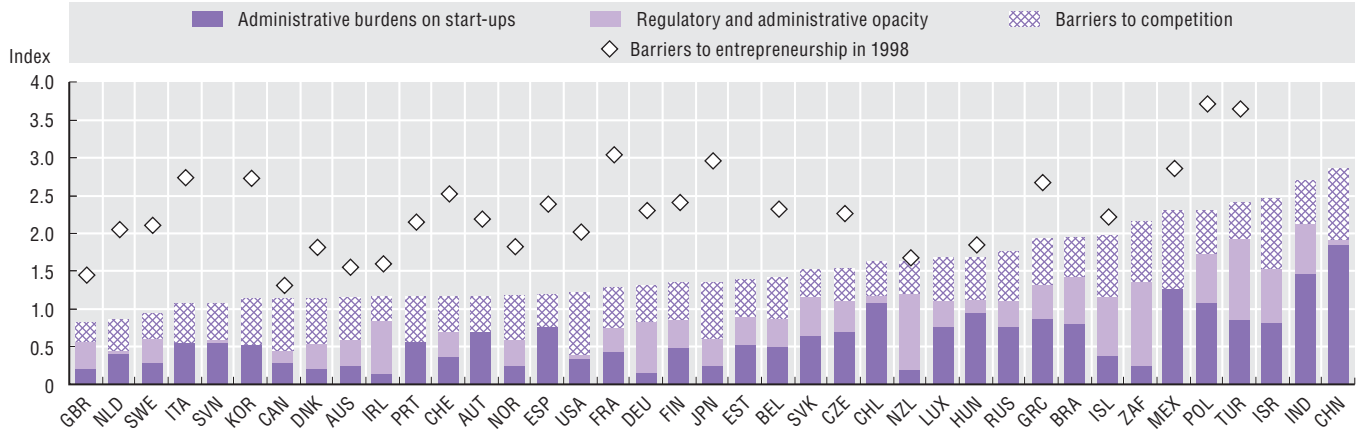
Individuals' decisions to start a business are also affected by taxes and tax policy: general taxes (personal income, corporate and capital gain tax rates, social security contributions) and targeted tax policies (tax incentives for start-ups, young firms, and small and medium-sized enterprises). OECD analysis finds that reducing top marginal personal income tax rates raises productivity in industries with potentially high rates of enterprise creation.

Definitions

Time required to open a business is the number of calendar days needed to complete the procedures to operate a business legally. If a procedure can be speeded up at additional cost, the fastest procedure is chosen independent of cost. *Time required to close a business* is the average number of years to close a business. Information is collected on the sequence of procedures and on whether any procedures can be carried out simultaneously. The *barriers to entrepreneurship* indicator measures regulations affecting entrepreneurship on a scale of zero to six; lower values suggest lower barriers. The index is composed of barriers to competition (legal barriers, antitrust exemptions, barriers in network sectors and in retail and professional services); regulatory and administrative opacity (licences, permits, simplicity of procedures); and the administrative burden for creating new firms. 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, 2008

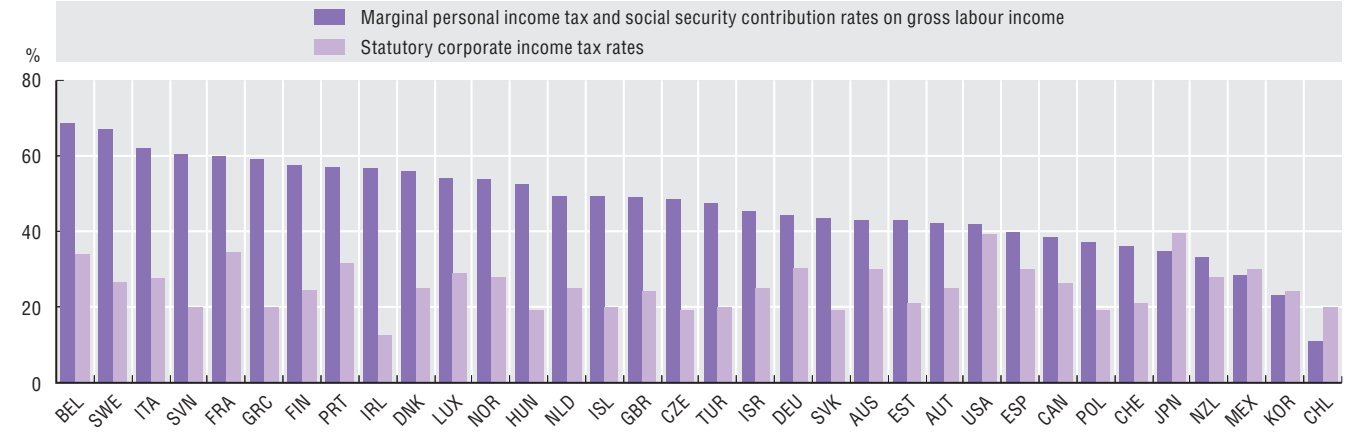
Scale of 0 to 6 from least to most restrictive



Source: OECD, Product Market Regulation Database, *www.oecd.org/economy/pmr*, June 2013.

StatLink http://dx.doi.org/10.1787/888932893050

Taxation on corporate income and personal income, 2012



Source: OECD (2013), *Taxing Wages 2011-2012*, OECD Publishing. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893069

Measurability

Product market regulations (PMR) indicators are quantitative indicators derived from qualitative information on laws and regulations that can affect competition. The qualitative information mainly comes from a questionnaire addressed to 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 next update of the PMR indicators is expected by the end of 2013. Personal income taxes and the difference between the treatment of self-employment income and wage income affect individuals' decision to start a business. 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, which allows for international comparability across countries.

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 recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'."

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

"The Republic of Cyprus is 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. Mixed modes of innovation

General notes for all figures:

For Australia, data refer to financial year 2010/11 and include product, process, marketing and organisational innovating firms (including ongoing or abandoned innovation activities).

For Brazil, data refer to 2006-08. Only the following activities are included in the services sector: ISIC Rev.4 Divisions 58, 61, 62 and 72.

For Canada, data refer to 2007-09 and to firms with 20 or more employees and with at least CAD 250 000 in annual revenue in 2009. Firms with ongoing or abandoned innovation activities are not identified. The industries covered are NAICS (2007) 31-33, 41, 48, 49, 51, 52 and 54.

For Chile, data refer to 2009-10 and to firms with more than UF 2 400 in annual revenue. Data include product, process, organisational and marketing innovating firms. Ongoing or abandoned innovative activities are not identified. The industries covered are based on ISIC Rev.3.1 and include a wider range of activities than the CIS, such as agriculture, forestry, fishing, construction and some services.

For Israel, data refer to 2006-08.

For Japan, data refer to financial years 2009/10 and 2010/11. Data are provisional estimates.

For New Zealand, data refer to financial years 2009/10 and 2010/11, and to firms with six or more employees with an annual goods and services tax (GST) turnover figure greater than NZD 30 000. Data refer to product, process, organisational and marketing innovating firms (including ongoing or abandoned innovation activities).

For the Russian Federation, data refer to 2009-11 and to firms with 15 or more employees. The industries covered are based on NACE Rev.1.1 and include manufacturing (D), and services (64, 72, 73, 74).

For South Africa, data refer to 2005-07 and to firms with 20 or more employees, with a minimum turnover of between ZAR 3 million and ZAR 6 million depending on the industry. Data also include the retail trade sector.

Additional notes:

Innovation types by firm size, 2008-10 and;

Types of innovation in the manufacturing sector, 2008-10

For Korea, data refer to 2005-07 and to firms with more than 10 employees in the manufacturing sector. Product innovation only covers innovation for goods.

5.2. Broader innovation

General notes for all figures:

For Chile, data refer to 2009-10 and to firms with more than UF 2 400 in annual revenue. Data include product, process, organisational and marketing innovating firms. Ongoing or abandoned innovative activities are not identified. The industries covered are based on ISIC Rev.3.1 and include a wider range of activities than the CIS, such as agriculture, forestry, fishing, construction and some services.

For Israel, data refer to 2006-08.

For Japan, data refer to financial years 2009/10 and 2010/11. Data are provisional estimates.

For South Africa, data refer to 2005-07 and to firms with 20 or more employees, with a minimum turnover of between ZAR 3 million and ZAR 6 million depending on the industry. Data also include the retail trade sector.

Additional notes:

Firms innovating in goods and services, manufacturing and services, 2008-10

For the United States, data refer to firms with more than five employees.

Product innovation, by R&D status, 2008-10 and;

R&D-active firms, manufacturing and services, 2008-10

For Brazil, data refer to 2006-08. Only the following activities are included in the services sector: ISIC Rev.4 Divisions 58, 61, 62 and 72.

For New Zealand, data refer to financial years 2009/10 and 2010/11, and to firms with six or more employees with an annual goods and services tax (GST) turnover figure greater than NZD 30 000. Data refer to product, process, organisational and marketing innovating firms (including ongoing or abandoned innovation activities).

For the Russian Federation, data refer to 2009-11 and to firms with 15 or more employees. The industries covered are based on NACE Rev.1.1 and include manufacturing (D), and services (64, 72, 73, 74).

For Switzerland, data refer to 2009-11.

Product innovation, by R&D status, 2008-10

For Korea, data refer to 2005-07 and to firms with more than 10 employees in the manufacturing sector. Product innovation only covers innovation for goods.

For Spain, R&D status corresponds to 2010 only.

For the United States, data refer to firms with more than five employees.

R&D-active firms, manufacturing and services, 2008-10

For Australia, data refer to financial year 2010/11 and include product, process, marketing and organisational innovating firms (including ongoing or abandoned innovation activities).

5.3. Public support to innovation

Government-financed R&D in the business sector, by firm size, 2011

National statistical agencies use different minimum thresholds for inclusion in R&D surveys. For reporting estimates, there are slight variations in the definition of small and medium-sized firms. Small firms (fewer than 50 employees): for Belgium, 1-49 employees; for the United States, 5-49 employees; for Luxembourg, the Netherlands and Sweden, 10-49 employees. For Japan, the survey excludes firms with capital of less than JPY 10 million.

For Australia, Chile, France, Italy, Portugal, Spain, the United Kingdom and the United States, data refer to 2010.

For Austria, Belgium, Canada, Denmark, Germany, Luxembourg, the Netherlands and Sweden, data refer to 2009.

For Switzerland, data refer to 2008.

General notes:

Firms receiving public support for innovation, by firm size, 2006-08 and 2008-10 and;

Firms receiving public support for innovation, manufacturing and services, 2008-10

For Australia, data refer to financial year 2010/11 and include product, process, marketing and organisational innovating firms (including ongoing or abandoned innovation activities).

For Brazil, data refer to 2006-08. Only the following activities are included in the services sector: ISIC Rev.4 Divisions 58, 61, 62 and 72.

For Chile, data refer to 2009-10 and to firms with more than UF 2 400 in annual revenue. Data include product, process, organisational and marketing innovating firms. Ongoing or abandoned innovative activities are not identified. The industries covered are based on ISIC Rev.3.1 and include a wider range of activities than the CIS, such as agriculture, forestry, fishing, construction and some services.

For Israel, data refer to 2006-08 and to public support for R&D.

For Japan, data refer to financial years 2009/10 and 2010/11. Data are provisional estimates.

For the Russian Federation, data refer to 2009-11 and to firms with 15 or more employees. The industries covered are based on NACE Rev.1.1 and include manufacturing (D), and services (64, 72, 73, 74).

Additional notes:

Firms receiving public support for innovation, by firm size, 2006-08 and 2008-10

For Austria and United Kingdom, data refer to 2006-08.

For Canada, data refer to 2002-04 and 2007-09 and to firms with 20 or more employees and with at least CAD 250 000 in annual revenue in 2009. Firms with ongoing/abandoned innovation activities are not identified. Data refer only to grants and tax credit programmes across all levels of government. The industries covered are NAICS (2007) 31-33, 41, 48, 49, 51, 52 and 54 for 2007-09 and manufacturing only for 2002-04.

For Mexico, data refer to 2008-09 and to firms with 20 or more employees. The industries covered are based on ISIC Rev.3.1 and include a wider range of activities, such as agriculture, construction and some services.

For Slovenia, the periods are 2004-06 and 2008-10.

For South Africa, data refer to 2005-07 and to firms with 20 or more employees, with a minimum turnover of between ZAR 3 million and ZAR 6 million depending on the industry. Data also include the retail trade sector.

For Switzerland, the periods are 2006-08 and 2009-11.

Firms receiving public support for innovation, manufacturing and services, 2008-10

For Switzerland, data refer to 2009-11.

5.4. The IP "bundle"

IP bundle of top 20 applicants, 2010-12

According to the European Patent Convention (EPC) "The grant of a European patent may be requested for one or more of the Contracting States" (Article 3). The 14th Edition of the EPC, published in August 2010, has 38 contracting states, i.e. the EU28 and AL, CH, IS, LI, MC, MK, NO, RS, SM, TR (see *http://documents.epo.org/projects/babylon/eponet.nsf/0/7bacb229e032863dc12577ec004ada98/$FILE/EPC_14th_edition.pdf*). European patents generally have a maximum duration of 20 years from the date of filing of the application and cannot be renewed.

The Community trademark (CTM), administered by OHIM, has a unitary character and is valid throughout the European Community. After any enlargement of the European Union CTMs registered or applied for are automatically extended to the new member states without formality or fee. The CTM system coexists with national systems (see *http://oami.europa.eu/ows/rw/pages/CTM/legalReferences/regulations.en.do* for more detail). CTMs are valid for 10 years and can be renewed indefinitely for periods of ten years. They must be put to genuine use in the European Community within a period of five years following registration. Otherwise, they are revoked.

Registered Community designs (RCD) also have a unitary character and are valid in the European Union as a whole. It is not possible to limit the geographic scope of protection to certain member states. An RCD initially has a life of five years from the date of filing and can be renewed for periods of five years up to a maximum of 25 years (see *http://oami.europa.eu/ows/rw/pages/RCD/legalReferences/regulations.en.do*).

Top two trademark application fields, by country, 2009-11

Distribution of classes designated in design applications filed at OHIM, WIPO and national offices (direct applications and applications via the Madrid system).

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 audiovisual: classes 9 and 38; Hotels, restaurants and other services: classes 40 and 43.

Top two design application fields, by country, 2009-11

Distribution of classes designated in design applications filed at OHIM, WIPO and national offices (direct applications and applications via the Hague system).

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 audiovisual: classes 14, 16 and 18; Electricity and lightning: classes 13 and 26; Advertising: classes 20 and 32; Transport: class 12; Packaging: class 9.

5.5. Trademarks

Top 20 trademark applicants, 2009-11 average

Counts are presented according to the application date and the address of the applicant. Economies are ordered according to USPTO figures.

Figures from national trademark offices are not fully comparable as some offices use single-class systems (Mexico, Brazil, China, South Africa), whereas most offices have a multi-class system. Some offices have recently been moving from a single-class to a multi-class system (e.g. the Israeli Patent Office adopted a multi-class trademark system in 2010).

Trademark applications by BRIICS countries, 2000-02 and 2009-11 averages

Counts are presented according to the application date and the residence of the applicant.

For Brazil, national trademark office figures refer to 2000-02 and 2009-10.

For Indonesia, national trademark office figures refer to 2001-02 and 2009-11.

Figures from national trademark offices are not fully comparable as some offices use single-class systems (Brazil, China, South Africa) whereas others have adopted a multi-class system (India, the Russian Federation). Some offices have recently been moving from a single-class to a multi-class system (e.g. Indonesia, where multi-class applications have been accepted since 2007).

Share of goods and services trademark applications at USPTO, OHIM and JPO, 2010-12

The shares are calculated as the proportion of trademark applications designating only goods classes (classes 1 to 34 of the Nice Classification), only service classes (classes 35 to 45 of the Nice Classification), or both goods and services classes.

Data from JPO are up to May 2012. The average number of trademark applications refers to 2010-11 for JPO.

5.6. Knowledge-asset-related trademarks

IP-transaction-related trademarks, 2004-07 and 2009-12

IP transactions-related trademarks refer to trademark applications designating class 45 of the Nice Classification and containing keywords related to IP transactions in the goods and services description (complete list of keywords available on demand).

Counts are presented according to the filing date and applicant's address. The top 20 applicants correspond to the economies with the largest number of IP transactions-related trademark applications at OHIM and USPTO in 2009-12. Economies are ordered according to OHIM 2009-12 figures.

R&D-related trademarks, 2004-07 and 2009-12

R&D-related trademarks refer to trademark applications designating class 42 of the Nice Classification. ICT-related R&D trademarks refer to trademark applications designating class 42 of the Nice Classification and containing ICT-related keywords in the goods and services description (complete list of keywords available on demand).

Counts are presented according to the filing date and applicant's address. The top 20 applicants correspond to the economies with the largest number of R&D-related trademark applications at OHIM and USPTO. Economies are ordered according to OHIM 2009-12 figures.

ICT-related trademarks, 2004-07 and 2009-12

ICT-related trademarks refer to trademark applications designating classes 9, 28, 35, 38, 41 and/or 42 of the Nice Classification and containing ICT-related keywords in the goods and services description (complete list of keywords available on demand).

Counts are presented according to the filing date and applicant's address. The top 20 applicants correspond to the economies with the largest number of ICT-related trademark applications at OHIM and USPTO. Economies are ordered according to OHIM 2009-12 figures.

5.7. Registered designs

Number of designs by Locarno class, 2006-08 and 2010-12

Number of individual designs contained in Community designs registered in each class of the Locarno Classification.

Class 32 (Graphic symbols and logos, surface patterns, ornamentation) has been included in the Locarno Classification since the ninth edition, which entered into force at OHIM in January 2009.

Transport-related designs, 2010-12

Figures are calculated using fractional counts of the Locarno classes mentioned in the design registration.

Transport designs correspond to class 12 of the Locarno Classification. Ships and boats correspond to subclass 12-06; Aircraft and space vehicles to subclass 12-07; Cars to subclass 12-08; and Cycles and motorcycles to subclass 12-11.

ICT and audiovisual-related designs, 2010-12

Figures are calculated using fractional counts of the Locarno classes mentioned in the design registrations.

Data processing and recording equipment correspond to the Locarno subclasses 14-01, 14-02 and 14-04; Communication devices correspond to subclass 14-03; Audiovisual devices correspond to class 16. Total ICT and audiovisual designs correspond to designs in classes 14, 16 and 18.

5.8. Trademarks and patents

General notes for all figures:

Firms with trademarks are firms that registered at least one trademark at the Office for Harmonization of the International Market (OHIM) or at the United States Patent and Trademark Office (USPTO) in 2009-11. Firms with patents are firms that filed at least one patent application at the European Patent Office (EPO) or at the USPTO in 2009-11.

Firms were linked to the ORBIS© database, using combinations of string matching algorithms that maximise the precision of the match. Only countries with matching rates above 80% of trademark and patent filings over 2000-11 are included, except for trademark filings of Canada (70%) and the United States (76%).

Additional notes:

Top two industries with trademarks and patents by country, 2009-11

Countries are listed according to the share of firms with trademarks in the top two trademarking industries.

Firms with trademarks and patents, by size, 2009-11

Only countries for which ORBIS© employment data were available for at least 45% of firms with patents or trademarks are included.

Countries are listed according to the share of firms with 20 to 49 employees among firms with trademarks.

5.9. Entry, exit and survival

Employer enterprise birth and death rates in the manufacturing sector, 2010

Birth rates: For Mexico, Sweden and Switzerland, data refer to 2008; for Brazil, Canada, Estonia, France and Slovenia, data refer to 2009 and for Israel, Korea, New Zealand and the United States, data refer to 2011.

Death rates: For Belgium, data refer to 2007; for Brazil and Canada data refer to 2008 and for the Czech Republic, Estonia, France, Israel and Slovenia, data refer to 2009.

Data are compiled according to ISIC Rev.4 except for Belgium, Israel, Mexico and the United States, which refer to ISIC Rev.3.

Employer enterprise birth and death rates in the services sector, 2010

Birth rates: For Mexico, Sweden and Switzerland, data refer to 2008; for Canada, Estonia, France and Slovenia, data refer to 2009 and for Israel, Korea, New Zealand and the United States, data refer to 2011.

Death rates: For Belgium, data refer to 2007, for Canada, data refer to 2008 and for the Czech Republic, Estonia, France, Israel and Slovenia, data refer to 2009.

Data are compiled according to ISIC Rev.4 except for Belgium, Israel, Mexico and the United States, which refer to ISIC Rev.3.

5.10. Firm employment dynamics

General notes for all figures:

Calculations are based on preliminary results from the OECD DYNEMP project.

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

Establishments and firms that appear only for one year are excluded.

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

The shares are calculated as shares of total employment, job destruction and job creation.

For Austria, data are at the establishment level.

For Austria, Italy, Luxembourg and Sweden, data refer to 2001-10.

For Brazil, data refer to 2002-10

For France, data refer to 2002-07.

For New Zealand, data refer to 2001-09.

For Spain, data refer to 2003-09.

Additional notes:

Employment, job creation and job destruction in young and mature firms, 2001-11 and;

Employment, job creation and job destruction in young firms, manufacturing, 2001-11

For Japan, data are at the establishment level, refer to 2001-09 and cover the manufacturing sector only.

5.11. Access to capital

Venture capital investment, 2012

Data correspond to the aggregation of investment data according to the location of the portfolio companies (i.e. the investee companies), regardless of the location of the private equity firms. Exceptions are Australia, Korea and Japan for which data refer to the location of the investing venture capital firms.

The early stage includes: for Australia, pre-seed and seed, and start-up stage; for Canada and European countries, seed and start-up, and other early stage; for Israel, seed/start-up and early stage/expansion stage; for Japan, seed and early stage, and expansion stage; for the United States, seed and early stage.

The later stage includes: for Australia, early expansion stage; for Canada, expansion stage; for the United States, expansion/later stage.

Korea, New Zealand, the Russian Federation and South Africa do not provide breakdowns of venture capital by stage that would allow meaningful international comparisons.

Data providers are: EVCA (European countries), ABS (Australia), CVCA (Canada), KVCA (Korea), NVCA (United States), NZVCA (New Zealand), PwC MoneyTree (Israel), RVCA (Russian Federation), SVCA (South Africa) and VEC (Japan).

For Canada and New Zealand, data refer to 2010.

For Australia, Estonia, Greece, Israel, Japan, Korea, the Russian Federation, Slovenia, South Africa, Switzerland and the United States, data refer to 2011.

SME loans, 2007 and 2011

For Norway, the Slovak Republic and Sweden, data refer to 2010.

5.12. Policy environment

Time needed to open and close a business, 2003 and 2012

For Iceland, data refer to 2004 and 2012.

For Luxembourg, data refer to 2006 and 2012.

Taxation on corporate income and personal income, 2012

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.

Notes on the statutory corporate income tax (CIT) rate:

For Australia, New Zealand and the United Kingdom, all with 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 (September 2012) permanently increased the Corporate Income Tax rate to 20%.

In Estonia, since 1 January 2000, the corporate income tax is levied on distributed profits.

For France, the rates include a surcharge (the turnover based solidarity tax, *Contribution de solidarité*), but exclude *i)* the local business tax (*Contribution économique territoriale*, a new tax replacing the former *Taxe professionnelle* from 1 January 2011) and *ii)* the 5% temporary surtax applied to the standard corporate income tax liability for large companies with a turnover exceeding EUR 250 million.

For Germany, the rates include the regional trade tax (*Gewerbesteuer*) and the surcharge.

For Hungary, the rates do not include the turnover-based local business tax, the innovation tax, temporary sectoral taxes on corporations in the financial sector, energy sector, telecommunication and retail sectors.

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 5.45% 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.

For Italy, these rates do not include the regional business tax (*Imposta Regionale sulle Attività Produttive*; IRAP).

In Luxembourg, the contribution to the unemployment fund is 5%.

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 has a state surtax since 2011. In 2012, the surtax was set at 3% for taxable profits above EUR 1.5 million and at 5% for taxable profits above EUR 10 million.

For Switzerland, church taxes, which enterprises cannot avoid, are included.

Note on the marginal personal income tax rate:

For Turkey, wage figures are based on the old definition of average worker (ISIC, Rev. 3, D).

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6. COMPETING IN THE KNOWLEDGE ECONOMY

1. Industry specialisation
2. ICT industry specialisation
3. Export structures
4. R&D specialisation
5. Technological advantage
6. Trade competitiveness
7. E-business uptake
8. Young innovative firms
9. Technological strengths

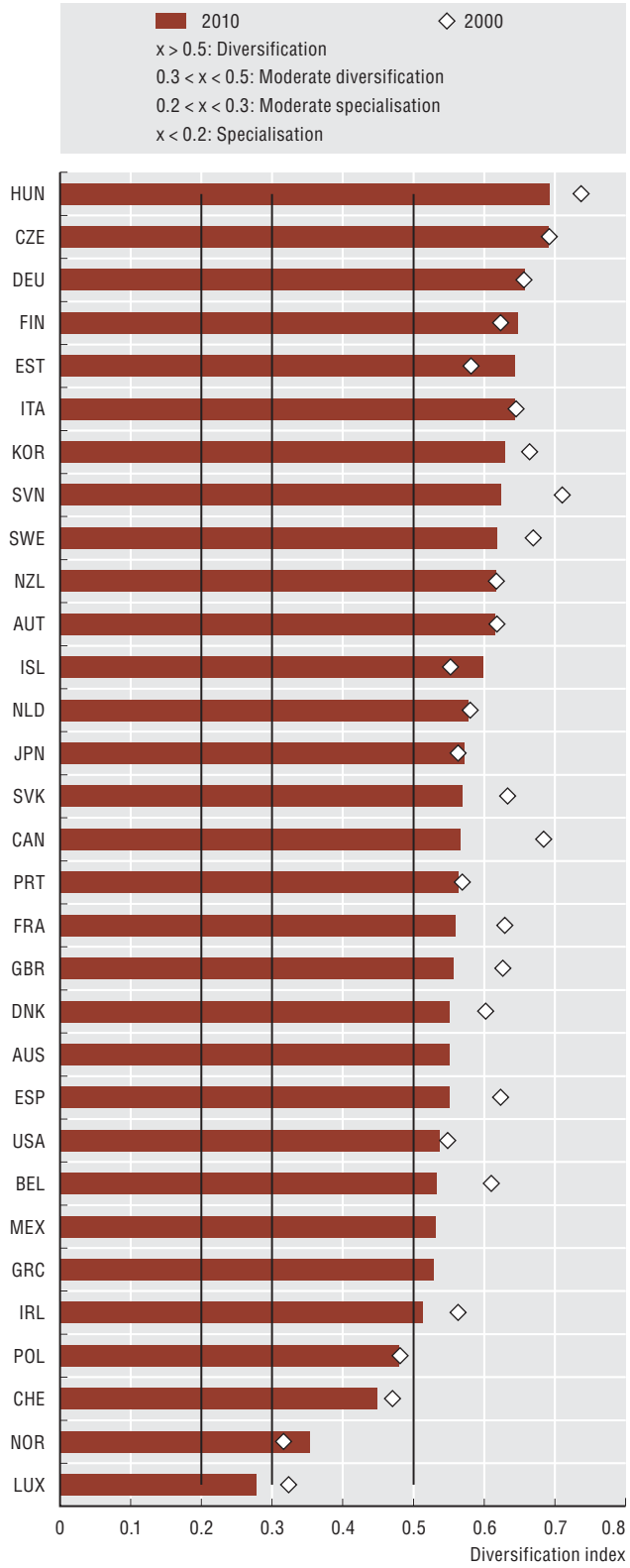
Notes and References

Today's knowledge economies are increasingly service-oriented and rely on fewer sectors to grow. Indicators of industry specialisation reveal which sectors contribute most to a given economy in terms of output and employment. ICT industries are often among the most dynamic sectors, and the new industrial classification makes it possible to take a closer look at the dynamics in this broad aggregate. Indicators of trade specialisation show that countries rely to different degrees on certain sectors to compete in export markets. The new Trade in Value Added (TiVA) Database can show how a country's output satisfies foreign demand, not only via exports of final goods and services, but indirectly via trade in intermediates. Also, for the first time, indicators of trade specialisation can be calculated in terms of value added rather than gross exports. Another set of indicators looks in depth at R&D specialisation and revealed technological advantage in biotechnology, nanotechnology and ICT. Competing in the knowledge economy requires firms to adopt new information technologies in business processes; indicators show less uptake by smaller businesses. The innovative capacity of nations is also central to competitiveness. Here the focus is on patenting firms, including younger ones, and experimental indicators match patent filings with company data. Finally, new indicators use patent data to construct indexes of relative technological and economic strengths and capture the impact of patented inventions.

1. Industry specialisation

Industrial specialisation, 2000 and 2010

Hannah-Kay index, calculated for theta equal to 2



Source: OECD, Structural Analysis (STAN) Database, ISIC Rev.4, May 2013. See chapter notes.

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An economy can be defined as "specialised" if a few sectors account for a relatively large share of the country's GDP, whereas it is "diversified" if each of a wide range of industries accounts for a relatively small share of it. Industry specialisation or diversification is related to an economy's investment patterns, employment, innovativeness, productivity and long-term performance.

The Hannah-Kay (HK) index captures a country's sectoral composition and shows the influence of larger sectors. The higher the HK index, the less specialised the economy, i.e. the broader the range of industrial activities it relies upon. The index is sensitive to the degree of industry disaggregation.

In 2010, most OECD economies could be considered diversified. Poland, Switzerland and Norway were only moderately diversified, while Luxembourg was moderately specialised. Except for Estonia and Iceland, most economies have become relatively more specialised since 2000 or have maintained their level of specialisation.

In 2010 economies' employment appeared slightly more concentrated than their value added. The share of value added of the top four industries ranged from 39% in Hungary to 67% in Luxembourg. The corresponding employment figures ranged from 46% in the Czech Republic to 67% in Mexico. In almost all economies considered, wholesale and retail trade was the most important sector on both indicators.

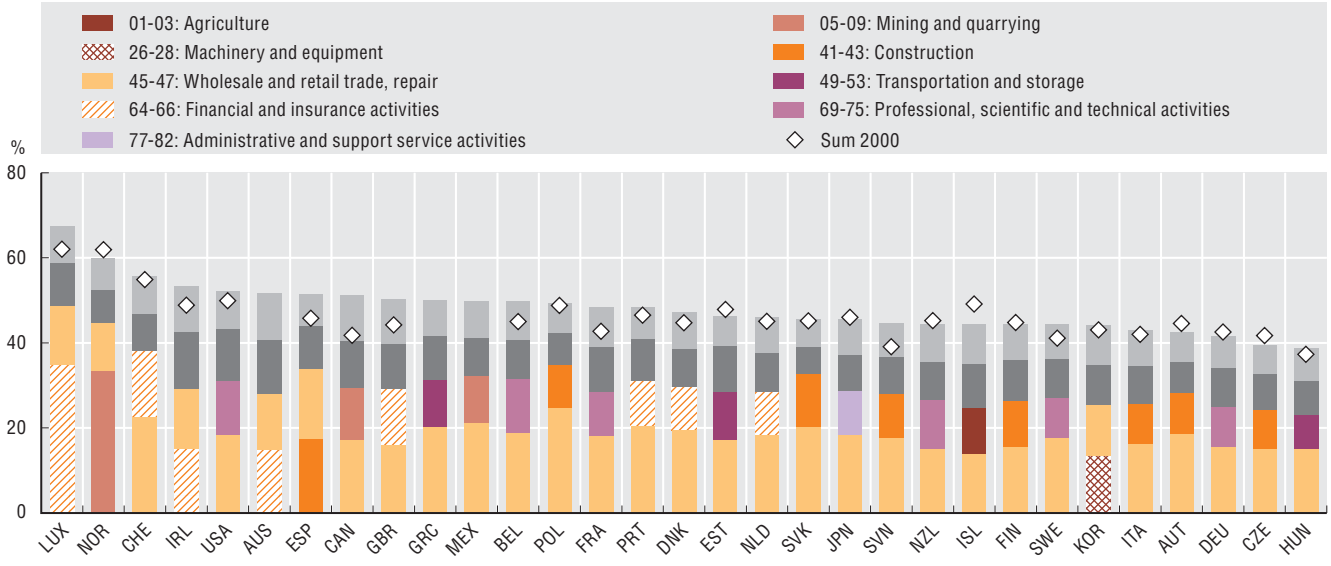
With that exception, the top four value added-generating industries generally differ from the top employment-generating sectors. Information and communication services appear in the top four industries in eight of the economies considered, including Japan and United States, for value added, but nowhere in the top four employment industries. In Norway, the most important generator of value added in 2010 was mining and quarrying, which was not among the top four employers.

Definitions

The Hannah-Kay (HK) index is calculated for a θ (theta) equal to 2, the value at which the HK corresponds to the inverse of the Herfindahl index. θ measures the extent to which the index is influenced by large sectors. The HK(2) calculated on 20 ISIC Rev.4 industrial aggregates is normalised and takes values ranging between 0-1. In an analogy to the threshold values suggested by the concentration literature, countries can be considered diversified if HK(2) is bigger than 0.5; moderately diversified if it is between 0.3 and 0.5; moderately specialised if HK(2) is between 0.2 and 0.3; and specialised if it is smaller than 0.2. The concentration ratio CR(4) is calculated on four sectors and is defined as the cumulative share of an economy's top four industries in terms of share of value added or employment.

Value added of the top four economic activities, 2008-10

As a percentage of average total value added, excluding real estate and the public services



Source: OECD, Structural Analysis (STAN) Database, ISIC Rev.4, May 2013. See chapter notes.

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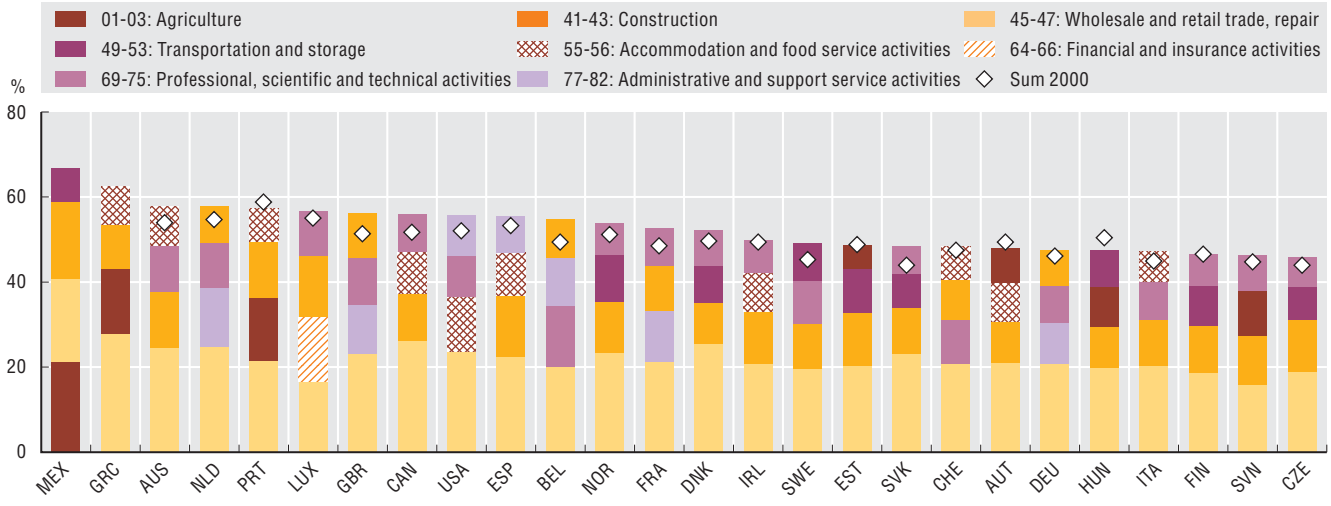
Employment of the top four economic activities, 2008-10

As a percentage of average total employment, excluding real estate and the public services



Source: OECD, Structural Analysis (STAN) Database, ISIC Rev.4, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893126

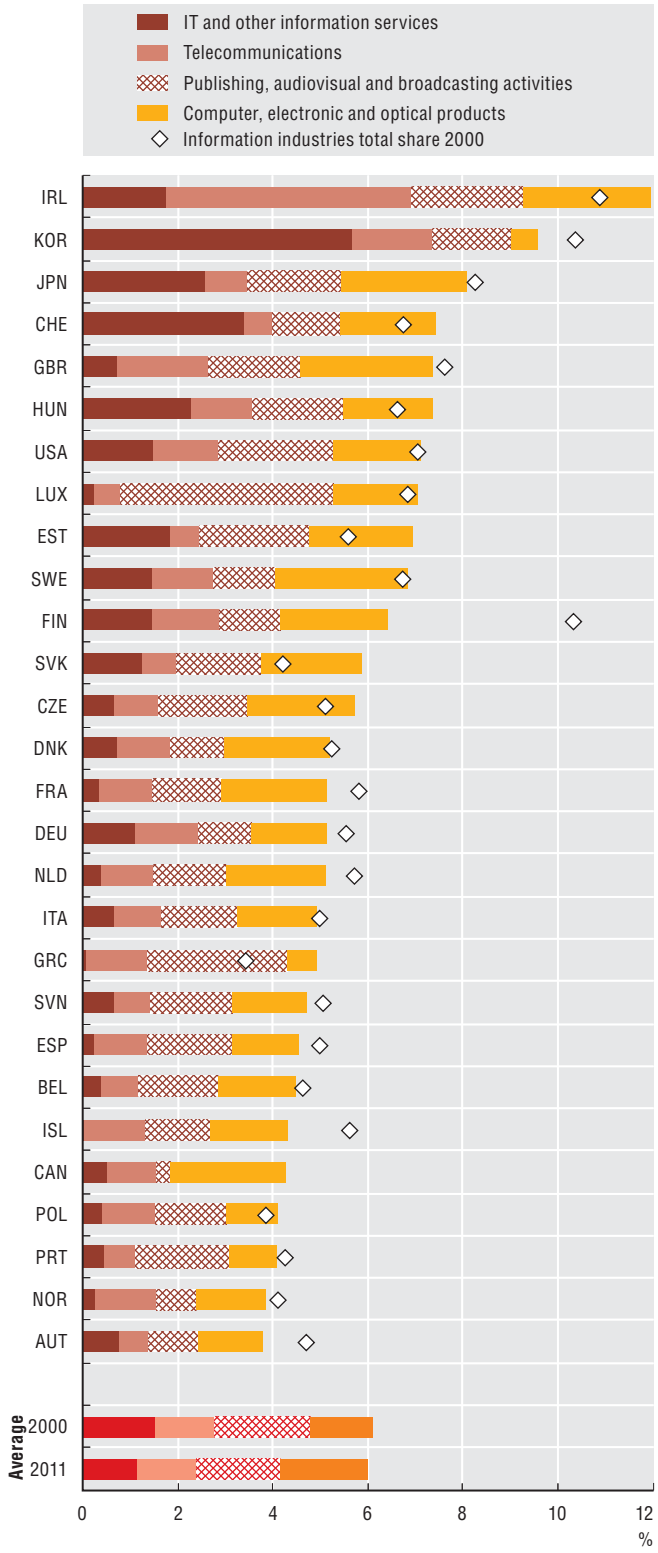
Measurability

The HK(2) and CR(4) indicators shown rely on 20 main industry aggregates chosen according to data availability and coverage, and to maximise comparability across economies and over time. The underlying National Accounts industry data are classified according to ISIC Rev.4. Comparisons with previous indicators based on ISIC Rev.3 may not be suitable, as the new classification, which reflects more recent economic structures, identifies and groups activities in a very different way. For example, under ISIC Rev.4, more attention can be paid to service sectors and indeed, the 20 aggregates considered here include more services aggregates than previous ISIC Rev.3 calculations. Value added is taken at current prices and real estate (Division 68) and community, social and personal services (84-99) are excluded from the calculation. Different levels of sectoral aggregation, reference periods, value added measures and indicator parameters would change the results. Greater sectoral disaggregation would improve the ability of the HK and CR indicators to identify key industries and trends.

2. ICT industry specialisation

Information industries in OECD economies, 2000 and 2011

As a percentages of total value added



Source: OECD, Structural Analysis (STAN) Database, ISIC Rev.4, June 2013.
StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893145

While demand for the products of Information industries increased relentlessly from 2000, the share in value added of these activities fell in most OECD economies. There were also changes in their composition. Indeed, the manufacture of computers and electronics and, to a lesser extent, telecommunication services saw their importance diminish as production shifted to other (mostly non-OECD) economies and unit prices fell as a result of productivity growth and increased competition. Meanwhile, the share of information technology (IT) services in total value added rose across all reporting economies, largely offsetting losses in the other sectors.

These changes are reflected in the dynamics of international trade. From 2000 to 2011, partly owing to the offshoring of production, the shares of the United States and Japan in world exports of ICT goods halved, while China's grew from less than 5% to 28%, with a tenfold increase in dollar terms. These moves accompanied a major shift in world trade (and consumption) patterns, with a fall in the share of computers and peripherals that was partly due to faster growth in trade of communication equipment and consumer electronics.

Since 2000, international trade in ICT services has grown extremely fast. The Computer and Information services component doubled its share in total services trade from 3% to 6%. Meanwhile, exports of telecommunications services have been particularly important for certain countries such as France and Italy. As with goods, few countries also account for a significant share of ICT service exports. Following some important shifts in recent years, India is now the leading exporter of IT services, having started from a very modest level. It is followed by Ireland, which, owing to a favourable tax environment, benefits from the presence of some large transnational IT corporations.

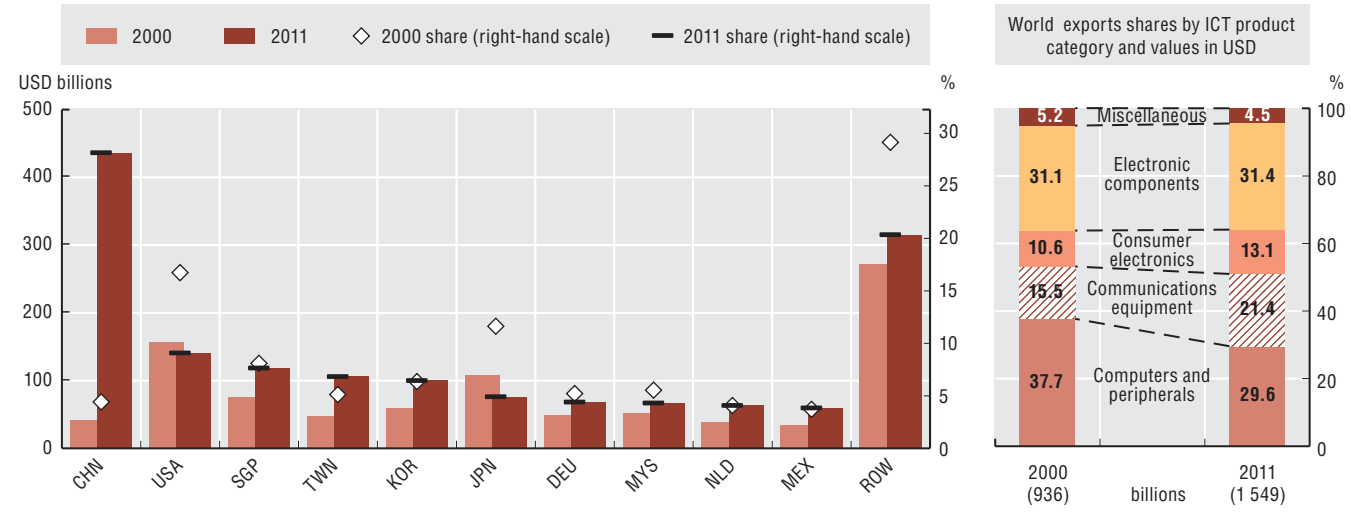
Definitions

The aggregate of *Information industries* includes ISIC-Rev.4 Division 26 (Manufacture of computer, electronic and optical products) and Section J (Information and communication), consisting of Divisions 58-60 (Publishing and broadcasting industries), 61 (Telecommunications) and 62-63 (Computer programming, and Information service activities). Hence Information industries encompass *ICT industries* (Divisions 26, 61 and 62-63, plus a small component in 58), with the exception of Trade and repair activities, as well as *Media and content industries* (included in Divisions 58-60 and in the Group 639).

ICT products are defined by the OECD with reference to the Central Product Classification (CPC) Rev.2 and include 99 subclasses of products, of which 52 goods and 47 services, grouped into four and six broad categories, respectively. In international trade, *computer and information services* are defined according to the IMF Balance of Payments Manual.

Global trade in ICT goods and top ten exporters, 2000 and 2011

Billions of USD and percentage shares



Source: OECD, STAN Bilateral Trade Database by industry and End-use (BTDIxE) May 2013. See chapter notes.

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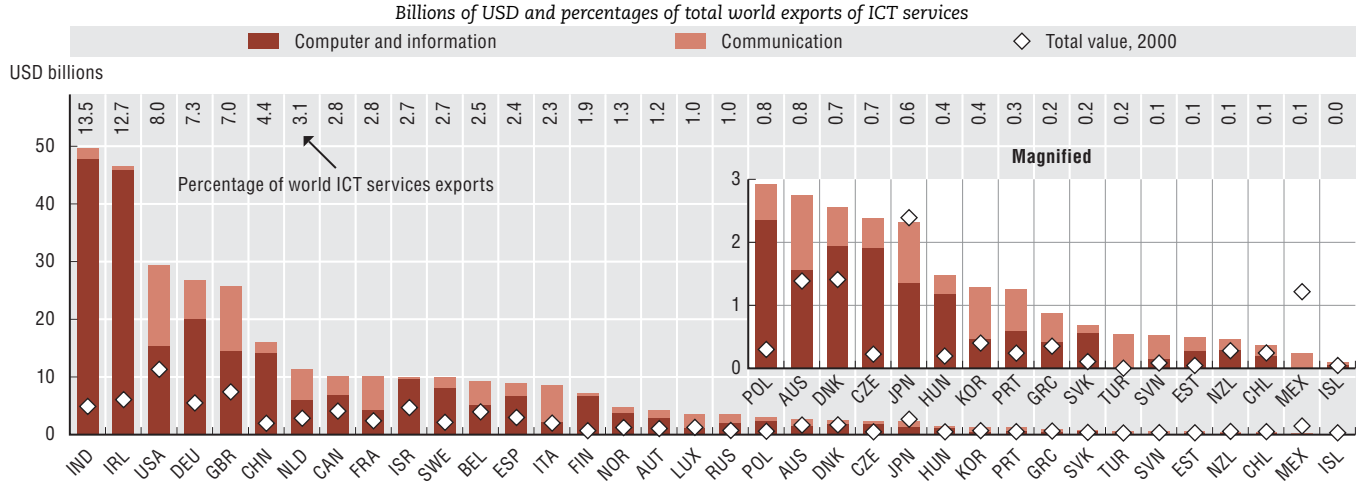
OECD and major exporters of ICT services, 2000 and 2012

Billions of USD and percentages of total world exports of ICT services



Source: UNCTAD, UNCTADstat, June 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893183

Measurability

Statistics on value added by activity are not always directly comparable across countries, owing to the co-existence of different regional classifications of economic activities, the transition to a revised classification (e.g. from NACE Rev.1 to NACE Rev.2), and the lack of sufficiently detailed information. In the case of Information industries, an important issue is the presence of significant shares of value added embodied in the output of other industries.

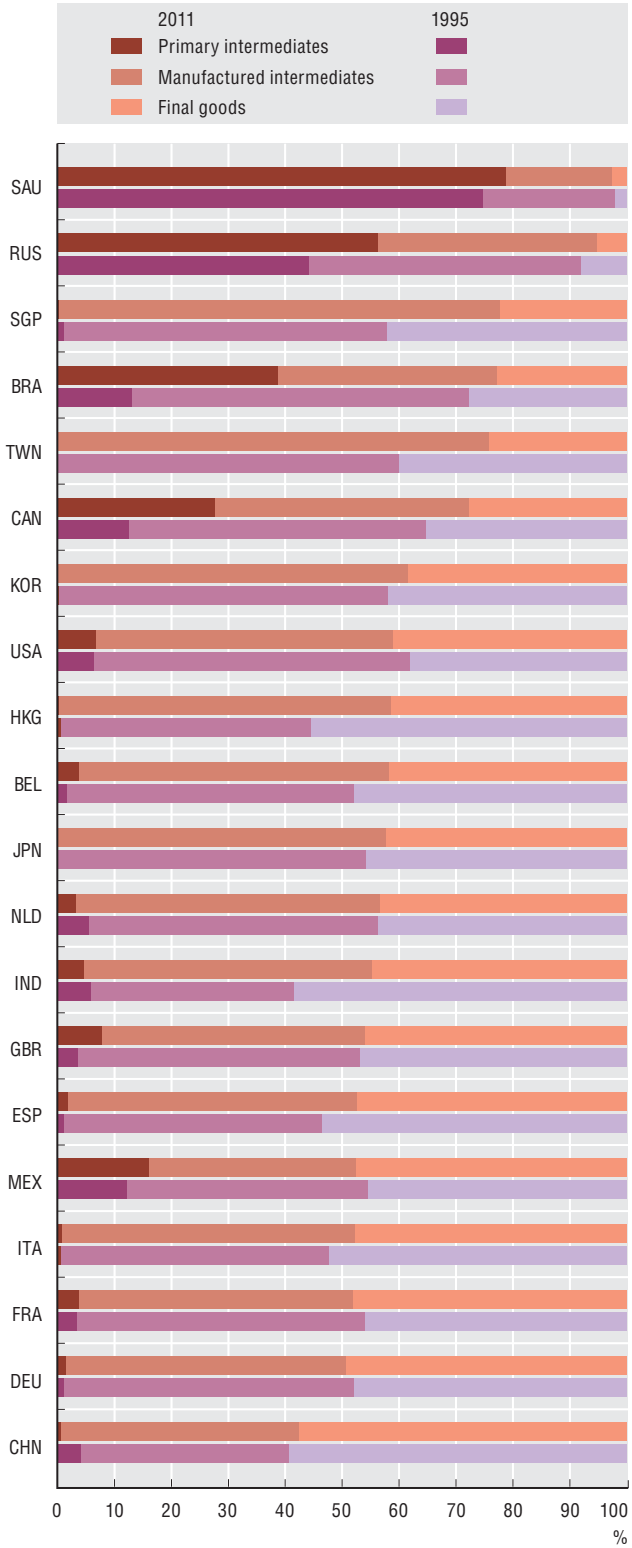
The globalisation of value chains has led to an acceleration of the dynamics of international trade with respect to that of economic activity, which increases the need to treat data (e.g. for transit trade, and/or for re-exports and re-imports). This is not always done consistently.

Statistics on international trade in services can also be prone to measurement and comparability issues. For example, increasingly tradable Information services, such as those provided by call centres, are difficult to measure as they are still included in the broad aggregate "Other business services".

3. Export structures

Top 20 exporting economies of primary and manufactured goods by end-use category, 1995 and 2011

As a percentage of total exports of goods



Source: OECD, STAN Bilateral Trade Database by Industry and End-use Category (BTDIxE), *www.oecd.org/sti/btd*, May 2013. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932893202*

OECD statistics on bilateral trade by industry and end-use category show how much of a country's exports are for foreign final consumption and for production abroad as intermediate inputs or capital goods.

On average, between 1995 and 2011, the share of intermediate goods in total exports rose from 58% to 63%, while final goods fell from 18.5% to about 13%. The 2 percentage point rise in the share of manufactured intermediates mainly reflects further fragmentation of production, while the 3.1 percentage point rise in primary intermediates to 12.7% is partly due to increases in primary commodity prices. This development is particularly clear for natural-resource-intensive economies such as Saudi Arabia, the Russian Federation, Canada and, increasingly, Brazil. In 1995, China's exports were valued at USD 148 billion, of which 60% destined for final consumption. By 2011, the value of China's exports had increased 12-fold to USD 1 890 billion and the structure of its exports had changed substantially towards high-end intermediates and capital goods.

The economies with the highest concentration of goods exports are mostly natural-resource-based. Motor vehicles is the top export industry in 12 countries and electronics in five others. This reflects the relative weight of these industries in overall international merchandise trade.

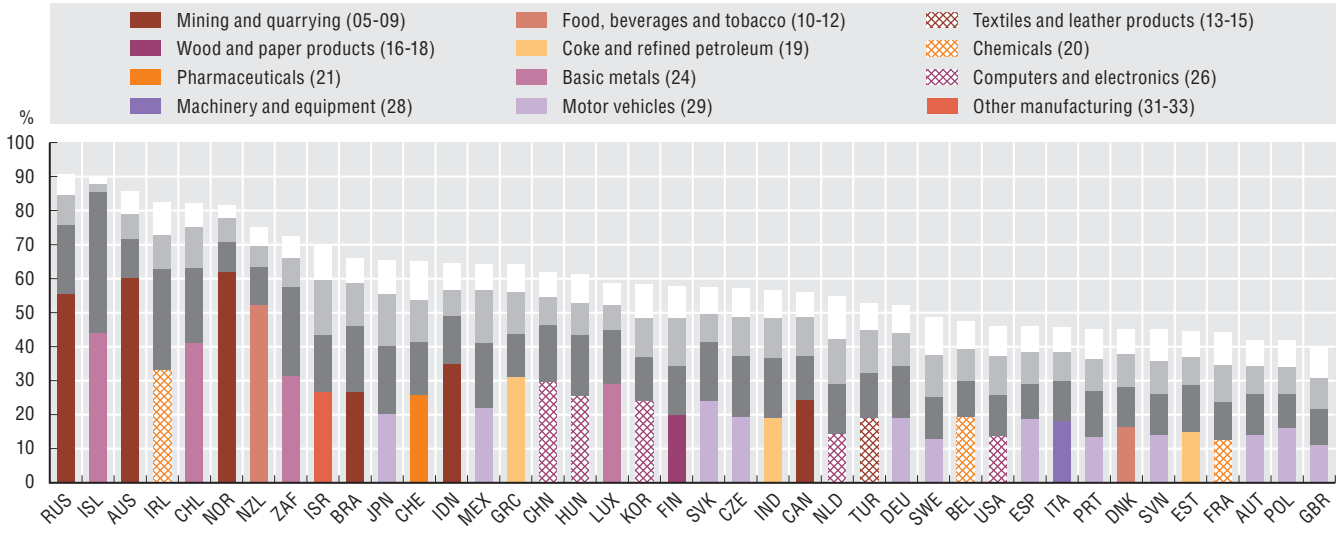
In services, OECD and BRIICS countries account for about 85% of world exports, and the three most important service items (excluding transport) represent about 40% to 90% of total exports; they almost always include travel and other business services. Many of the top exporting economies have an above-average trade specialisation in services. Those with the highest concentration of exports are relatively specialised in financial services and/or in ICT services, except for Spain. An important share of US and French service revenues comes from royalties.

Definitions

The OECD STAN Bilateral Trade Database by Industry and End-Use Category (BTDIxE) provides estimates of current price imports and exports of goods by end-use, i.e. of household and capital consumption and intermediate inputs into production, as well as of a few mixed end-use categories such as passenger vehicles and personal computers. Standard conversion keys are used to map merchandise trade data according to various HS product classifications to ISIC Rev.3 and ISIC Rev.4 and to end-use categories based on broad economic categories. Where identifiable, waste and scrap, which increasingly flow between countries, are allocated to special categories in the industry list. Trade in services data are drawn from international balance of payments statistics and they exclude transport services; the categories corresponding to the higher level of the standard classification are used.

Top four exporting industries by country, 2011

As a percentage of total primary and manufactured goods

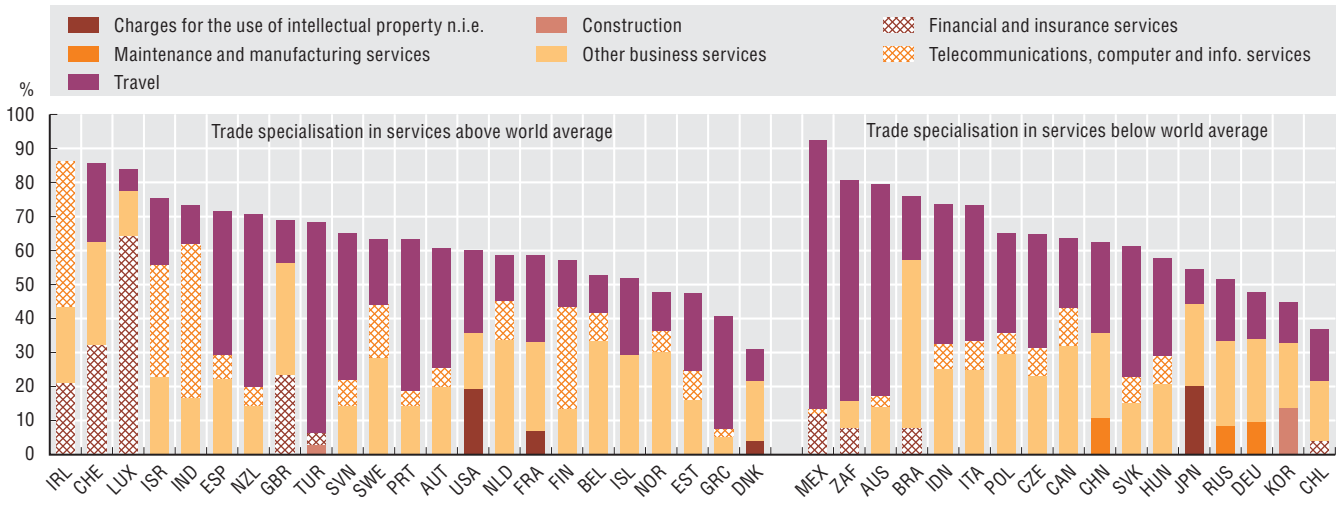


Source: OECD, STAN Bilateral Trade Database by Industry and End-use Category (BTDIxE), *www.oecd.org/sti/btd*, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893221

Top three exporting services by country, 2011

As a percentage of total services



Source: IMF, Balance of Payments Database, June 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893240

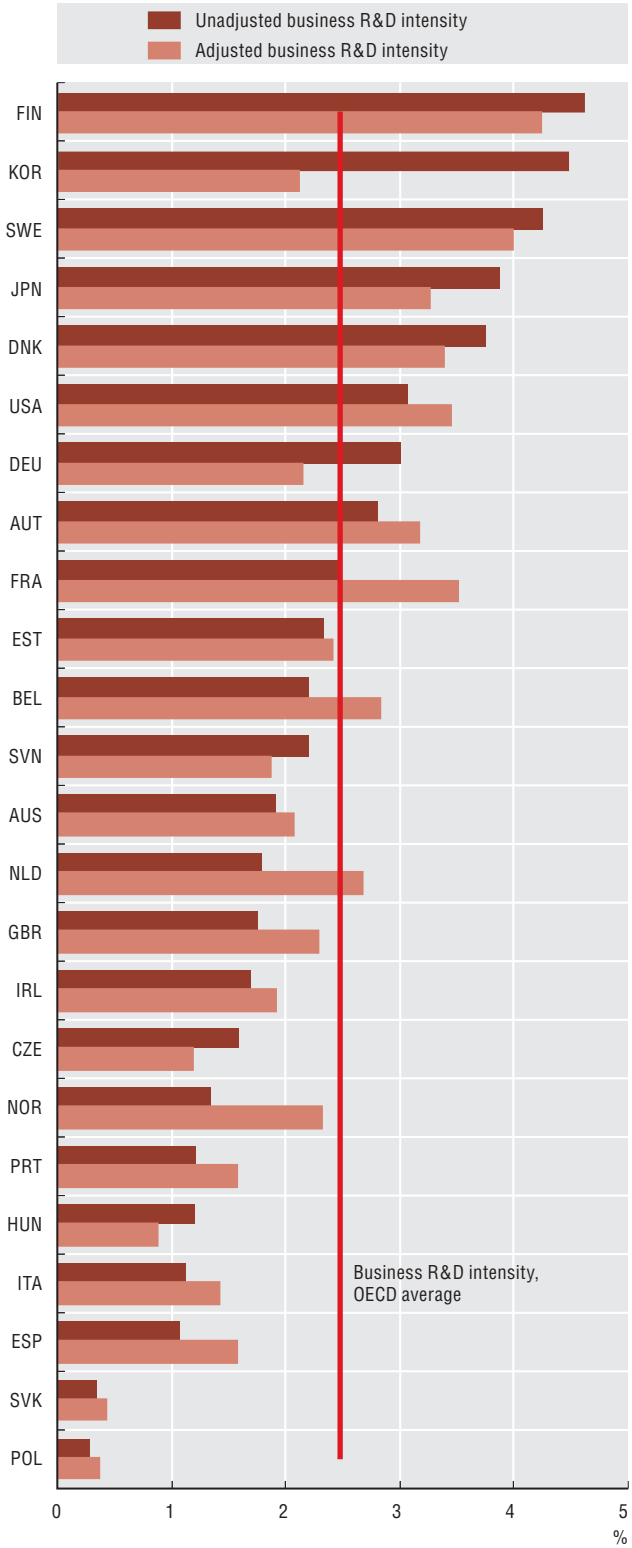
Measurability

The OECD STAN Bilateral Trade Database by Industry and End-Use Category (BTDIxE) can provide insights into patterns of trade in intermediate goods between countries and into global production networks and supply chains and thus help to address a range of industry and trade policy issues. The database is an important component of the OECD's inter-country input-output (ICIO) system from which trade in value added (TiVA) indicators are derived. Converting commodity-based statistics into industry and end-use figures presents certain challenges. For example, personal computers and passenger cars can be both consumer and investment goods: 6-digit HS codes do not give information on final purchasers. As a result, it is hard to tell whether a computer exported from country A to country B is eventually purchased by a household for final consumption or by an enterprise as investment. Also, second-hand and used goods (such as transport equipment) cannot be easily distinguished from new goods.

4. R&D specialisation

Business R&D intensity adjusted for industrial structure, 2011

As a percentage of value added in industry



Source: OECD calculations based on the Structural Analysis (STAN), Research and Development Statistics (RDS) and ANBERD Databases, June 2013; OECD, Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893259

When comparing countries' business R&D intensity (R&D expenditure relative to value added or GDP), it is often important to take account of differences in their industrial structure since R&D intensity varies considerably across sectors. An understanding of the extent to which structural differences account for observed differences in overall business R&D intensity can be achieved by showing what a country's total R&D intensity in business would be if it had the same industrial structure as the average of OECD countries.

If countries had an average OECD industrial structure, adjusted business R&D intensity for Germany and Korea would be below the OECD average of 2.5% since these economies are relatively specialised in high- and medium-high-technology industries. In Belgium, France and the Netherlands, business R&D intensity would be higher than the OECD average, while in countries in southern and eastern Europe, an industry structure closer to the OECD average would not significantly change their overall R&D intensity.

High- and medium-high-technology industries account for the largest share of business enterprise expenditure on R&D (BERD) in manufacturing in most countries. In the Russian Federation and Israel, they account for over 90% of manufacturing BERD although manufacturing accounts for less than a third of total BERD. Among OECD countries, only in Chile and Estonia does low- and medium-low-technology manufacturing account for more than half of all manufacturing BERD.

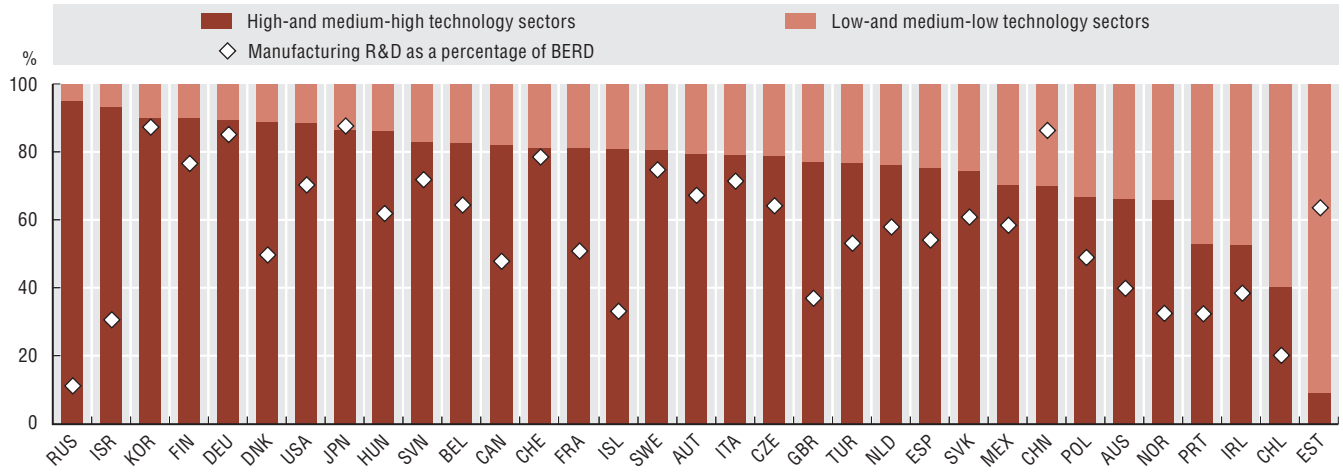
Many service industries are increasingly knowledge-intensive and R&D often plays a significant role. In most OECD countries, services account for a third or more of BERD, a share that has generally increased over the last decade. Cross-country comparisons of the sectoral distribution of BERD should nonetheless 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.

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. For the first time, the calculations are based on the ISIC Rev.4 classification. Manufacturing industries are classified by level of technology (high- and medium-high-; low- and medium-low-technology activities) on the basis of average OECD R&D intensity defined as R&D relative to value added and gross output. R&D services correspond to ISIC Rev.4 Division 72.

Business R&D in manufacturing, by technology intensity, 2011

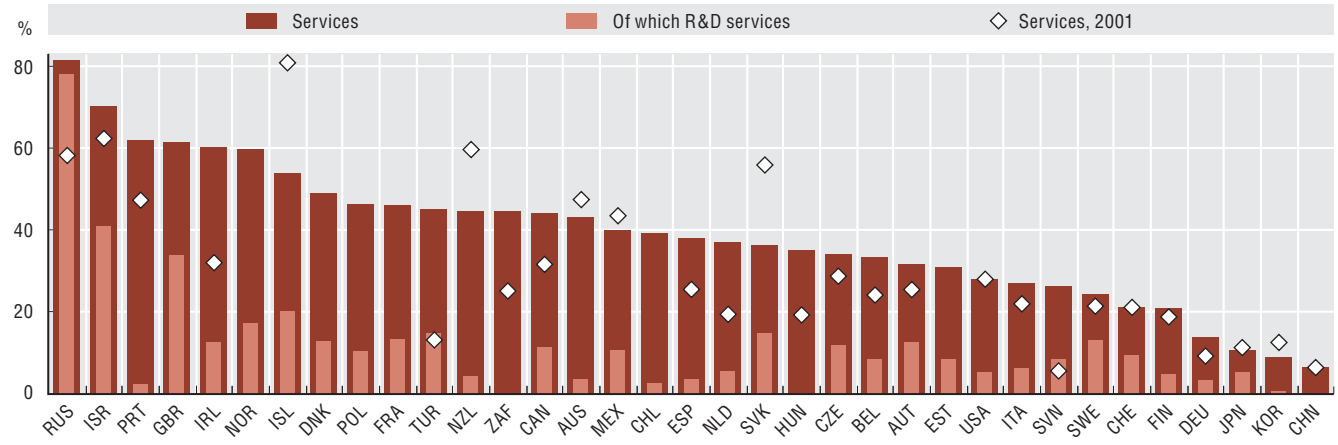
As a percentage of R&D in manufacturing



Source: OECD, ANBERD Database, *www.oecd.org/sti/anberd* and OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893278

Share of services in business R&D, 2001 and 2011



Source: OECD, Research and Development Statistics Database, *www.oecd.org/sti/rds* and Main Science and Technology Indicators Database, *www.oecd.org/sti/msti.htm*, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893297

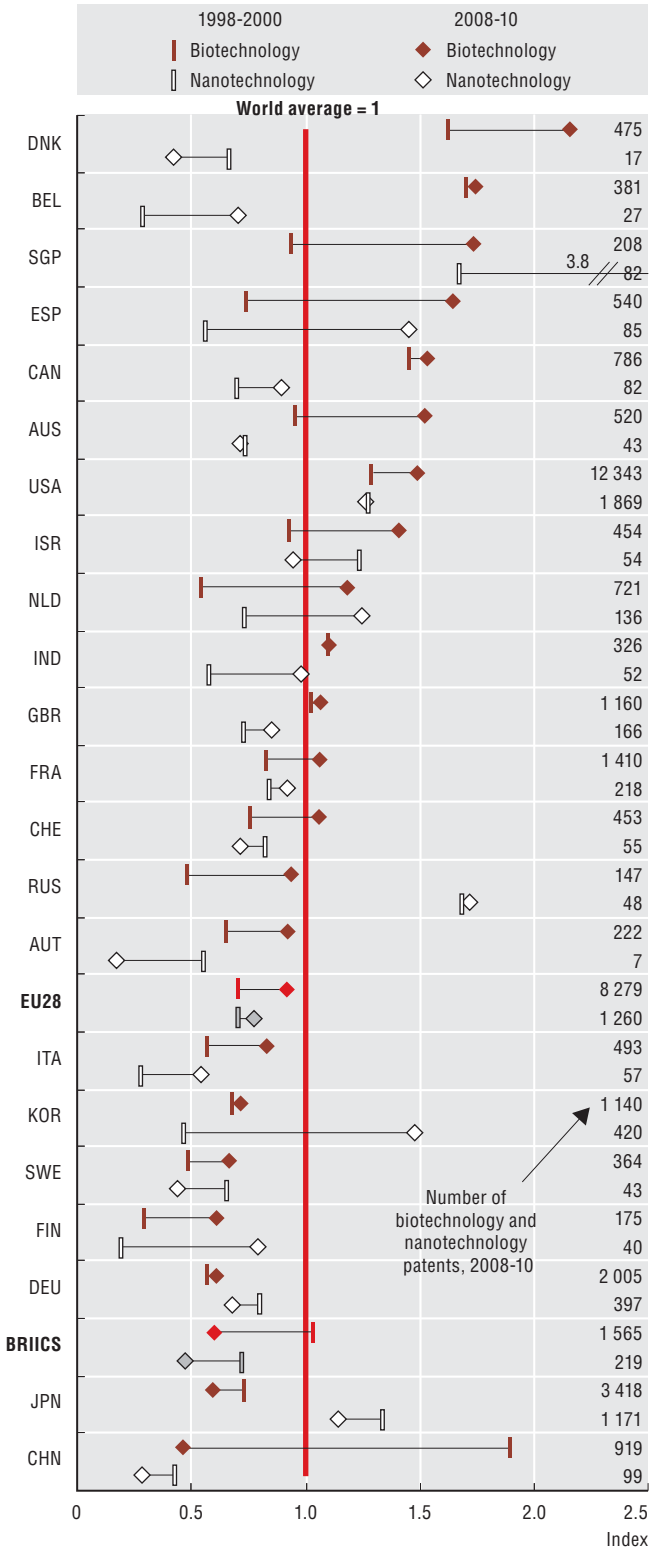
Measurability

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 ("main activity" approach). In some, it is based on the main *R&D activity* of the firm or the content of the R&D itself ("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: for Finland, using ISIC Rev.4 to calculate the adjusted R&D intensity results in a significantly smaller adjustment than what was previously obtained using ISIC Rev.3 (see *STI Scoreboard 2011*). Other factors which have an impact are the level of aggregation at which the sectoral weights are calculated and the countries included in the benchmark. For Estonia, a large R&D investment in the oil industry resulted in a significant jump of BERD in low-technology manufacturing for 2011.

5. Technological advantage

Change in revealed technological advantage in biotechnology and nanotechnology, 1998-2000 and 2008-10

Index based on patent applications filed under the Patent Cooperation Treaty



Source: OECD, Patent Database, June 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893316

Patent documents contain a wealth of information, including the date on which intellectual property (IP) protection was sought, the technology classes to which the invention belongs, and the nationality of owners and inventors. These data can be used to classify patents in particular fields and to investigate the emergence and growth of new technologies. A revealed technological advantage (RTA) index, built from information on the International Patent Classification (IPC) of inventions, provides an indication of a given economy's relative specialisation in various technology domains.

The extent to which economies have specialised in biotechnology and nanotechnology can be inferred by looking at changes in their RTA in these fields. While the overall number of biotechnology patents remained fairly stable over the last decade, nanotechnology patent applications grew at a pace similar to the average of all technologies (about 5.2% a year). Denmark became the most specialised in biotechnologies, with an index of 2.2 in 2008-10, and Australia, Israel, the Netherlands, Singapore and Spain became relatively more specialised in this field. For nanotechnologies, Singapore (3.8), the Russian Federation (1.7) and Korea (1.5) had the largest RTA in 2008-10, and Spain and the Netherlands substantially increased their specialisation.

In information and communication technology (ICT), China's patenting increased the most of all economies to reach an RTA similar to that of Finland, Korea and Japan. Israel and the Netherlands, instead, appeared to become less specialised in ICT in the 2000s.

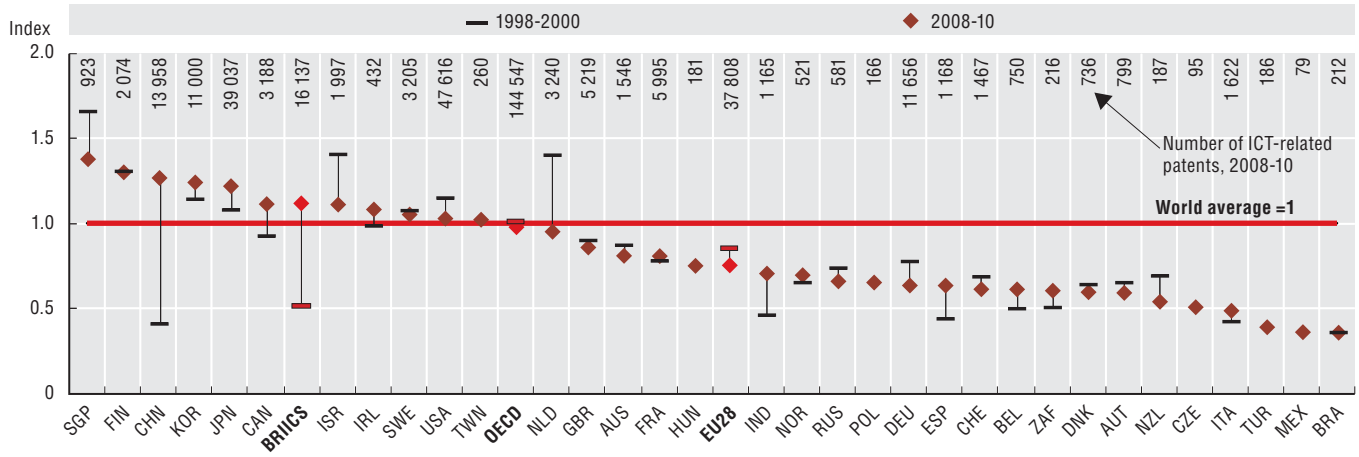
The level of technological specialisation changes substantially across economies and technologies. The RTA values for 2008-10 suggest that most economies are generally relatively unspecialised in most technology fields, and that median values are far from those of top performers. There are a few cases of very high specialisation, with RTA values of 5 or more: China in digital communication; India in organic chemistry; Singapore in microtechnology and nanotechnology; Turkey in other consumer goods; and Norway in civil engineering.

Definitions

The *revealed technological advantage* index is defined as the share of an economy's patents in a particular technology field relative to the share of total patents in that economy. The index is equal to zero when the economy has no patents in a given field; is equal to 1 when the economy's share in the sector equals its share in all fields (no specialisation); and above 1 when a positive specialisation is observed. The index is calculated on patent applications filed under the Patent Cooperation Treaty (PCT). Patent counts are based on the priority date, the inventor's residence and fractional counts.

Change in revealed technological advantage in ICT, 1998-2000 and 2008-10

Index based on patent applications filed under the Patent Cooperation Treaty

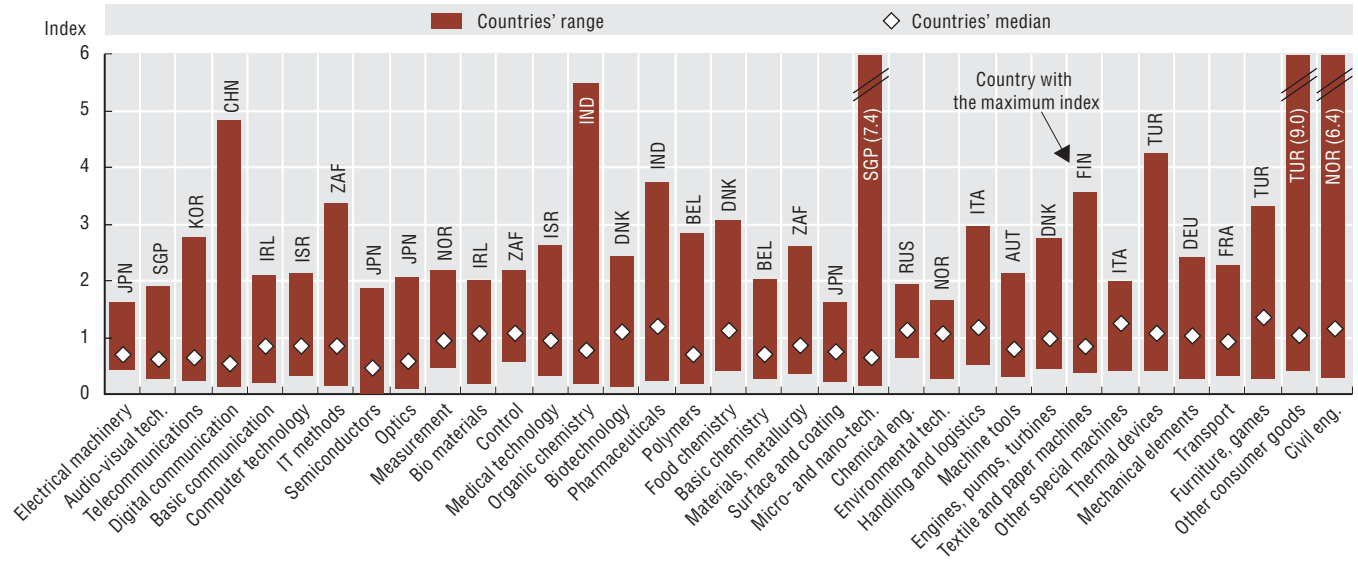


Source: OECD, Patent Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893335

Countries' range of revealed technological advantage by field, 2008-10

Index by technology field, based on patent applications filed under the Patent Cooperation Treaty



Source: OECD, Patent Database, June 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893354

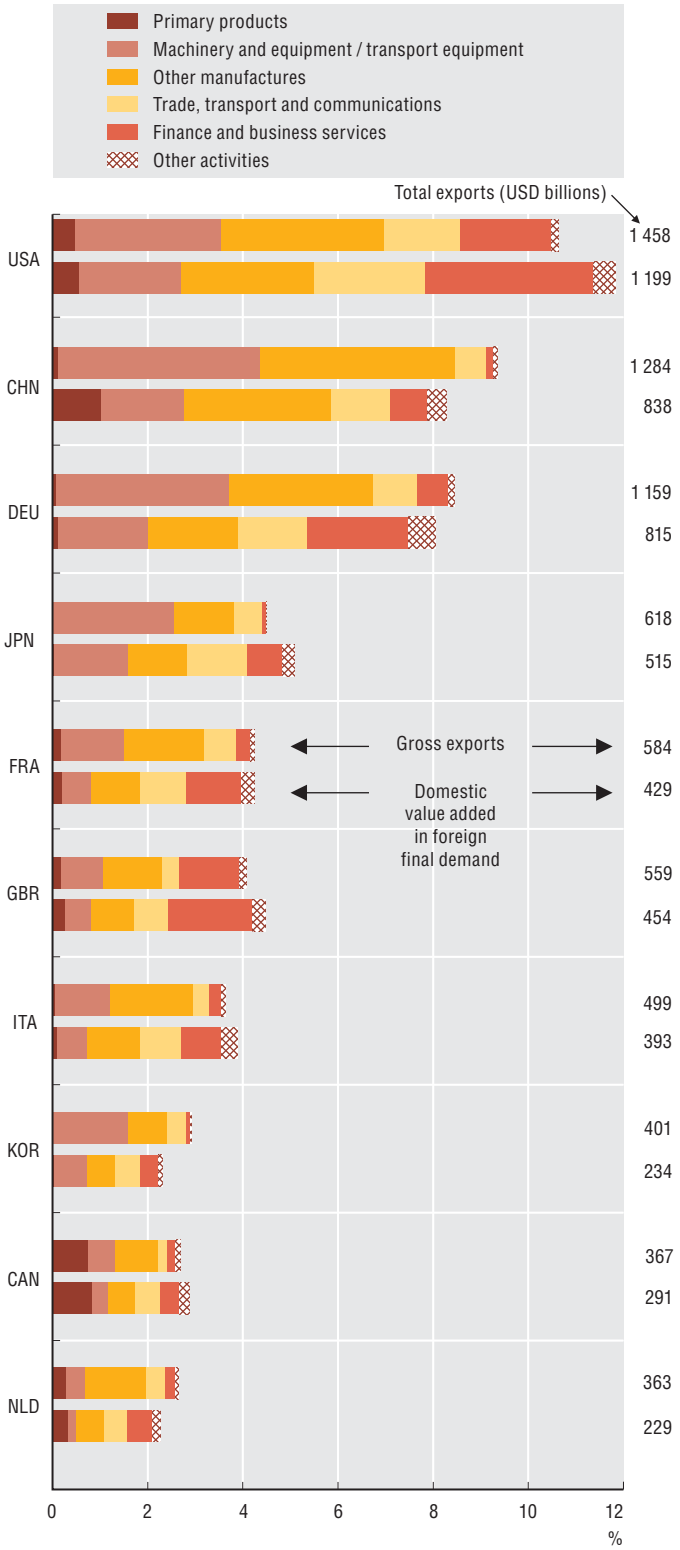
Measurability

The IPC codes contained in patents identify the technological domains to which inventions belong. They are attributed by patent examiners during the examination process. The IPC classification is 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 and to the absence of specific classes. Key technological domains such as ICT, biotechnology and nanotechnology are defined following *ad hoc* lists of IPC classes compiled by experts in the fields, using tagging systems of the European Classification System (ECLA), that highlight the area of application of patented inventions (*www.oecd.org/sti/ipr-statistics*). A comprehensive classification of technology fields has been proposed by Schmoch (WIPO, 2008, revised in 2013), who groups all existing IPC classes into 35 technology fields. These are identified on the basis of their content, and the classification tries to account for the size of the field and to minimise possible overlaps between different fields. Using data from other patent offices may change the patterns observed.

6. Trade competitiveness

Top ten exporting economies in gross and value added terms, 2009

As a percentage of total world exports in gross and value added terms



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932893373*

The Trade in Value Added (TiVA) Database provides a new perspective on trade competitiveness. Indicators of value added in exports, particularly of domestic value added generated by foreign final demand, may reveal more about the performance of a country's industries than an analysis of its gross exports of goods and services. Comparing a country's shares in gross world exports of different industries with its shares of domestic value added in final demand reveals the greater weight of services in global markets, and particularly of financial and business services in France, Germany, the United States and the United Kingdom. Shares of manufactured output are lower for most countries in value added terms because the multiple counting of manufactured intermediates reported in "gross" trade statistics is eliminated.

New indicators of revealed comparative advantage (RCA) in value added terms throw new light on countries' competitiveness. For example, they show the United States with a comparative advantage in exports of computers, electronic and optical products in 2009, whereas gross measure suggests otherwise. In contrast, Mexico's comparative advantage shrank because its gross exports of computers, electronic and optical products contain much value added from other countries, notably the United States. The pattern is similar for Factory Asia, with a reduction in China's comparative advantage and increases in neighbouring countries such as Japan and Korea. In the case of machinery and equipment the relative advantage of several European countries is larger in value added terms.

Definitions

The TiVA indicator of domestic value added generated by foreign final demand (FDDVA) accounts for the fact that industries export value both directly, via exports of final goods and services, and indirectly, via exports of intermediates embodied in other countries' exports to meet foreign final demand. It reflects how industries (upstream in a value chain) are connected to consumers in other countries, even when no direct trade relationship exists. It can contribute to a better understanding of the impact on domestic output of changes in final demand in foreign markets.

Industry RCA is calculated as country industry shares of country total exports of goods and services divided by world industry shares of total world exports of goods and services. RCAs are "normalised" around zero by using the transformation (RCA-1)/(RCA+1) so that a figure greater than 0 reveals a comparative advantage. The latest year covered by the 2013 version of the OECD-WTO TiVA Database is 2009. It covers 18 major activity groups defined according to ISIC Rev.3. For RCA calculations, finer industry breakdowns would be preferable and will be possible in future versions of the TiVA database.

Revealed comparative advantage in exports of computers, electronic and optical products, 2009

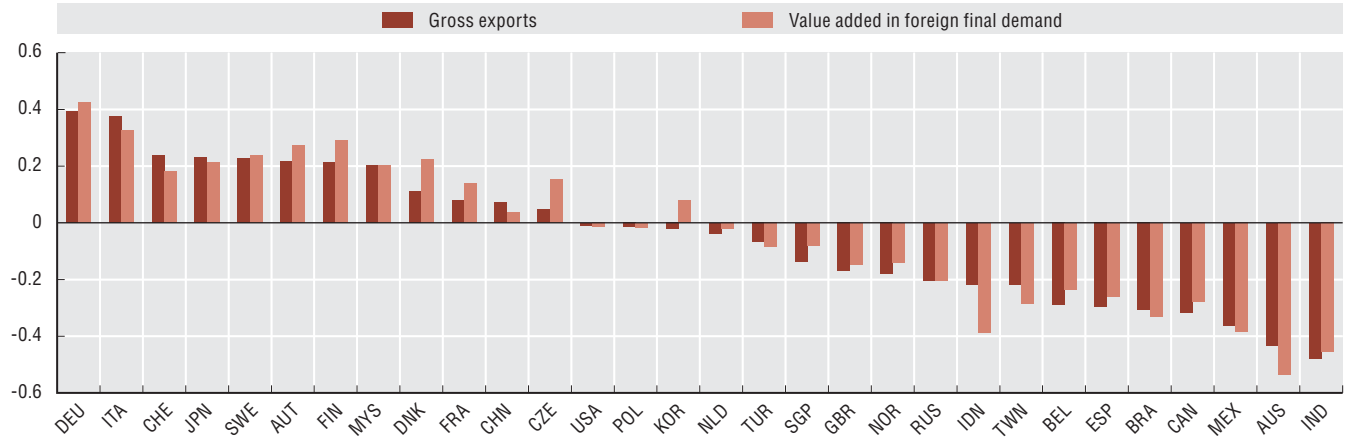
Top 30 exporters

Source: OECD, Inter-Country Input-Output (ICIO) Database, May 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893392

Revealed comparative advantage in exports of machinery and equipment, 2009

Top 30 exporters



Source: OECD, Inter-Country Input-Output (ICIO) Database, May 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893411

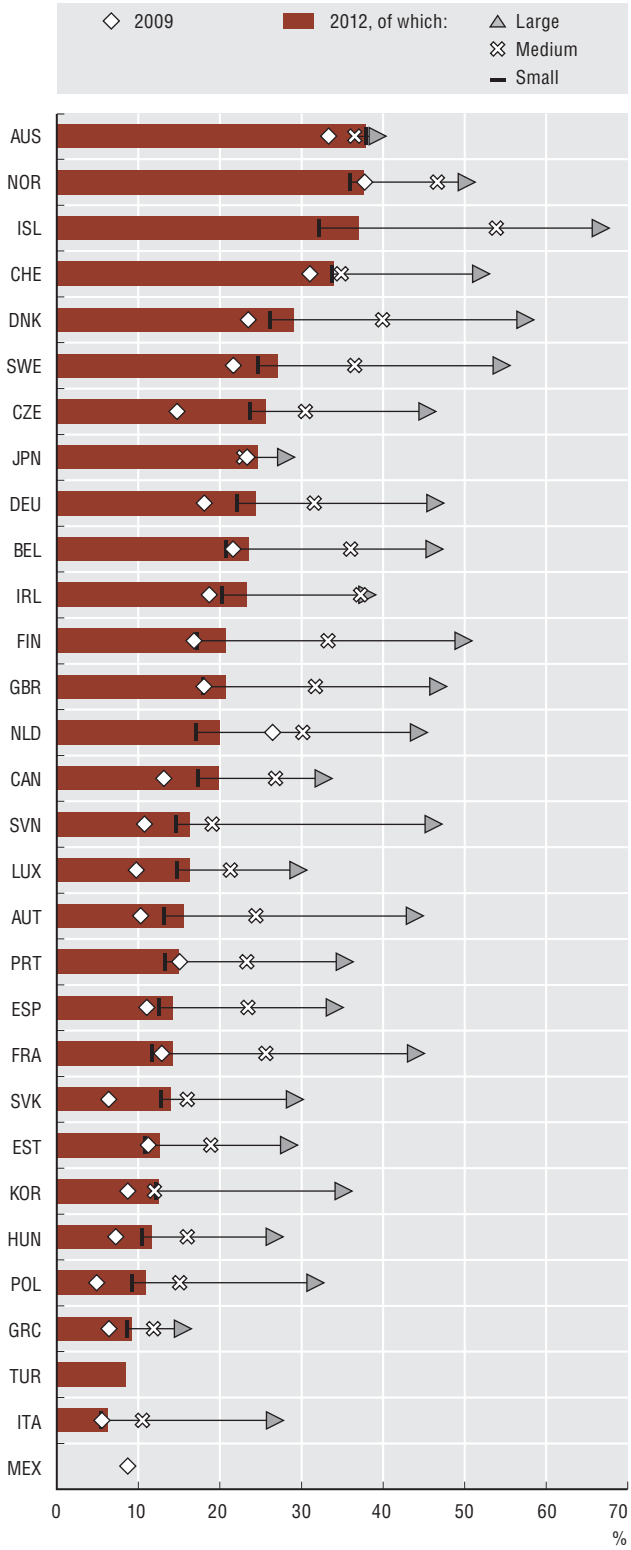
Measurability

The gross exports of goods and services used here are estimates from the underlying OECD inter-country input-output (ICIO) system used to produce the Trade in Value Added (TiVA) indicators. By necessity, the system requires consistent bilateral trade matrices in which exports of products X from country A to B are equal to imports of products X by B from A. Efforts are made to ensure consistency with aggregate exports and imports of goods and services as reported in countries' National Accounts or Balance of Payments statistics. However, owing to the required balancing of global bilateral trade matrices, certain results may not match countries' perceptions of their trading patterns. Although they are not without flaws, estimates of bilateral gross trade flows by industry from the ICIO provide a basis for constructing a range of indicators for a new understanding of international trade and global value chains, including domestic value added in foreign final demand.

7. E-business uptake

Enterprises selling on line, by size, 2009 and 2012

As a percentage of enterprises in the same size category



Source: OECD ICT Database and Eurostat, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893430

Electronic business (e-business) can help drive business growth by enlarging enterprises' market reach and saving on costs.

On average in 2012, almost 20% of firms in reporting OECD countries with at least 10 persons employed received electronic orders, almost 4 percentage points more than in 2009. Differences among countries are considerable: in Australia, Norway, Iceland and the Czech Republic the share is above 30%, while in Poland, Greece, Turkey and Italy it is 10% or less. These figures mimic closely shares of smaller firms, which dominate in numbers: for enterprises with 250 or more persons employed the average value approaches 40%, and the share is over 30% even in some lagging countries.

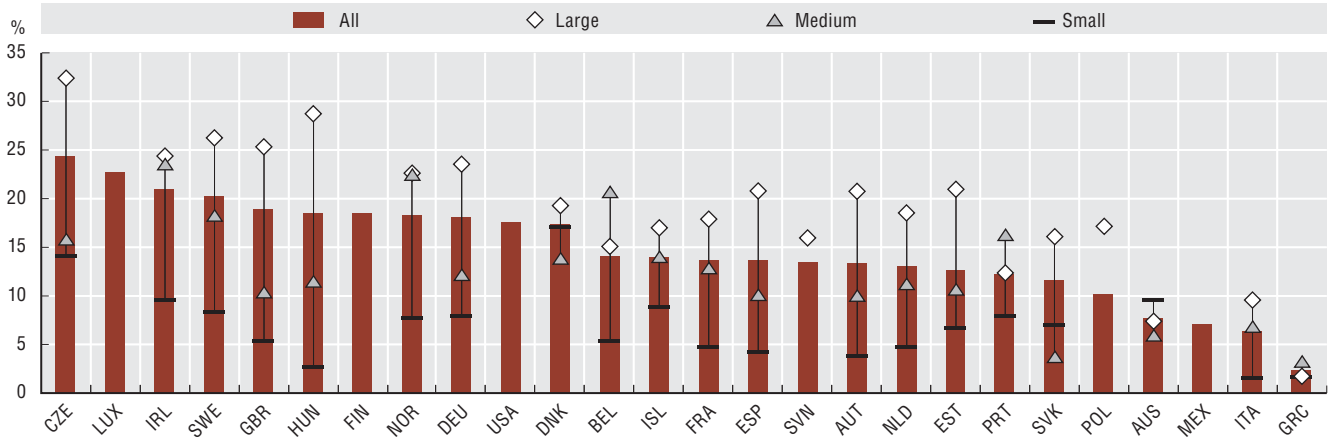
The overall economic relevance of e-business transactions, measured by the share of e-commerce sales in turnover stands at about 14.5% of total turnover on average in reporting countries. Up to about 90% of the value of e-commerce (based on proxy information) comes from transactions between businesses (B2B). Results are dominated by the economic weight of large enterprises whose e-commerce sales represent about 19% of turnover against 7% for small firms. Owing to the weight of larger firms in the value of e-sales, differences among countries are less sizeable than in terms of propensity to sell online. The role of e-business processes in handling enterprises' internal information flows can be seen in the diffusion of enterprise resource planning (ERP) software. In reporting countries, ERP is now used to share information on average by 70% of larger, and more complex, organisations but by less than 20% of small firms, for which ERP is only now becoming more affordable. Adoption rates across countries range from 50% to 90% for larger enterprises, and from about 30% to less than 10% for smaller ones.

Definitions

According to the 2009 OECD definition, *e-commerce transactions* are 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*; payment and delivery are not considered. Transactions can occur between enterprises, households, individuals, governments and other organisations. The definition includes orders made through web pages, extranet or EDI and excludes orders by telephone calls, fax or manually typed e-mail. *ERP* systems are software-based tools that can integrate the management of internal and external information flows, from material and human resources to finance, accounting and relations with customers. Here, only the sharing of information within the firm is considered. Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249), large (250 and more).

Turnover from e-commerce, by enterprise size, 2012

As a percentage of total turnover

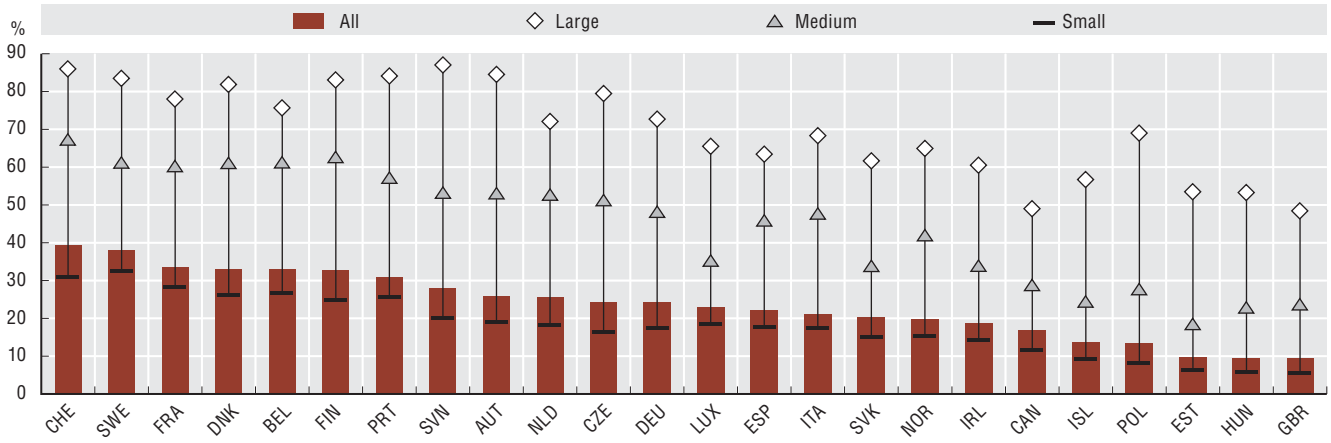


Source: OECD ICT Database and Eurostat, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893449

Enterprises using enterprise resource planning software for internal information sharing, by size, 2012

As a percentage of enterprises with 10 or more persons employed



Source: OECD ICT Database and Eurostat, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893468

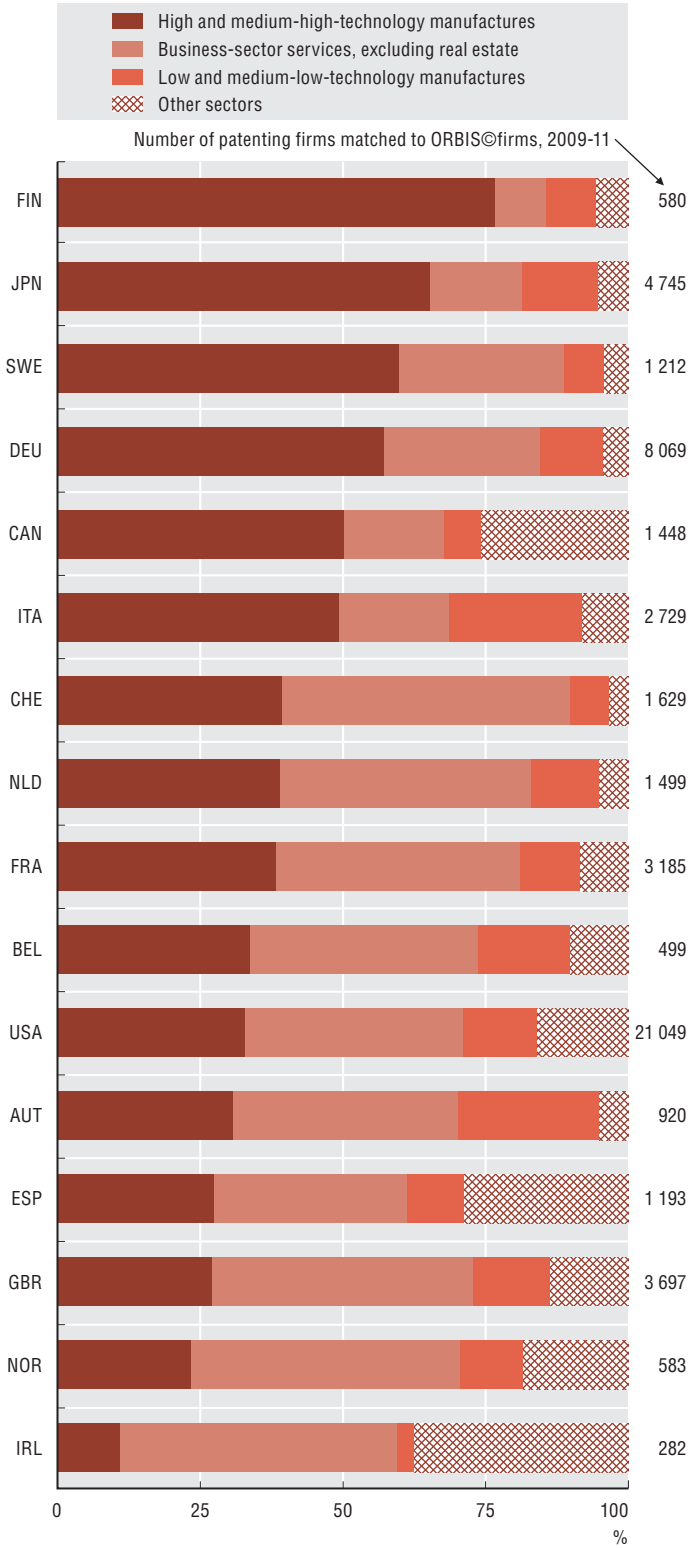
Measurability

The measurement of e-commerce presents many methodological challenges that can affect the comparability of estimates, such as the adoption of different practices for data collection and estimations, for treatment of outliers and of e-commerce by multinationals, or for the imputation of values from ranges recorded in surveys. Other issues include differences in sectoral coverage of surveys, and a lack of measures concerning the actors involved (B2B, business-to-consumer [B2C], business to government [B2G], etc.). For this last aspect, Korea provides direct estimates, while the United States' Census Bureau proxies B2C with transactions originating from the retail sector. For European countries the best available proxy consists of EDI (B2B+B2G) vs. web sales (B2C, etc.). Convergence of technologies brings additional challenges for the treatment (and surveying) of emerging transactions, notably over mobile phones, via SMS or using devices that enable near-field communication. Various software tools with different functionalities fall under the ERP heading: taking account of the sophistication of ERP systems and their degree of implementation may lead to substantial changes in the picture of usage.

8. Young innovative firms

Patenting activity by sector, 2009-11

As a percentage of patents filed by firms



Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013; and ORBIS© Database, Bureau van Dijk Electronic Publishing, June 2011; matched using algorithms in the Imalinker system developed for the OECD by Idener, Seville, 2013.. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893487

Patent applications are filed by enterprises, organisations or individuals – generally referred to as applicants. Firms' names can be used to obtain information on e.g. their industrial sector, age, and size in terms of number of employees, by linking their names to the names of firms contained in national business registers (BR) or in commercial datasets based on BR. By linking patent and BR-based data it is possible to address policy-relevant issues such as the innovative performance of firms of different ages and sizes or industries' contribution to the development of key fields (e.g. ICT, environment).

In economies where patents can be linked to enterprise data, indicators reveal very different patterns of patenting activity by sector. In Finland, Japan, Germany, Sweden, Canada and Italy, the high-technology sector dominates patenting activity (50% to 77% of patents). In the other economies, the business services sector accounts for the largest shares of patents.

Matched enterprise and patent data also reveal the broad industrial basis of key enabling technologies. R&D service providers are essential to all these fields, contributing to the advancement of biotechnology (27% of patents), pharmaceuticals (24%), and to a lesser extent nanotechnology (14%), ICT (7%) and environmental technologies (7%). Not surprisingly, universities are important for developments in the life sciences. One-fifth of inventions patented in the ICT field originate from computer and electronics manufacturers and programming and consultancy services firms. Environmental technologies are shaped by a wide range of industries, including specialised machinery manufacturers.

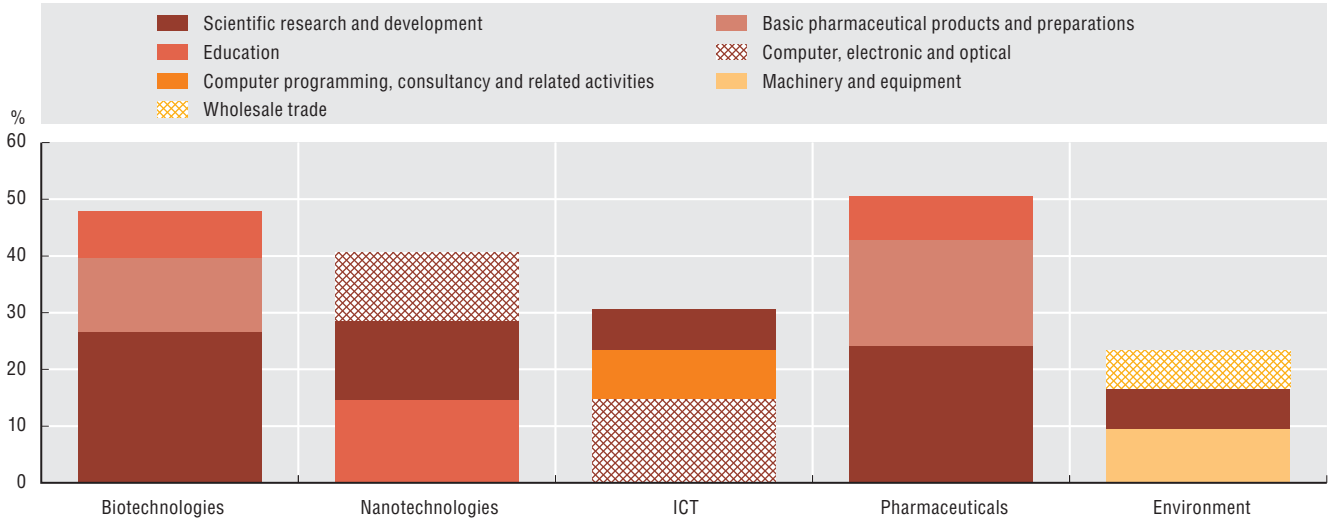
The high proportion of young firms applying for patents underlines the inventive capacity of these firms and their willingness to develop new activities and products that may affect their survival and growth. In the economies considered, young firms represented 31% of all firms in ORBIS©, 24% of all patenting firms and applied on average for 12% of patents.

Definitions

The indicators were compiled from patent data linked to the ORBIS© database, which contains structural and financial information on firms worldwide. The links were established using combinations of string matching algorithms. The patent portfolio of firms refers to families of patents filed between 2009 and 2011 at the European Patent Office (EPO), the United States Patent and Trademark Office (USPTO) or under the Patent Cooperation Treaty (PCT). The industry list is based on the ISIC Rev.4 classification, and individual firms are allocated to industries according to the information contained in ORBIS©. Young patenting firms are those with an incorporation date between 2006 and 2011. See Squicciarini and Dernis (2013) for details.

Top three industries patenting in selected technology fields, 2009-11

Share of industries' contribution to patent applications in selected technology fields

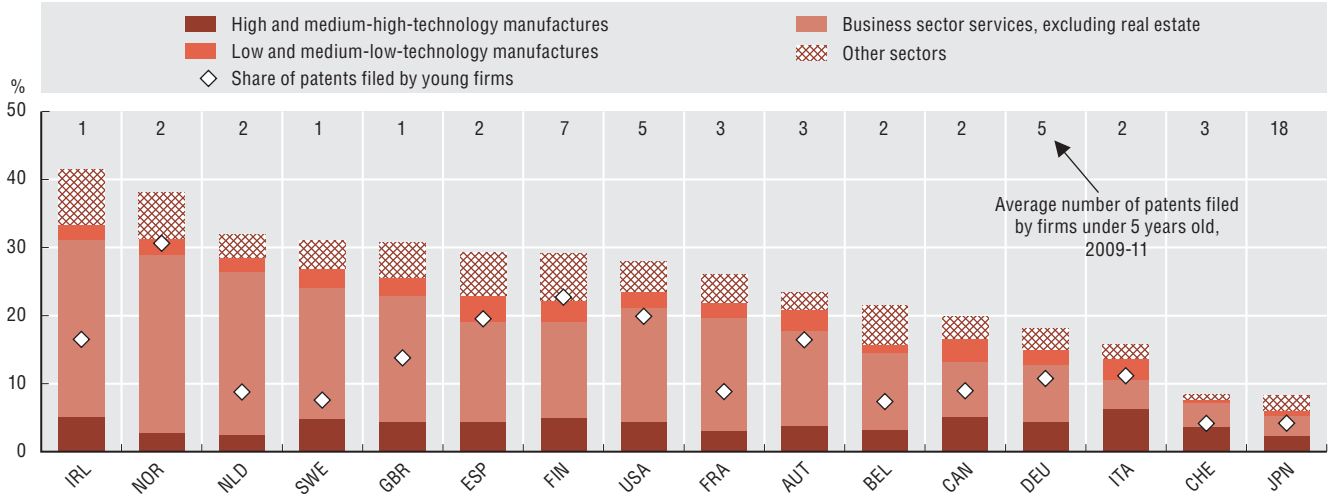


Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013; and ORBIS© Database, Bureau van Dijk Electronic Publishing, June 2011; matched using algorithms in the Imalinker system developed for the OECD by Idener, Seville, 2013.. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893506

Patenting activity of young firms by sector, 2009-11

Share of young patenting firms and share of patents filed by young patenting firms



Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013; and ORBIS© Database, Bureau van Dijk Electronic Publishing, June 2011; matched using algorithms in the Imalinker system developed for the OECD by Idener, Seville, 2013.. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893525

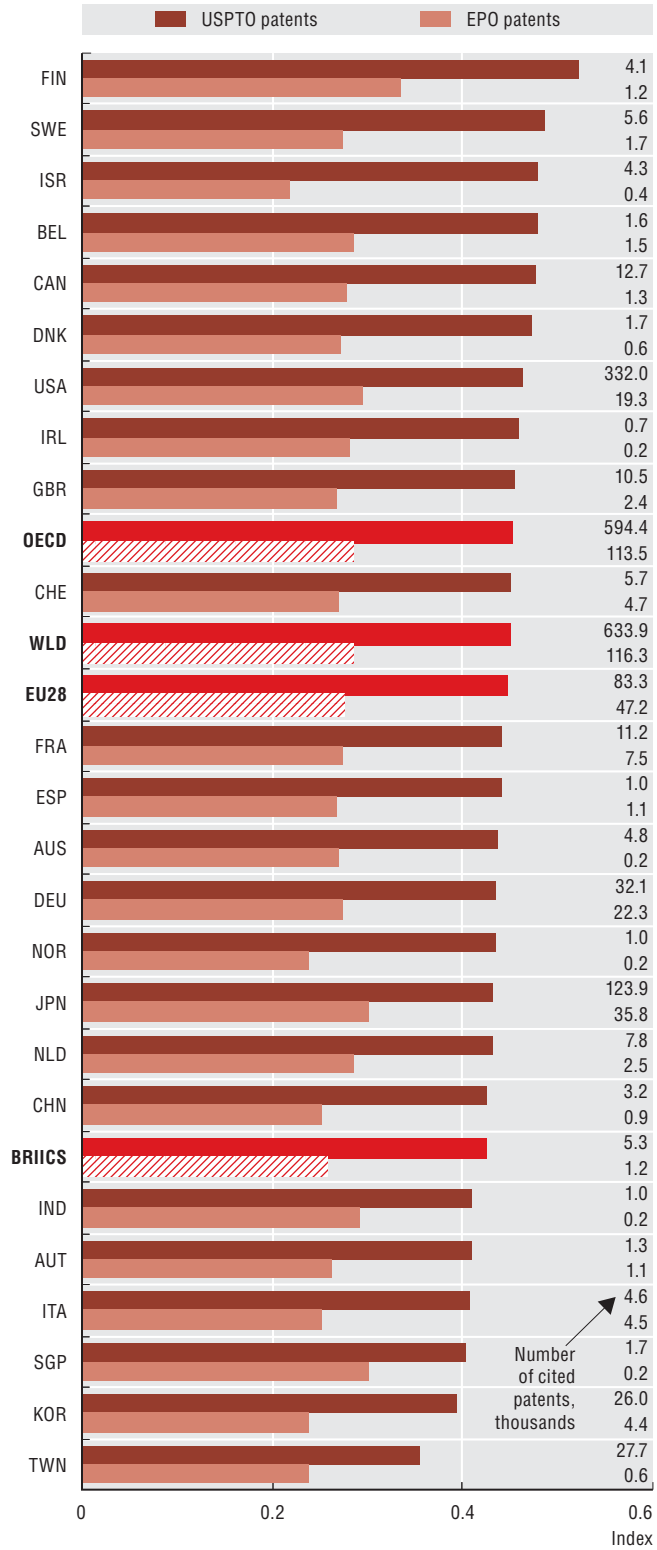
Measurability

Linking patent data to enterprise data requires harmonising firms' names using country-specific "dictionaries" covering legal entities, common names and expressions, phonetic and linguistic rules that may affect how enterprise names are written. String matching algorithms – mainly token-based and string-metric-based – then compare the names in the different datasets and provide a matching accuracy score. The matching exercise was performed on patent records in the EPO's Worldwide Patent Statistical Database (PATSTAT) and the list of companies in Bureau van Dijk's ORBIS© firm data, using software developed for the OECD by IDENER, Seville. Ideally, the matching should be performed on official data such as national BR, as ORBIS's coverage is not exhaustive and differs across countries. In particular small firms are underrepresented. To address selection and data consistency issues, the analysis is restricted to economies with matching rates above 80% of patent filings in the 2000s. Firm-level data are not consolidated at the group level, and young patenting firms may include affiliates of conglomerates featuring a recent date of incorporation in ORBIS©.

9. Technological strengths

The relevance of patents for later inventions, 2002-06

Average generality index based on patent applications to the EPO and the USPTO



Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893544

The technological and economic value of patented inventions is known to vary widely across patents, firms and sectors, and over time. Many indicators attempt to capture the different meanings that patent value may have for stakeholders such as inventors, firms, attorneys and policy makers.

The generality index uses information on the citations received by a patent to assess the extent to which later inventions in a variety of technology fields have benefited from the patent. It gives an indication of how important a patent is for subsequent developments and in how wide an array of technology fields.

The scope of a patent, i.e. the number of distinct International Patent Classification (IPC) classes a patent is registered in, is associated with an invention's technological and economic value and relates positively to the valuation of the firm and to a patent's importance for later inventions.

Breakthrough inventions are high-impact innovations, i.e. highly cited patents. They are associated with entrepreneurial strategies and further technological developments.

The differences observed in the value of patents filed at the United States Patent and Trademark Office (USPTO) and at the European Patent Office (EPO) are likely to reflect differences in the type, nature and number of patents applied for at the two offices, as well as differences in the practices and regulations of these patent authorities, and possible home biases. The number and distribution of breakthrough inventions also differs between EPO and USPTO patents. For instance, the United States own 1% of breakthrough inventions filed at USPTO, and less than 0.2% of those filed at EPO.

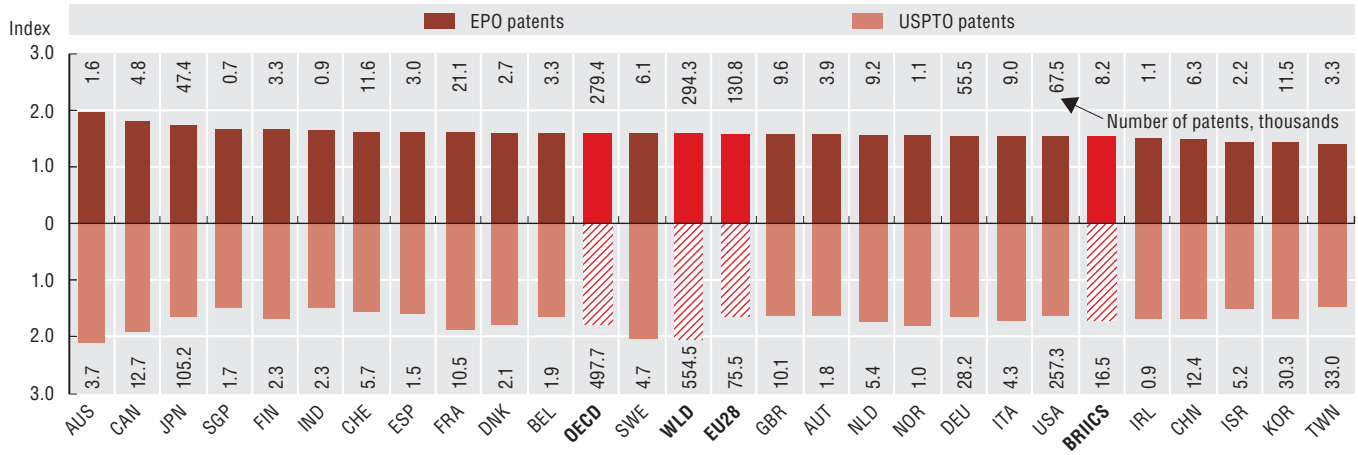
Definitions

The generality index relies on information about the number and distribution of citations received (forward citations) and the IPC classes of the patents these citations come from. All IPC classes in the citing patents are considered. The indicator accounts for the distribution of both 4-digit and *n*-digit IPC classes in citing patents, where *n* is the highest level of disaggregation possible. See Squicciarini, Dernis and Criscuolo (2013) for a formal definition.

The scope indicator is based on Lerner (1994) and corresponds to the number of IPC classes to which a patent is assigned. Breakthrough inventions are defined following Ahuja and Lampert (2001) as the top 1% of cited patents in each technology field and year cohort. Technology fields are defined according to the classification of Schmoch (WIPO, 2008, revised in 2013) and rely on the IPC codes of the patent document. Patent indexes are built by normalising patent-specific values over the maximum value of any patent in the same cohort.

Scope of patent applications, 2009-11

Average number of IPC classes per patent application to the EPO and to the USPTO

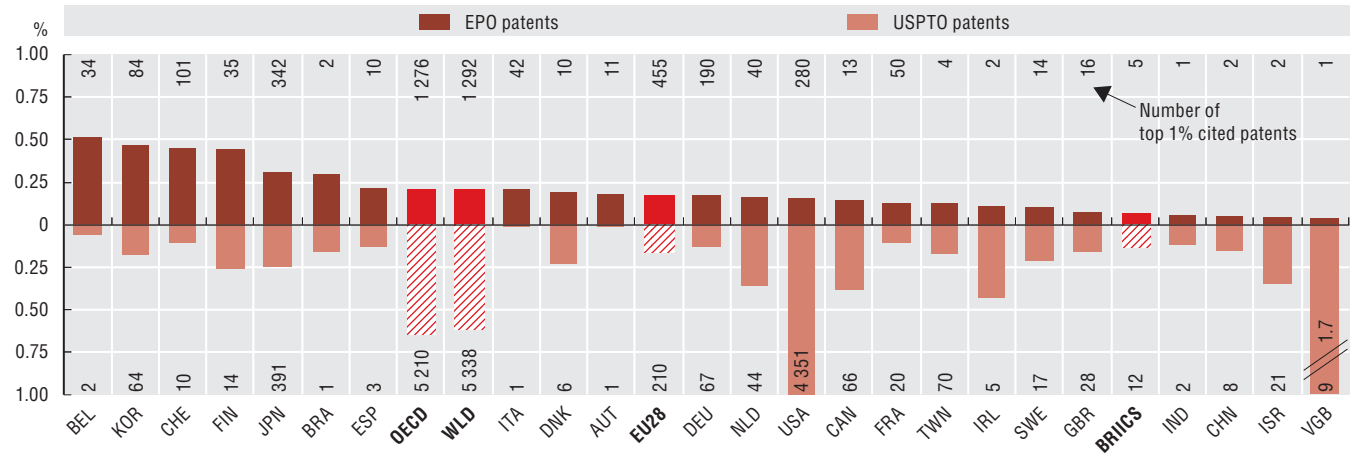


Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893563

Highly cited patent applications, 2002-06

Top 1% of cited patent applications, as a share of total EPO and USPTO patents



Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893582

Measurability

The generality measure is high when a patent is cited by subsequent patents belonging to a wide range of fields, i.e. the patented invention is relevant for a number of later inventions, not only in its own technology class. If most citations are concentrated in a few fields the generality index is low and close to zero (see Squicciarini, Dernis and Criscuolo, 2013). Citations are consolidated and take patent equivalents into account. Forward citations cover all categories of citations and relate to a 5-year citation window after publication. The top 1% of cited patents is identified for cohorts defined by filing date and technology field. Patents belonging to more than one technology field are assigned to the field accounting for the majority of its 4-digit IPC subclasses. Indicators based on data from different patent authorities are built and shown separately. As different intellectual property offices comply with different legislations and administrative regulations, their practices differ, e.g. in their propensity to cite prior art or to assign patents to different technology fields. This hinders the comparability of the proposed measures.

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 recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'."

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

"The Republic of Cyprus is 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. Industry specialisation

General notes for all figures:

The sectors considered cover the following ISIC Rev.4 activities 01-03 (Agriculture, forestry and fishing), 05-09 (Mining and quarrying), 10-12 (Food products, beverages and tobacco), 13-15 (Textiles, wearing apparel, leather and related products), 16-18 (Wood and paper products, and printing), 19-23 (Chemical, rubber, plastics, fuel products and other non-metallic mineral products), 24-25 (Basic metals and fabricated metal products, except machinery and equipment), 26-28 (Machinery and equipment), 29-30 (Transport equipment), 31-33 (Furniture; other manufacturing; repair and installation of machinery and equipment), 35 (Electricity, gas, steam and air conditioning supply), 36-39 (Water supply; sewerage, waste management and remediation activities), 41-43 (Construction), 45-47 (Wholesale and retail trade, repair of motor vehicles and motorcycles), 49-53 (Transportation and storage), 55-56 (Accommodation and food service activities), 58-63 (Information and communication), 64-66 (Financial and insurance activities), 69-75 (Professional, scientific and technical activities), 77-82 (Administrative and support service activities).

Industrial specialisation, 2000 and 2010

The HK index is specified as:

$$HK(\theta) = \left(\sum_{i=1}^{N} s_i^{\theta}\right)^{1/(1-\theta)}$$

where s_i is the relative output of the i^{th}sector, N the total number of sectors in an economy, and θ measures the extent to which the index is influenced by large sectors. The HK(2) is calculated for a value of θ (theta) equal to 2, value for which it corresponds to the inverse of the Herfindahl Index.

Information for Australia, Canada, Japan and New Zealand refer to 2009.

General notes:

Value added of the top four economic activities, 2008-10 and;

Employment of the top four economic activities, 2008-10

The sector concentration ratio index shown is analogous to the K-firm concentration ratio and is defined as the cumulative share of the Kth sector, where s_i is the relative output of the ith sector. CR(4) is calculated for a value of K equal to 4.

$$CRK = \sum_{i=1}^{K} s_i$$

The denominator "total value added" excludes Real estate activities (ISIC Rev.4, Section L, Division 68) and Community, social and personal services (Divisions 84-99).

Information for Australia, Canada, Japan and New Zealand is based on the average value of 2008 and 2009 only.

Additional notes:

Value added of the top four economic activities, 2008-10

The colour palette on the figure is reduced to highlight the two industries with the largest value added shares in each country. The shades of grey correspond to the shares (in descending intensity) of each country's other two main industries, in terms of value added.

6.2. ICT industry specialisation

Information industries in OECD economies, 2000 and 2011

For Germany, Poland, Portugal, Switzerland and the United Kingdom, data refer to 2010.

For Canada, data refer to 2009.

For Japan, data refer to 2008.

Unweighted means exclude Canada.

Global trade in ICT goods and top ten exporters, 2000 and 2011

China and World data are computed net of China's re-imports and Hong Kong, China re-exports. Gross of these components, world exports of ICT products totalled USD 985 billion in 2000 and USD 1 813 billion in 2011, while China's exports totalled USD 44 billion in 2000 and USD 508 billion in 2011, with no substantial change in its shares. Netting for the flows of goods mediated by Hong Kong, China, and for Chinese re-imports removes two key intertwined elements of distortion in ICT trade statistics. Indeed, re-exports sum up to 99% of Hong Kong, China, exports of ICT goods, while China extensively uses East Asian logistics hubs (including Hong Kong, China) for internal trade. Estimates do not consider similar flows for other countries owing to a lack of exhaustive data.

OECD and major exporters of ICT services, 2000 and 2012

For Canada, Finland, Iceland, Israel, Mexico, Norway, Slovenia, Turkey and the United States, data refer to 2011 instead of 2012.

For Luxembourg and Kuwait, data refer to 2002 instead of 2000.

For Denmark, data refer to 2004 instead of 2000.

For Mexico and Kuwait, exports of computer and information services are not included.

6.3. Export structures

Top 20 exporting economies of primary and manufactured goods by end-use category, 1995 and 2011

Primary goods are defined as those coming from the following ISIC Rev.4 activities: Agriculture, hunting, forestry (01-03) and Mining and quarrying (05-09); Manufactured goods come from the Manufacturing sector (10-33). Exports of Electricity, gas and water (35) and identifiable scrap metal and waste products are not included in this analysis. Products that cannot be allocated to an industry due to confidentiality, or other reasons, are excluded too. On average, in OECD and BRIICS countries, exports of primary and manufactured goods (01-33) represented about 96% of total reported trade in goods in 2011.

Total final goods include the following final demand end-use categories: consumption goods, capital goods and certain mixed end-use goods such as personal computers, personal telephones (including smart phones), passenger cars, precious goods (such as diamonds) and packed medicines. Reported exports that can be allocated to an industry but not to an end-use category are also included. Note that Packed medicines is considered a mixed end-use category as they can be final goods for households or intermediate goods for medical centres.

Exports include re-exports (i.e. imported goods which are subsequently exported with no further transformation). Many countries re-export but few report these flows by commodities. Since, the share of re-exports may vary across countries and products and over time, care should be taken when interpreting this chart. For example, in 2011 about 96% of Hong Kong, China's exports were re-exports to and originating from mainland China, up from 83% in 2005. If re-exports were excluded, Hong Kong, China would not feature in the top 20. Other countries with significant re-exports include Singapore, Belgium, the

Netherlands and Germany, countries that are major regional hubs for goods transported by sea. Including re-exports shows countries with a significant role in international trade who may not necessarily be major producers of goods.

Top four exporting industries by country, 2011

The colour palette on the figure is reduced to highlight the sector with the largest export share in each country. The shades of grey correspond to the shares (in descending intensity) of each country's other three main exporting industries.

The top four industries are chosen from the following ISIC Rev.4 activities: 01-03 (Agriculture, forestry and fishing); 05-09 (Mining and quarrying); 10-12 (Food products, beverages and tobacco); 13-15 (Textiles, wearing apparel, leather and related products); 16-18 (Wood, paper products and printing); 19 (Coke and refined petroleum products); 20 (Chemicals); 21 (Pharmaceuticals); 22-23 (Rubber, plastics and other non-metallic mineral products); 24 (Basic metals); 25 (Fabricated metal products, except machinery and equipment); 26 (Computers, electronic and optical products); 27 (Electrical equipment); 28 (Machinery and equipment); 29 (Motor vehicles, trailers and semi-trailers); 30 (Transport equipment); 31-33 (Furniture; other manufacturing).

Top three exporting services by country, 2011

Countries are divided into two groups, according to whether the share of services in goods and services exports is above or below the world average (about 19.1%). Within each group, they are ranked according to the sum of the percentage shares of the three largest services export categories.

6.4. R&D specialisation

Business R&D intensity adjusted for industrial structure, 2011

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 2011 – as common weights across all countries. The unadjusted measure of BERD intensity is by definition an average based on each country's actual sector shares.

For Denmark, France, Germany, Italy, Poland, Portugal, Slovenia, Spain and the United Kingdom, data refer to 2010.

For Australia, Austria, Belgium, Sweden and the United States, data refer to 2009.

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.

Value added is measured at basic prices except for Japan and the United States (market prices).

Based on estimates of business R&D by sector reported on a main activity basis.

Business R&D in manufacturing, by technology intensity, 2011

High- and medium-high-technology manufacturing includes: Chemicals and chemical products (ISIC Rev.4 20 and 21); Electrical and optical equipment (ISIC Rev.4 26 and 27); Manufacture of machinery and equipment n.e.c. (ISIC Rev.4 28); and Transport equipment (ISIC Rev.4 29 and 30). Low- and medium-low-technology manufacturing includes all other manufacturing industries.

Based on estimates of business R&D by sector reported on a main activity basis, with the exception of the Russian Federation (product basis).

For Australia, Denmark, France, Israel, Italy, Portugal, Spain, the United Kingdom and the United States, data refer to 2010.

For Austria, Belgium, Iceland, the Russian Federation and Sweden, data refer to 2009.

For Chile and Switzerland, data refer to 2008.

For Estonia, the high share of low- and medium-low-technology manufacturing in 2011 is due to an important investment in new technology in the oil industry (ISIC Rev.4 19).

Share of services in business R&D, 2001 and 2011

Figure are based on estimates of business R&D by sector reported on a main activity basis, with the exception of the Russian Federation (product basis).

For Australia, Chile, Denmark, France, Italy, Portugal, Spain and the United Kingdom, data refer to 2010 instead of 2011.

For Austria, Belgium, Iceland, the Russian Federation, South Africa and Sweden, data refer to 2009 instead of 2011.

For China, data refer to 2000 instead of 2001.

For Slovenia, data refer to 2003 instead of 2001.

For Switzerland, data refer to 2000 and 2008 instead of 2001 and 2011.

For the United States, data refer to 2004 and 2010 instead of 2001 and 2011.

For Denmark, Norway and Poland, data for 2001 are not reported because of significant breaks in series.

6.5. Technological advantage

Change in revealed technological advantage in biotechnology and nanotechnology, 1998-2000 and 2008-10

Biotechnology and nanotechnology patents are defined on the basis of their International Patent Classification (IPC) codes or European Classification System (ECLA) codes.

Only the top 20 economies with more than 500 biotechnology or nanotechnology patents in 2008-10 are included.

Change in revealed technological advantage in ICT, 1998-2000 and 2008-10

ICT-related patents are defined on the basis of their International Patent Classification (IPC) codes.

Only economies with more than 500 ICT patents in 2008-10 are included.

Countries' range of revealed technological advantage by field, 2008-10

Patents are allocated to technology fields on the basis of their International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised in 2013).

Only countries with more than 1 000 patents in 2008-10 are included.

6.6. Trade competitiveness

Top ten exporting economies in gross and value added terms, 2009

The major activity groups are defined according to the 18 ISIC Rev.3 categories in the TiVA database: Primary products (Divisions 01-05, 10-14, i.e. agriculture and mining); Machinery and equipment and transport equipment (29, 30-33, 34-35: a proxy for high- and medium-high-technology manufactures); Other manufacturing (15-16, 17-19, 20-22, 23-26, 27-28, 36-37: a proxy for low- and medium-low-technology manufactures); Trade, transport and communications (50-55, 60-64); Finance and business services (65-67,70-74); and Other activities (40-41, 45 and 75-99, i.e. utilities, construction and public services).

Revealed comparative advantage in exports of computers, electronic and optical products, 2009

Computers, electronic and optical equipment refers to the ISIC Rev.3 Divisions 30-33.

Revealed comparative advantage in exports of machinery and equipment, 2009

Machinery and equipment corresponds to the ISIC Rev.3 Division 29.

6.7. E-business uptake

General notes for all figures:

Except otherwise stated, the sector coverage consists of all activities in manufacturing and non-financial market services. Only enterprises with 10 or more persons employed are considered. Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249), large (250 and more).

Additional notes:

Enterprises selling on line, by size, 2009 and 2012 and;

Turnover from e-commerce, by enterprise size, 2012

For Australia, data refer to the fiscal year ending 30 June 2011 (2010/11) instead of 2012. Total includes Agriculture, forestry and fishing.

For Mexico, data refer to 2008 instead of 2012 and to businesses with 20 or more persons employed.

Enterprises selling on line, by size, 2009 and 2012

For Canada, data refer to 2007 instead of 2009. Medium-sized enterprises have 50-299 employees. Large enterprises have 300 or more employees.

For Korea, Japan and Switzerland, data refer to 2011 instead of 2012.

For Japan, data refer to businesses with 100 or more employees. Medium-sized enterprises have 100-299 employees. Large enterprises have 300 or more employees.

For Mexico, data refer to 2008 instead of 2009 and to businesses with 20 or more persons employed.

For Switzerland, data refer to 2008 instead of 2009. In 2008, data refer to businesses with five or more persons employed.

For Turkey, data refer to 2010 instead of 2012.

Turnover from e-commerce, by enterprise size, 2012

For Denmark and Germany, data refer to 2010.

For Finland, Luxembourg, Mexico, Poland, Slovenia and the United States, data are not available by firm size.

For the United States, data are drawn from the Bureau of the Census. Includes Manufacturing, Merchant wholesale, Retail and Selected services. Selected services includes NAICS 22 (Utilities), NAICS 48-49 (Transportation and warehousing), NAICS 51 (Information), NAICS 52 (Finance and insurance), NAICS 53 (Real estate and rental and leasing), NAICS 54 (Selected professional, scientific and technical services), NAICS 56 (Administrative and support and waste management and remediation services), NAICS 61 (Educational services), NAICS 62 (Health care and social assistance), NAICS 71 (Arts, entertainment and recreation), NAICS 72 (Accommodation and food services), and NAICS 81 (Other services, except public administration).

Enterprises using enterprise resource planning software for internal information sharing, by size, 2012

For Canada, medium-sized enterprises have 50-299 employees. Large enterprises have 300 or more employees.

For Switzerland, data refer to 2011.

6.8. Young innovative firms

General notes for all figures:

Patenting firms were linked to the ORBIS© database, using combinations of string matching algorithms that maximise the precision of the match. The patent portfolio of firms refers to families of patents applied for at the European Patent Office (EPO), at the United States Patent and Trademark Office (USPTO) or using the Patent Cooperation Treaty (PCT) between 2009 and 2011. Only countries with matching rates above 80% of patent filings over 2000-11 are included.

Patenting activity by sector, 2009-11 and;

Patenting activity of young firms by sector, 2009-11

High and medium-high-technology manufactures cover sectors 20, 21, 26, 27, 28 and 29-30; low and medium-low-technology manufactures include 10-12, 13-15, 16-18, 19, 22-23, 24-25 and 31-33; business-sector services, excluding real estate, refer to 45-47, 49-53, 55-56, 58-63, 64-66, 69-82; other sectors comprise 01-03, 05-09, 35, 36-39, 41-43, 68, 84-88, 90-99.

Top three industries patenting in selected technology fields, 2009-11

Patents in biotechnologies, nanotechnologies, pharmaceuticals and ICT-related technologies are based on a selection of International Patent Classification (IPC) classes.

Patents in environment-related technologies are defined using combinations of IPC classes and codes Y02 of the European Classification (ECLA).

Patenting activity of young firms by sector, 2009-11

For Japan, the average number of young patenting firms is overestimated as it includes affiliates of large conglomerates with a recent date of incorporation registered in the ORBIS© database.

6.9. Technological strengths

General note for all figures:

Data refer to patent applications filed at the European Patent Office (EPO) and the US Patent and Trademark Office (USPTO), by filing date and applicant's residence. Only economies with more than 500 patents at the EPO and at the USPTO in 2009-11, or, in the case of the patent generality index, only economies with more than 100 EPO patents and 500 USPTO patents that received forward citations up to five years after publication, are included.

Additional notes:

The relevance of patents for later inventions, 2002-06

The patent generality index is a modified version of a market concentration index, the Hirschman-Herfindahl Index (HHI), which relies on the number and distribution of citations received (forward citations) and the technology classes (International Patent Classification, IPC) of the patents these citations come from.

Scope of patent applications, 2009-11

The scope of a patent application is calculated as the number of distinct International Patent Classification (IPC) subclasses (i.e. 4-digit IPC codes) the application is assigned to by the patent office.

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7. PARTICIPATING IN THE GLOBAL ECONOMY

1. Employment
2. Services-manufacturing linkages
3. Firm size
4. Firm dynamics
5. Foreign affiliates
6. Trade and global value chains
7. Global demand
8. Trade and jobs
9. Trade and household consumption

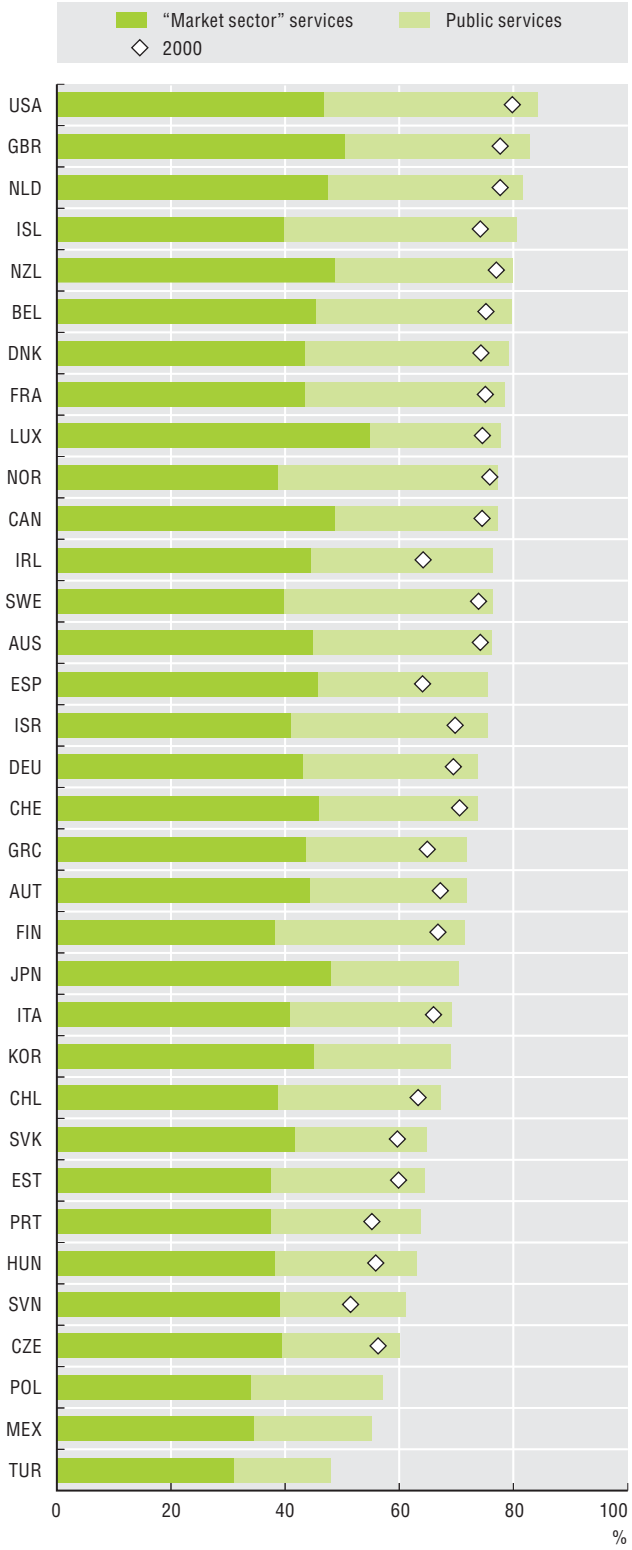
Notes and References

The international fragmentation of production is driven by changes in the business and regulatory environment, new technologies, shifts in corporate thinking and firm strategies, and the systematic liberalisation of trade and investment over the past two decades. The extent to which economies integrate and specialise in the world economy 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 explain countries' participation in global value chains. Novel indicators building on the OECD-WTO 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.

1. Employment

Employment in services, 2000 and 2011

As a percentage of total employment



Source: OECD, National Accounts (SNA) Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904070

The share of employment in service activities has continued to rise steadily. The recent crisis, which hit manufacturing and construction particularly hard, has reinforced this long-term trend. By 2011, the share of employment in services in OECD countries averaged about 74%, ranging from 48% in Turkey to 84% in the United States. Between 2000 and 2011, shares of employment in services increased by over 15% in Ireland, Portugal, Slovenia and Spain. On average in 2011, public services accounted for about 40% of OECD-area employment in services, ranging from 29% in Luxembourg to 51% in Iceland.

Knowledge-intensive market services are significant users of high technology (e.g. ICT capital) and/or have a relatively highly skilled workforce able to meet the demands of modern, highly competitive business environments. Their share of employment has increased in most OECD countries since 2000; by 2011, they accounted on average for 12% of total employment. The increase was mainly driven by professional, scientific and technical activities, which account for about half of employment in these services. ICT services account for only about 3% of total employment in OECD countries.

In contrast, the share of employment in high- and medium-high-technology manufacturing has continued to decline in many OECD countries, partly as a result of increased international sourcing of manufactured products, particularly from non-OECD countries, and active offshoring by multinationals. Exceptions include countries such as the Czech Republic, Estonia, Hungary, Poland and the Slovak Republic which have increased their presence in EU manufacturing value chains. Employment in high- and medium-high-technology manufacturing fell significantly over 2000-11 in the United Kingdom (-42%), Spain (-39%) and the United States (-31%).

Definitions

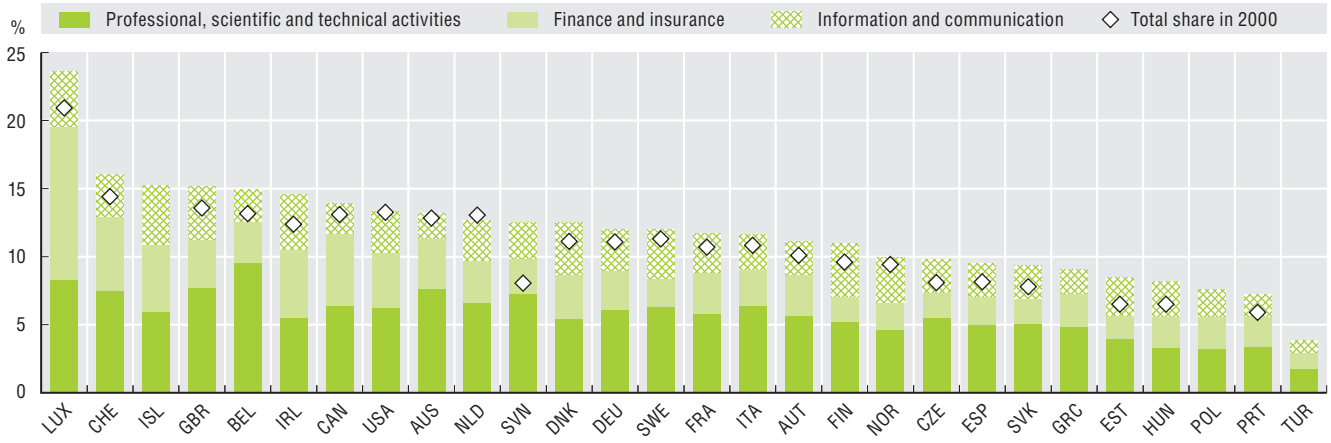
Market sector services correspond to ISIC Rev.4 Divisions 45-82. *Public sector services* encompass ISIC Rev.4 Divisions 84-98, i.e. Government (84), Education (85), Health (86-88), Other community, social and personal services (90-96), and Private households (97-98).

Knowledge-intensive "market" services refer to ISIC Rev.4 Section J: Information and communication (Divisions 58-63); K: Finance and insurance (64-66); and M: Professional, scientific and technical activities (69-75).

High- and medium-high-technology manufacturing is defined in ISIC Rev.4 as Chemicals and chemical products (Division 20), Pharmaceutical products (21), Computer, electronic and optical products (26), Electrical equipment (27), Machinery and equipment n.e.c. (28), Motor vehicles (29) and Other transport equipment (30).

Employment in knowledge-intensive "market" services, 2000 and 2011

As a percentage of total employment

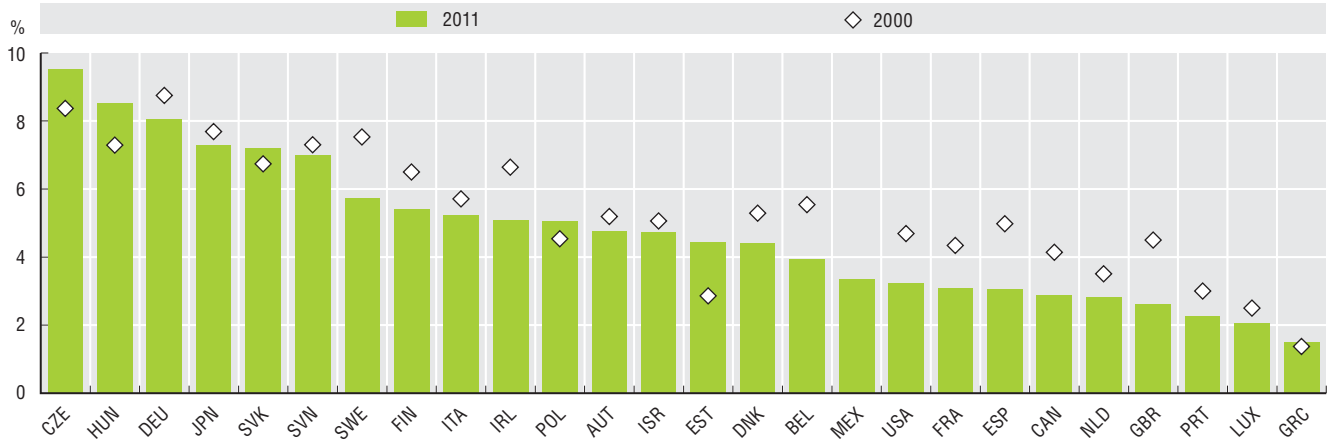


Source: OECD, Structural Analysis (STAN) Database, ISIC Rev.4, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904089

Employment in high- and medium-high-technology manufacturing, 2000 and 2011

As a percentage of total employment



Source: OECD, Structural Analysis (STAN) Database, ISIC Rev.4, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904108

Measurability

On an industry-based definition, the distinction between market and public services is only approximate, as some services can be provided by public or private entities, or by a mix of the two. For example, in OECD countries, private education and health services are available to varying degrees while in some countries, transport and postal services remain in the public realm.

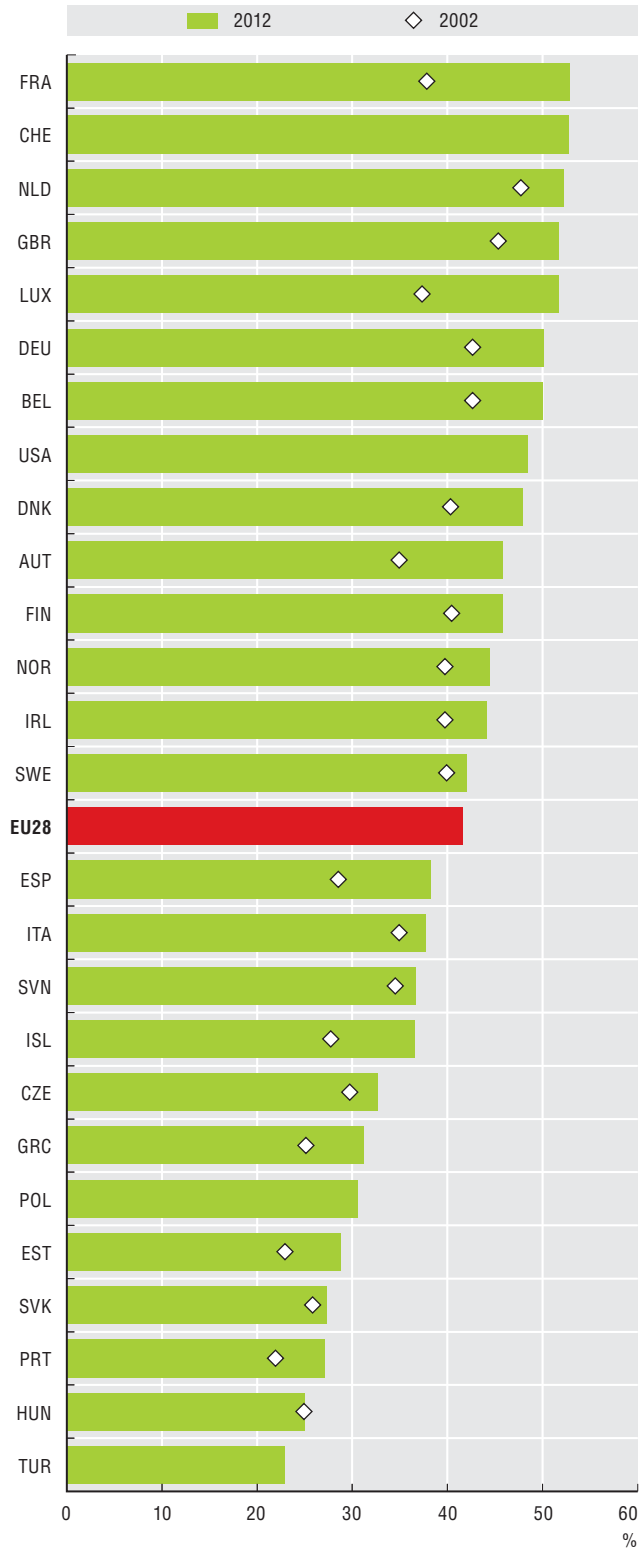
Recent employment statistics compiled according to ISIC Rev.4 (NACE Rev.2) are used here. High- and medium-high-technology manufacturing is usually defined on the basis of industry R&D intensity, i.e. R&D expenditures relative to output. However, as ISIC Rev.4 data availability is currently insufficient, an approximate correspondence from the ISIC Rev.3 definition has been adopted.

For services, alternative measures, beyond R&D expenditure, have been used to determine the preliminary ISIC Rev.4 definition of knowledge-intensive market services applied here. These include the skill composition of the workforce and, indicators of innovation intensity based on data coming from innovation surveys.

2. Services-manufacturing linkages

Services-related occupations in manufacturing, 2002 and 2012

As a percentage of total employment in manufacturing



Source: OECD calculations based on EU Labour Force Survey and US Current Population Survey, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904127

Manufacturing production in many OECD countries has declined in recent decades so that, on average, services now account for about 70% of OECD GDP. In France, the United Kingdom and the United States, manufacturing accounts for only 10%, or lower, of total employment. In addition to the general decline, the scope and nature of manufacturing has changed in many OECD countries and now relies more on service occupations and inputs. This is due to the greater use of technology in production, the international sourcing of manufactured goods and a range of social factors (such as the changing skills of populations). Two indicators presented here provide insights into the interdependence of services and manufacturing industries.

Data on occupations show a steady increase over the last decade in the share of workers in manufacturing employed in occupations that can be considered services-related, such as managers, accountants, lawyers and IT professionals. In 2012, the share in Europe had reached about 41% (up from 35% in 2002) and varied between 25% and 53% across countries.

Estimates from the new OECD-WTO Trade in Value Added (TiVA) database reveal the amount of value added derived from services embodied in the exports of manufactured goods. In 2009, the services content embodied in manufactured exports varied between 25% and 40% across OECD countries, and between 1995 and 2009, it rose significantly in most countries. For many this was mainly due to increases in embodied foreign services. The sectors Wholesale and retail trade, hotels and restaurants and Business services account for the bulk of services embodied in manufacturing; business services posted the greatest increases between 1995 and 2009.

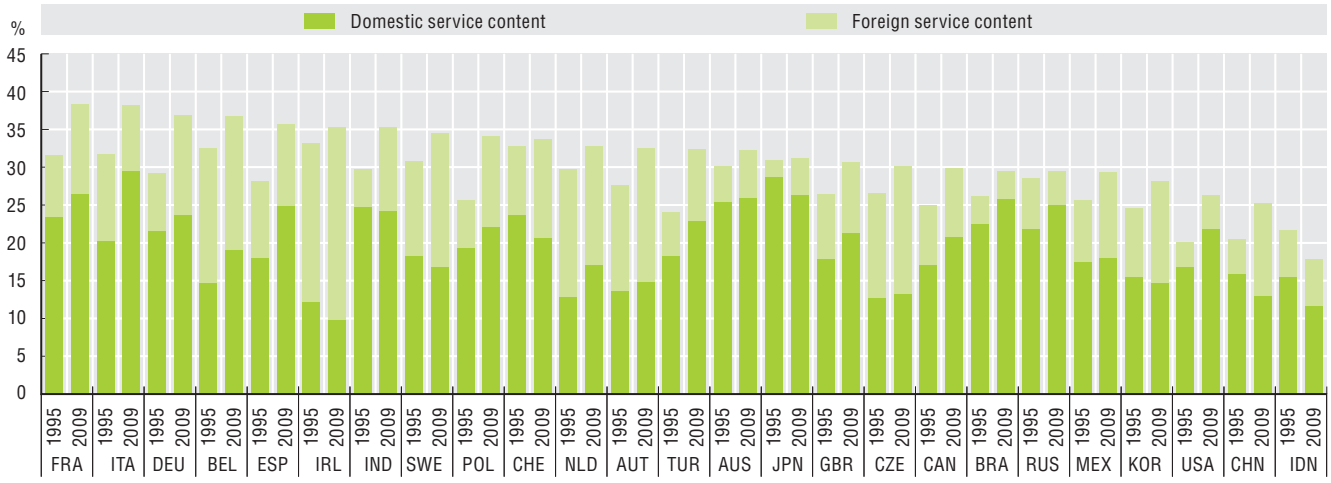
Definitions

Services-related occupations correspond to ISCO-08 (2002: ISCO-88) major groups 1, Legislators, Senior officials and Managers; 2, Professionals; 3, Technicians and Associate professionals, 4, Clerks; and 5, Service workers and shop and market sales workers. Manufacturing refers to ISIC Rev.4 (NACE Rev.2) Divisions 10 to 33 (2002: ISIC Rev.3/NACE Rev.1 Divisions 15 to 37).

For services content of exports, sectors of economic activity are defined according to ISIC Rev.3: Manufactures: Divisions 15-37; Construction: 45; Wholesale and retail trade, hotels and restaurants: 50-55; Transport and storage, post and telecommunications: 60-64; Financial intermediation: 65-67; Business services: 70-74; and Other services: 75-99.

Services content of manufactured exports, domestic and foreign, 1995 and 2009

As a percentage of total manufactured exports



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013. StatLink contains more data.

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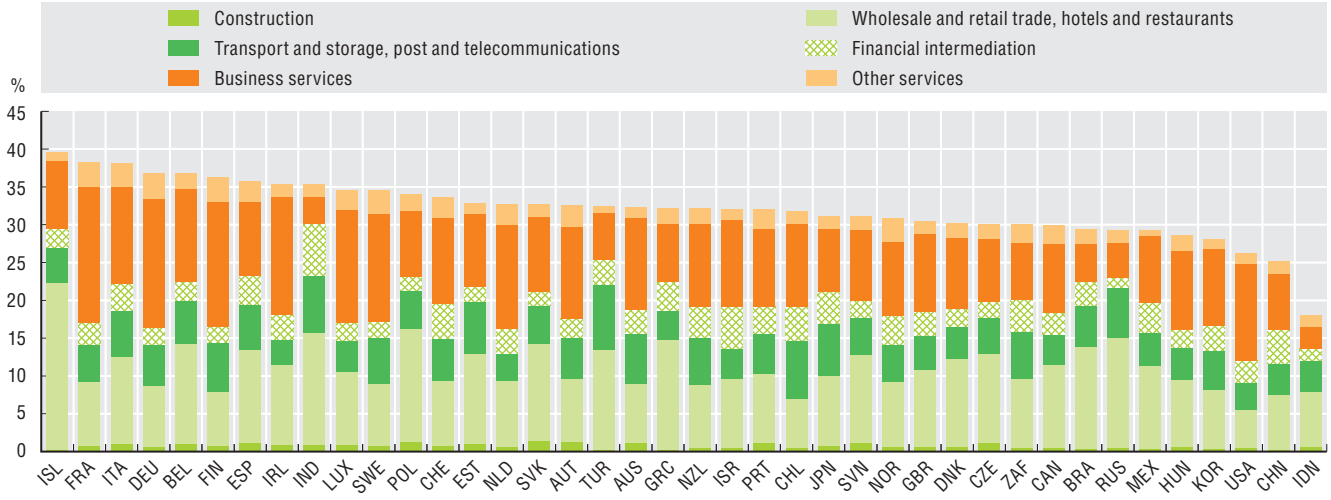
Services content of manufactured exports by type of service, 2009

As a percentage of total manufactured exports



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013. StatLink contains more data.

StatLink *http://dx.doi.org/10.1787/888932904165*

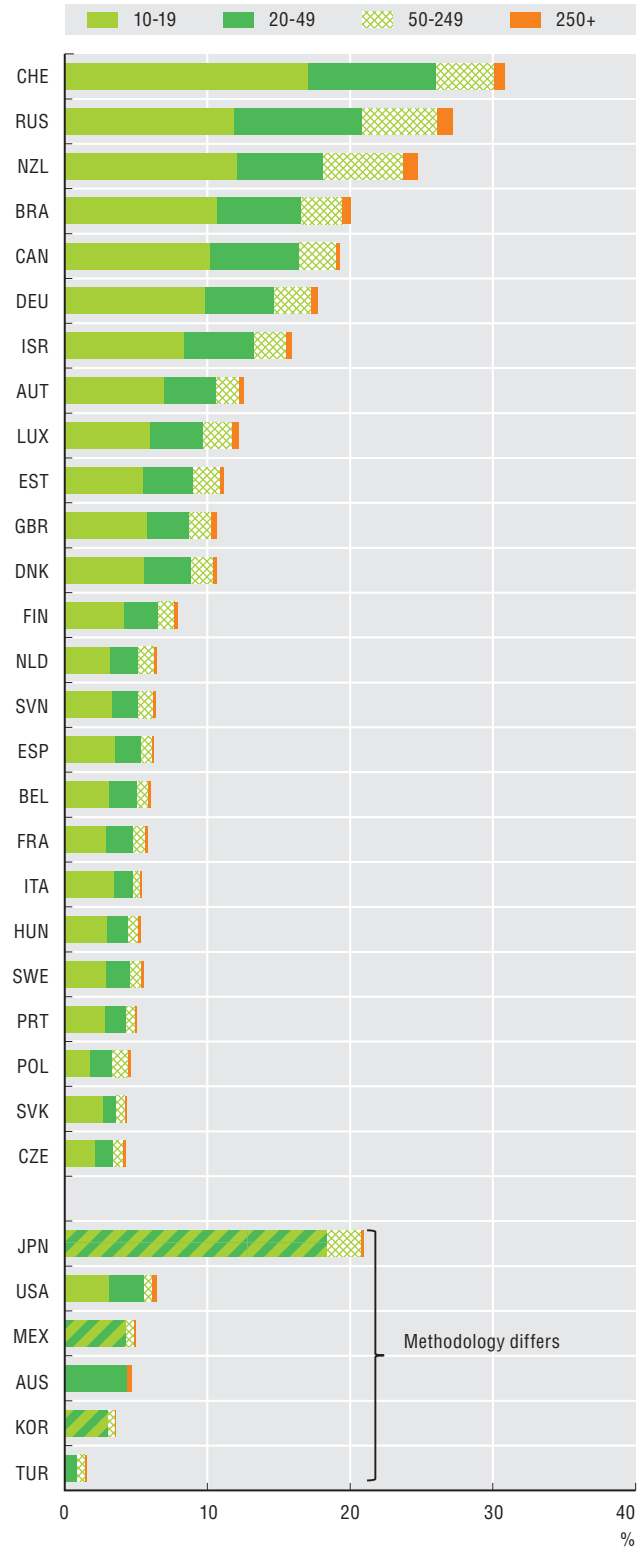
Measurability

The indicators of service content of manufacturing exports are based on the global input-output system developed by the OECD, the Inter-Country Input-Output (ICIO) Database. This data set describes interactions between industries and consumers for 58 economies, 37 industries and 95% of global output. ICIO is very useful for policy analysis and aims at better reflecting: *a)* the significant contribution made by services in global value chains; *b)* the important role of imports for export performance; *c)* the true nature of economic interdependencies as reflected in bilateral trade balances in value added terms; *d)* the role of emerging economies in global value chains; and *e)* the impact of supply and demand shocks on downstream and upstream production.

3. Firm size

Number of enterprises by size class, 2010

As a percentage of all enterprises



Source: OECD (2013), *Entrepreneurship at a Glance 2013*, OECD Publishing. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904184

Business dynamics have a significant impact on an economy's overall productivity growth. This in turn affects a country's ability to compete globally. While small businesses are important drivers of growth and innovation, larger businesses typically have competitive advantages owing to economies of scale, cheaper credit and direct access to global value chains. Measures of enterprise, employment and value added broken down by size class can provide valuable insights into structural factors that drive growth, employment and entrepreneurship. Understanding countries' characteristics in terms of firm size is important for developing a policy framework able to stimulate innovation and growth through appropriate labour market regulation, bankruptcy legislation or R&D support policies.

In all countries, most businesses are micro-enterprises. In half of OECD countries, these account on average for more than 90% of all enterprises.

Countries vary significantly in terms of the distribution of employment among enterprises of different sizes. In Greece, Italy, Mexico, Portugal and Spain more than 40% of enterprises have fewer than ten persons employed, while the share is less than 20% in Germany, New Zealand, Switzerland and the United Kingdom.

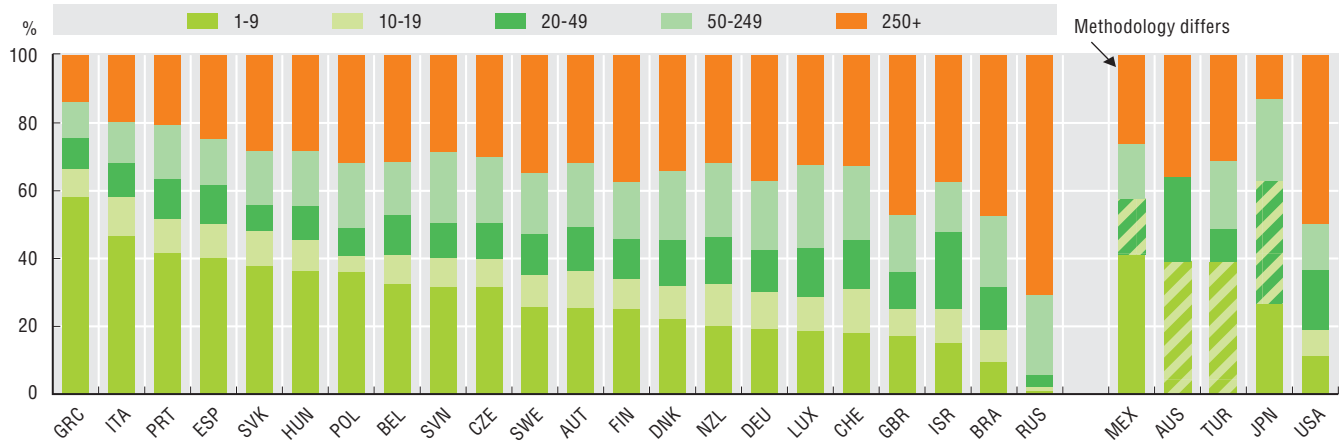
In most countries, enterprises with more than 250 persons employed account for an average of 42% of the value added of the business sector, although they represent less than 2% of businesses. The share of value added created by large enterprises varies significantly from more than 50% in Brazil, Japan, Korea and the United Kingdom to approximately 25% in Greece.

Definitions

Micro enterprises are firms with fewer than ten persons employed. An enterprise is defined as the smallest combination of legal units that is an organisational unit producing goods or services and benefits from a certain degree of autonomy in decision making, especially for the allocation of current resources. An enterprise carries out one or more activities at one or more locations. The basis for size classification is the *total number of persons employed*, which includes the self-employed. The *number of persons employed* includes all persons who worked for the concerned unit during the reference year. *Value added* corresponds to the difference between production and intermediate consumption, where total intermediate consumption is valued at purchaser prices. Depending on the valuation of production and on the treatment applied to indirect taxes and subsidies of production, the valuation of value added is either at basic prices, producers' prices or factor costs.

Employment by enterprise by size class, 2010

As a percentage of total employment

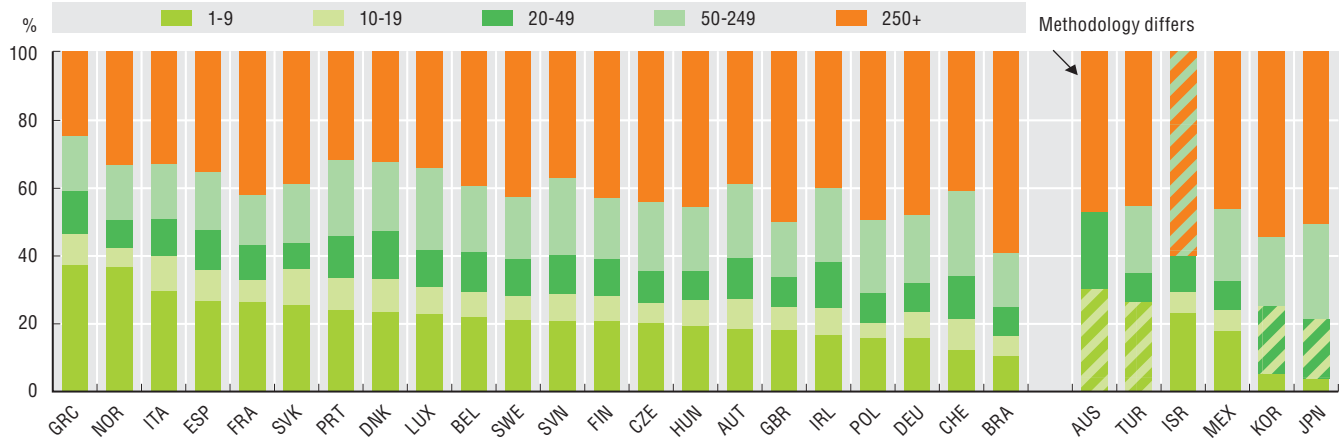


Source: OECD (2013), *Entrepreneurship at a Glance 2013*, OECD Publishing. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904203

Value added by enterprise by size class, 2010

As a percentage of total value added



Source: OECD (2013), *Entrepreneurship at a Glance 2013*, OECD Publishing. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904222

Measurability

For most countries, the main sources of information used to compile the OECD Structural and Business Demography Statistics (SDBS) are economic censuses, business surveys and business registers. In spite of the goal of full coverage of existing businesses in a given country, countries differ in terms of coverage of business registers owing to national circumstances and data availability.

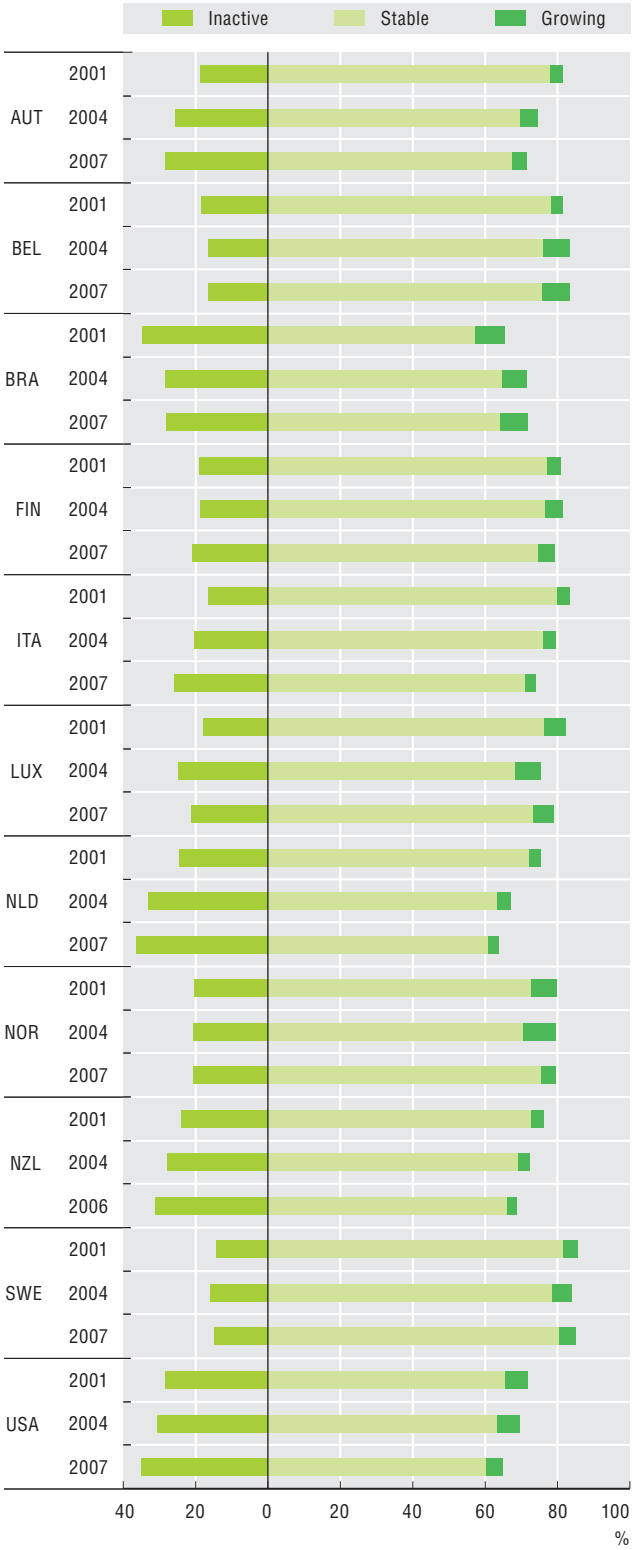
The Business Size Class (BSC) Dataset is a part of SDBS and provides information by enterprise size class. To improve data harmonisation and enable country comparisons, the BSC focuses on five size classes for which the data across countries and variables can be most closely aligned. Countries with a different size class breakdown are shown separately in the figures.

The SDBS, in combination with the BSC, provides an input to the OECD Entrepreneurship Indicators Programme (EIP).

4. Firm dynamics

Three-year survival and growth performance of micro start-ups, 2001-04, 2004-07, 2007-10

Firms with fewer than 10 employees and less than 3 years old, non-financial business sector



Source: OECD calculations based on the OECD DYNEMP data collection, July 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904241

Young firms are generally characterised by an up-or-out dynamics. A significant share of start-ups does not survive beyond the first two years, but those that do contribute more than proportionally to job creation than old businesses. On average across 12 countries over 2001-10, the probability of micro start-up exit is 8 percentage points higher than for businesses more than 10 years old of the same size; however, they contribute 10 points more to gross job creation.

Throughout the periods and economies considered, at least 60% of start-ups remain micro-firms after three years. On average across countries and cohorts, some 5% of micro start-ups grow, but their contribution to net job creation amounts to 24% of initial employment of all micro start-ups. The data collected do not allow for quantifying how much growth is due to mergers and acquisitions. Almost everywhere, the 2008 crisis seemingly triggered an increase in the share of start-ups that became inactive at the end of the three-year period. This is not true for the share of start-ups that grow: while growing start-ups account for 3-9% of these firms, the crisis years are not necessarily those in which the share of growing firms is smaller, nor those in which they contribute less to net job creation.

When comparing the average size of firms in different age classes across economies at a given point in time, it appears that while two year-old firms have on average no more than 15 employees, the size of old businesses differs widely, with US firms almost five times larger than those in Italy.

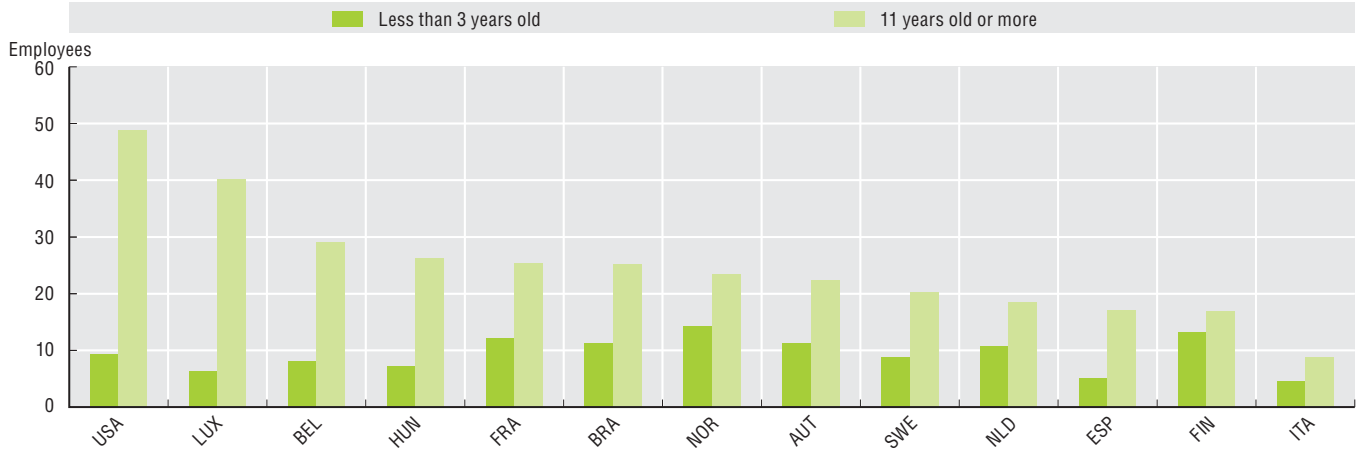
In all economies considered, the initial size of start-ups is on average larger in manufacturing than in services. However, the difference in size between 11 year-old and 3 year-old businesses is much smaller in services than in manufacturing. Economies in which manufacturing firms are born relatively large on average, e.g. Norway, Japan and Finland, are not those in which old firms are the largest. This may reflect differences in industrial composition, market size and framework conditions.

Definitions

Micro start-ups are less than three years old, with fewer than ten employees at the beginning of the observation period. A firm's *survival* refers to its existence at the end of the period considered. *Inactive firms* are those for which no employment information is available at the end of the observation period. *Stable firms* remain in the same size class at the end of three years. *Micro-firms* still have fewer than ten employees. *Growing firms* increase the number of their employees during the three-year period and are in size classes larger than the initial one at the end of the period. *Old firms* are 11 years old or more.

Average size of firms less than 3 years old and 11 years old or more, 2001-10

Non-financial business sector, reference cohorts 2001, 2004 and 2007



Source: OECD calculations based on the OECD DYNEMP data collection, July 2013. See chapter notes.

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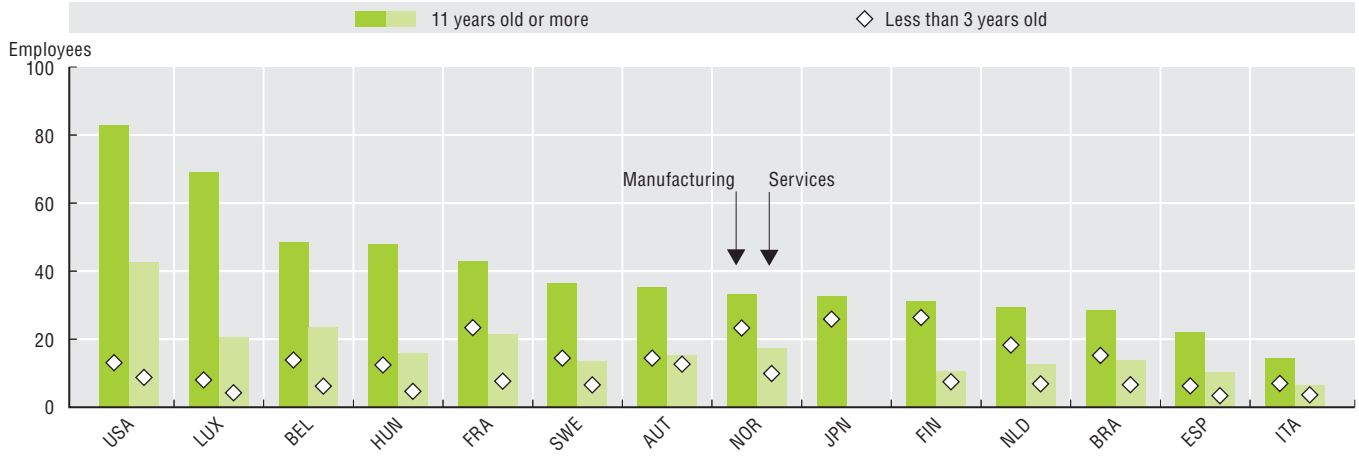
Average size of firms less than 3 years old and 11 years old or more, by sector, 2001-10

Reference cohorts 2001, 2004 and 2007



Source: OECD calculations based on the OECD DYNEMP data collection, July 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904279

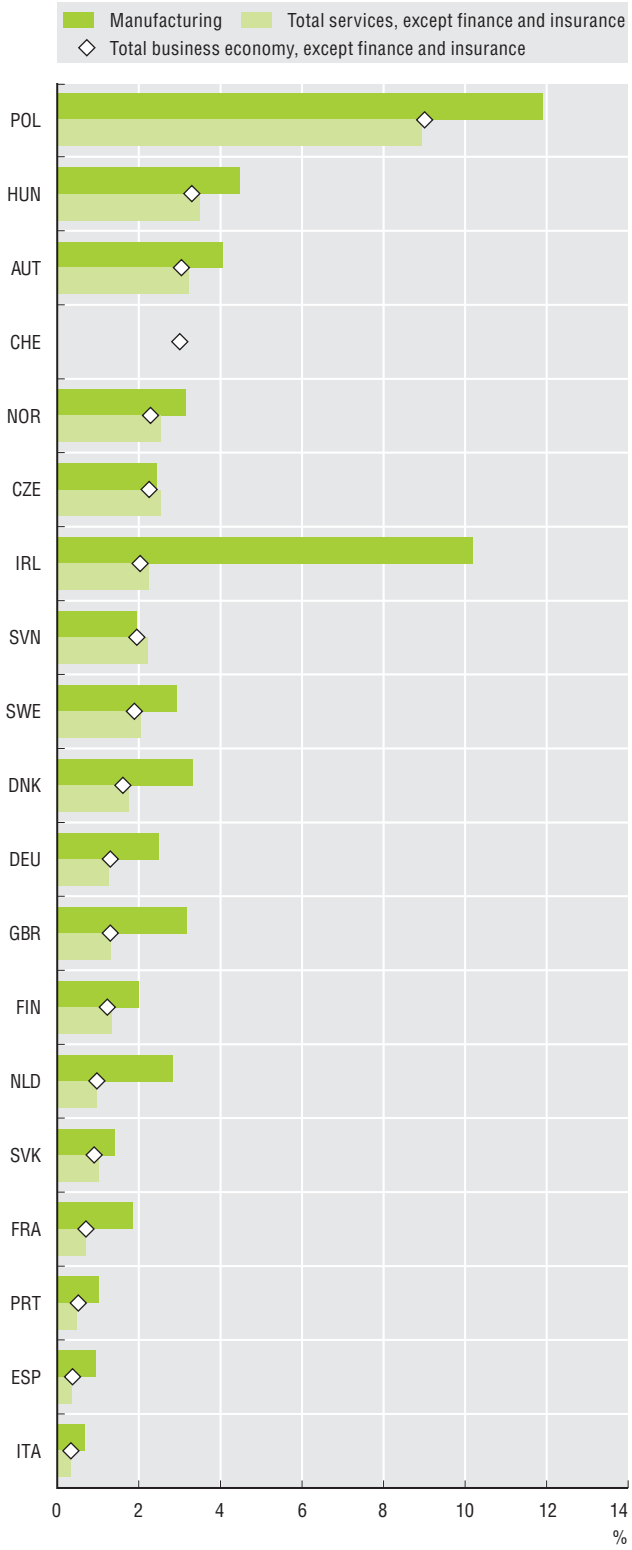
Measurability

The DYNEMP project has collected micro-aggregated data for start-ups (firms less than 3 years old) to look at performance and survival rates in 2001-04, 2004-07 and 2007-10. As there are differences in how long inactive firms are maintained in business registers before they are considered to have failed, the share of active firms in the last years may be underestimated until corrections are made. Caution is needed when comparing business over long time periods, especially across economies, since mergers, acquisitions and restructuring – which cannot be measured with the data available – may affect the comparison. The concept of firm size stability also needs to be interpreted with care, as firms may grow or shrink but remain in the same size class, particularly when the median size of firms is very close to the lower bound of the size class. For instance, in the case of start-ups with ten or fewer employees, the median firm has only two employees in all three macro sectors. Stable firms contribute to job creation: among jobs created by start-ups over the three-year periods considered, 25% came from stable start-ups in the period starting in 2001, 29% in 2004 and 27% in 2007.

5. Foreign affiliates

Share of foreign affiliates in total enterprises, 2010

By manufacturing and services



Source: OECD, Activity of Multinational Enterprises Database, *www.oecd.org/sti/ind/amne.htm*; Eurostat, Inward FATS Database, June 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904298

Foreign affiliates contribute to a host country's international competitiveness in several ways. They provide access to new markets and new technologies for domestic suppliers and buyers, generate knowledge spillovers for domestic firms and typically invest a higher share of revenues in R&D. They traditionally account for a larger share of host countries' employment than their numbers would suggest, owing to their larger average size. In 2010, foreign affiliates represented less than 5% of enterprises in most countries, but foreign-controlled employment varied between 10% and 40%. Their share in value added is even larger than in employment, partly because multinational enterprises are typically active in capital- and scale-intensive industries. In addition, foreign affiliates display on average higher labour productivity, even at the industry level. This may be due to reasons such as more capital-intensive production processes, greater efficiency and larger size.

Smaller countries, such as Ireland, the Czech Republic, the Slovak Republic and Hungary, have a stronger presence of foreign-owned firms. In France, the United States, Spain and Italy, foreign affiliates account for a significantly smaller share of total activity.

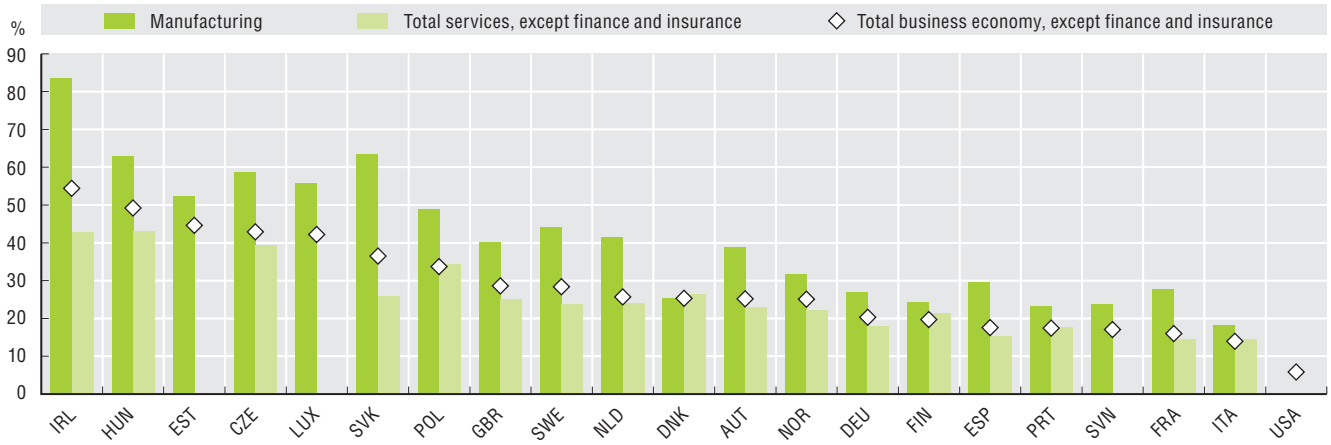
In most OECD countries, the importance of foreign affiliates is larger in manufacturing than in services. This is especially true for central European countries, in which many western European companies have relocated production over the past decade because of lower labour costs and the availability of a skilled workforce. Nevertheless, in absolute terms, foreign employment and value added are larger in services than in manufacturing in several OECD countries, owing to the importance of services in national economies but also to the growing internationalisation of services during the past decade.

Definitions

The term *"foreign affiliate"* is restricted to affiliates under foreign control. The notion of control implies the ability to appoint a majority of administrators empowered to direct an enterprise and determine its strategic choices. In most cases, this ability can be exercised by a single investor holding more than 50% of the shares with voting rights. The notion of control allows all of a company's activities to be attributed to the controlling investor. An investor is considered the investor of ultimate control if it is at the head of a chain of companies and controls directly or indirectly all the enterprises in the chain without itself being controlled by any other company or individual.

Share of national value added under control of foreign affiliates, 2010

By manufacturing and services

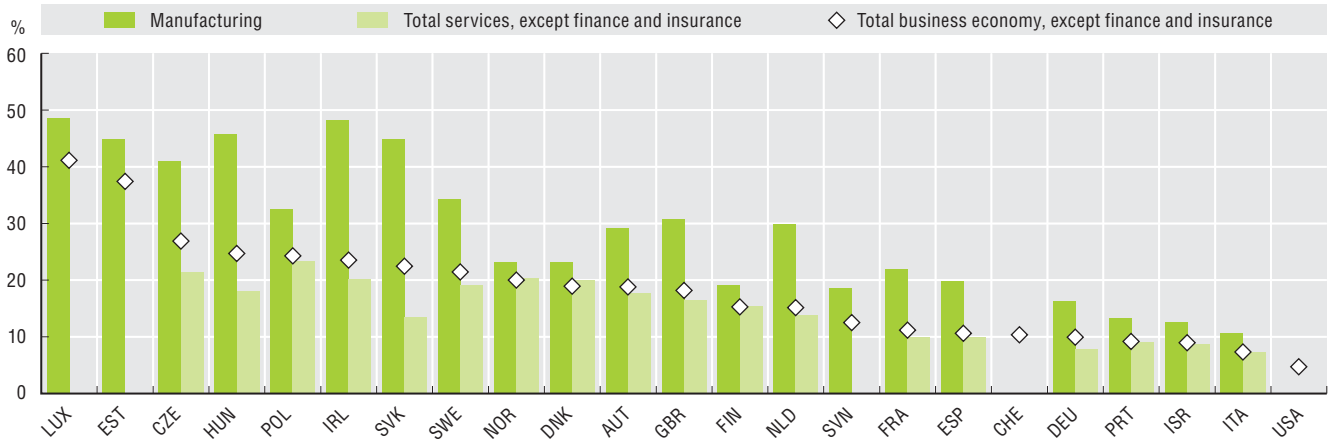


Source: OECD, Activity of Multinational Enterprises Database, *www.oecd.org/sti/ind/amne.htm*; Eurostat, Inward FATS Database, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932904317*

Share of national employment under control of foreign affiliates, 2010

By manufacturing and services



Source: OECD, Activity of Multinational Enterprises Database, *www.oecd.org/sti/ind/amne.htm*; Eurostat, Inward FATS Database, June 2013. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932904336*

Measurability

The share of foreign-controlled affiliates in total enterprises is generally small. However, it may be overestimated if national surveys do not include micro or small firms.

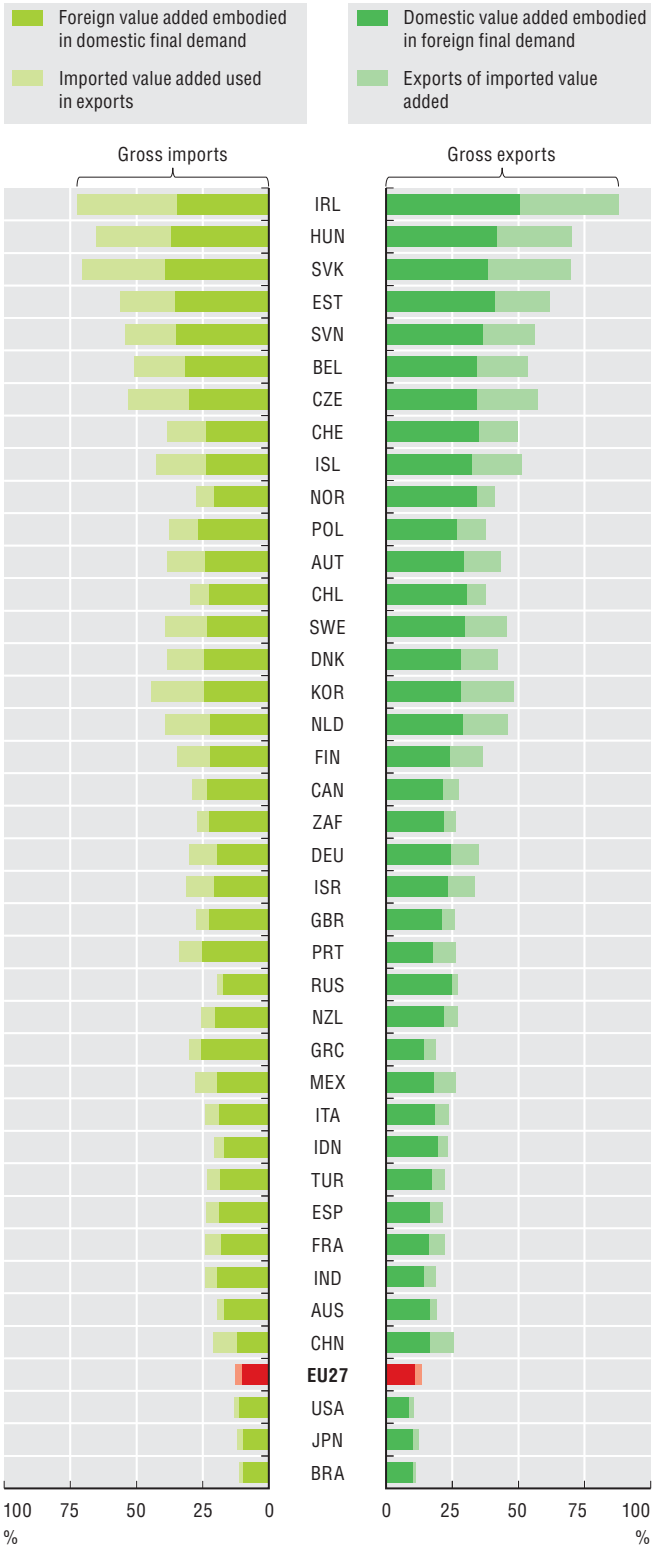
The share of affiliates under foreign control in host country employment may reflect the importance of foreign direct investment in maintaining or creating employment in a country. However, this information does not allow for evaluating net job creation due to foreign investment in the host country.

Value added is the portion of an enterprise's output that originates within the enterprise itself, so it provides a better measure than turnover. However, the share of affiliates under foreign control in host country value added may be biased because production processes have increasingly become geographically fragmented.

6. Trade and global value chains

Trade linkages in global value chains, 2009

Decomposition of gross imports and exports as a percentage of GDP



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932904355*

A country's integration in the global economy can be summarised in terms of the imports of value added required to meet its domestic final demand and produce its exports and in terms of the extent to which its domestic value added is sustained by foreign demand, both directly, via exports of final goods, and indirectly, via exports of intermediates subsequently embodied in its partners' exports.

Countries with relatively open and liberal trade regimes and high levels of foreign investment will typically have more foreign content in both their exports and their domestic consumption. A number of other factors affect a country's integration, and its specialisation, in global value chains (GVCs). Economies that are large, have significant mineral resources, or are relatively far from foreign markets and suppliers, tend to have higher domestic (and lower foreign) value added content in their exports than others. Similarly, countries that specialise in activities at the beginning of the value chain (upstream), such as mining and agriculture, or that specialise in services will typically have higher domestic value added content in their exports.

The increasing interdependency of the global economy is reflected in the general increase in the foreign content of exports since the mid-1990s, interrupted only by a widespread fall between 2008 and 2009 when the impact of the global financial crisis on trade peaked.

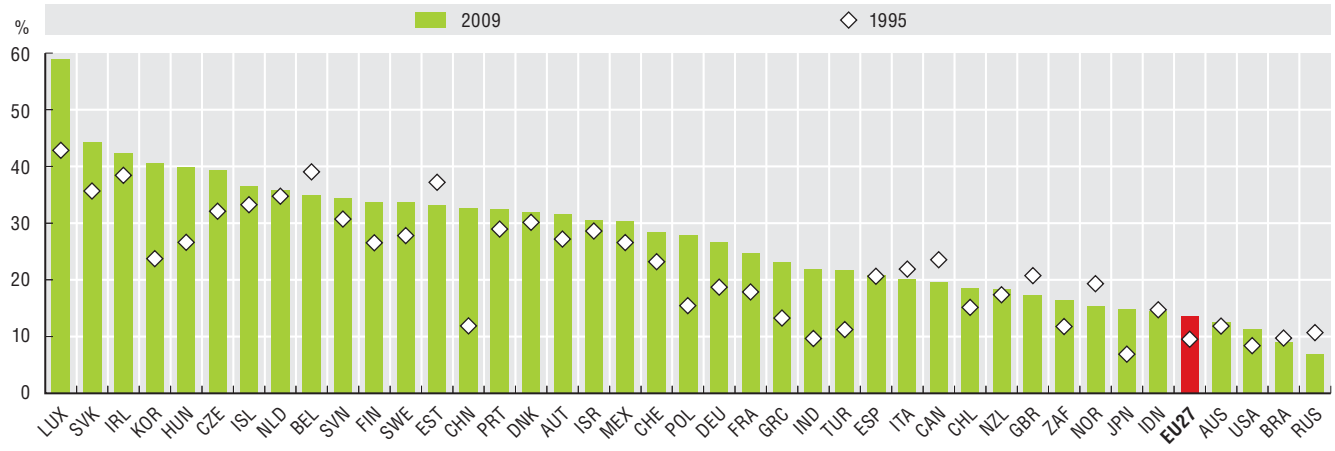
A country's integration in GVCs can also be seen in the share of imported intermediate inputs embodied in its exports following their incorporation in the production of goods and services. The indicator can demonstrate the importance of imported products for a country's export performance and the potential counterproductive effect of tariffs.

Definitions

Indicators of the origin of value added embodied in final demand are principal outputs of the new OECD-WTO Trade in Value Added (TiVA) collection of indicators. *Domestic value added embodied in foreign final demand* shows how industries export value both directly through exports of final goods and services and indirectly via exports of intermediates to other countries which are then embodied in further exports to final consumers abroad. It reflects how industries (upstream in a value chain) are connected to consumers in other countries even if no direct trade relationship exists. Similarly, *foreign value added embodied in domestic final demand* ultimately shows how industries abroad are connected to consumers at home. The measure of foreign value added content of exports considers the foreign content of gross exports as measured "conventionally" and thus includes intermediate as well as final goods and services.

Foreign value added content of exports, 1995 and 2009

As a percentage of total exports of goods and services

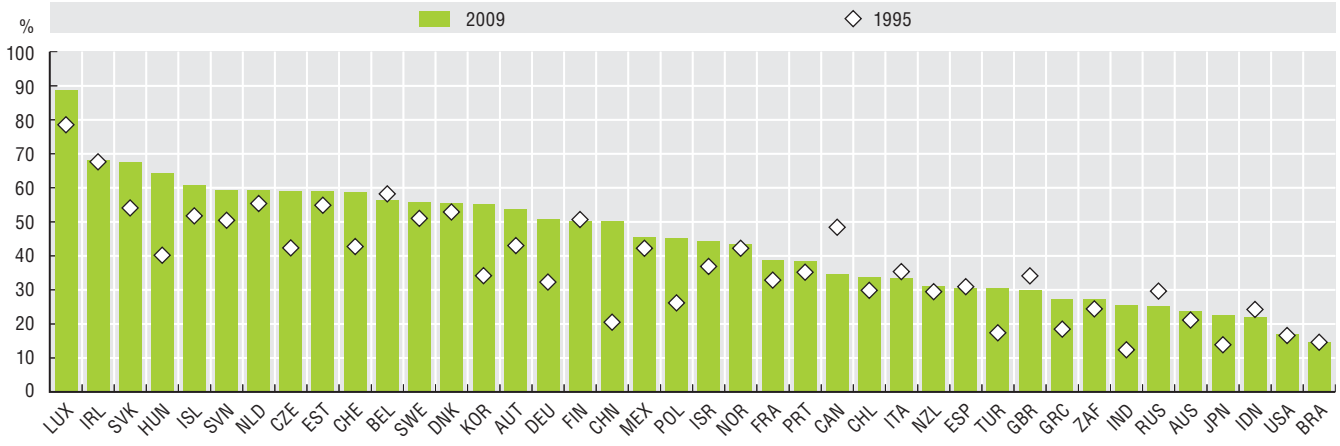


Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932904374*

Imported intermediate inputs used in exports, 1995 and 2009

As a percentage of total imports of intermediate inputs



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013. StatLink contains more data.

StatLink *http://dx.doi.org/10.1787/888932904393*

Measurability

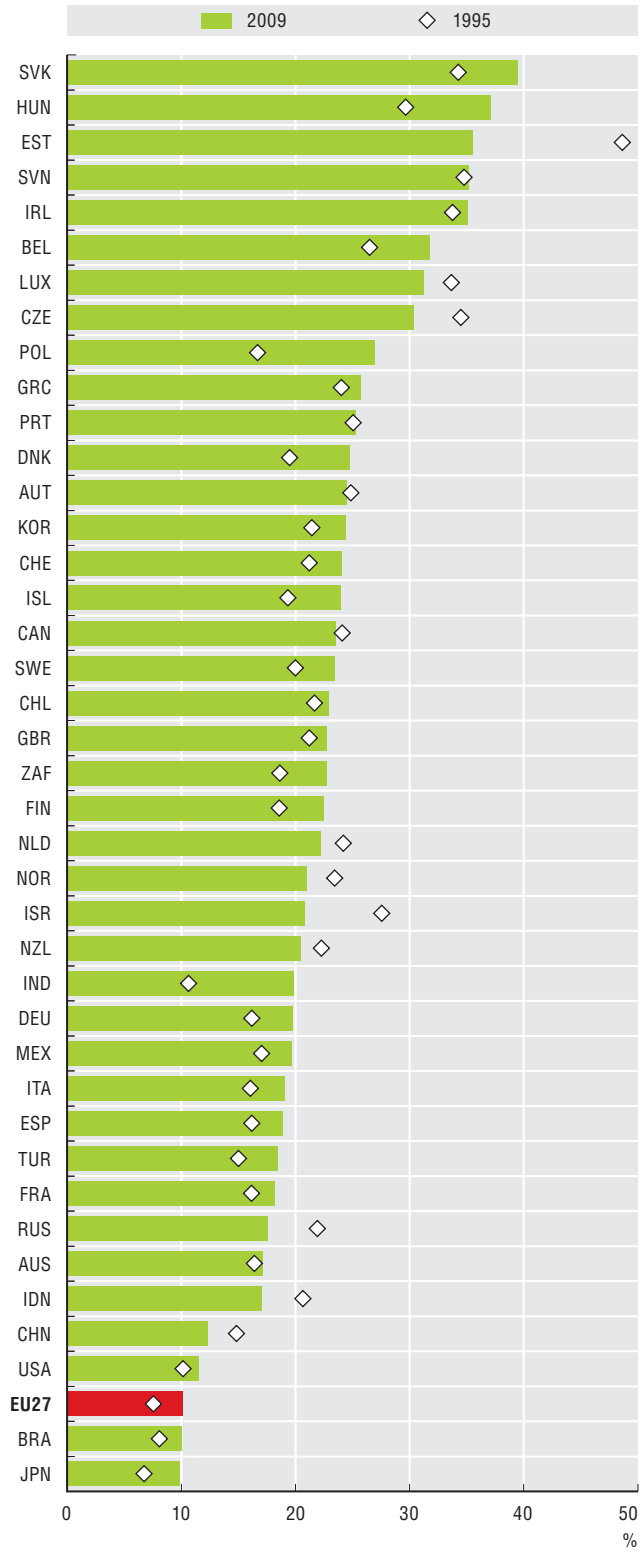
Official statistics on international trade are measured in gross terms so that the value of products that cross borders several times for further processing are counted multiple times. For example, the production of goods for export may require intermediate inputs from manufacturers abroad, who may also require significant imports of intermediates. Thus, much of the revenue, or value added, from selling the exported good may accrue to other countries, leaving only marginal benefits in the exporting economy.

The OECD and WTO recently developed a set of Trade in Value Added (TiVA) indicators based on the OECD Inter-Country Input-Output (ICIO) Database. The theory for developing such indicators is well established. The main challenge is data availability and the need to create balanced matrices of international flows of trade in goods and services that are consistent with official National Accounts. Reported exports by country A to country B often do not match reported imports by country B from country A. The global balancing of the ICIO essentially removes inconsistencies but resulting bilateral gross trade flows may not match some countries' perceptions of their trading patterns.

7. Global demand

Foreign value added embodied in domestic final demand, 1995 and 2009

As a percentage of GDP



Source: OECD-WTO, Trade in Value Added (TiVA) Database, *http://oe.cd/tiva*, May 2013. StatLink contains more data. See chapter notes.

StatLink *http://dx.doi.org/10.1787/888932904412*

Foreign value added embodied in domestic final demand is the value of a final good or service consumed domestically that is generated by other countries. It shows how industries abroad (upstream in a value chain) are connected to consumers at home, even if there is no apparent direct trade relationship. It can also be described as "imports of value added". With a few exceptions, dependency on other countries to fulfil domestic demand increased between 1995 and 2009.

This growing interdependency may limit the degree to which policy makers directly influence growth and job creation within their national borders. Moreover, policies to promote domestic activities can have spillover effects in other countries. Similarly, policies that target domestic demand may be less effective because of the large foreign value added content in final demand.

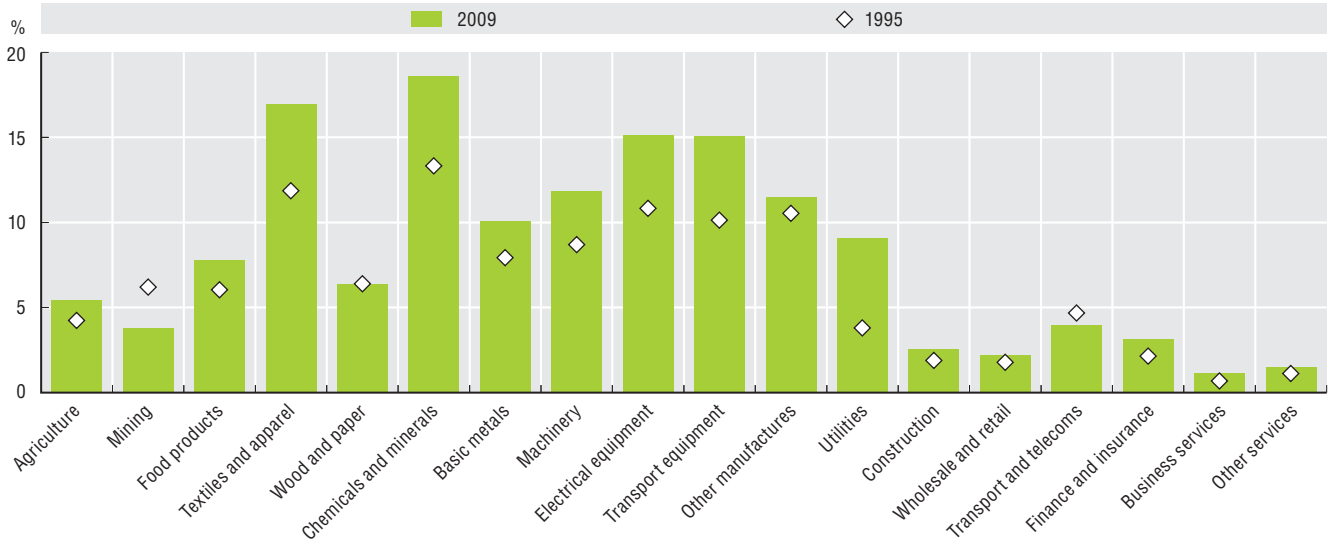
The level of foreign value added in an economy's final demand is determined by its industry composition, its demand patterns and relative product prices. Fulfilment of domestic final demand by foreign production is linked to the technical characteristics of products and is far more developed in manufacturing than in services, which are less likely to be sliced up than manufacturing products, particularly if they require face-to-face contact between the provider and the consumer. Foreign value added is very large in basic industries that make heavy use of imported primary goods such as minerals and chemicals but also textiles and transport equipment. Fragmentation is also significant for modular products in high-technology industries such as electronics, where the share of foreign value added in final demand increased by 50% across OECD countries between 1995 and 2009, from 10% to 15%. Meanwhile, Brazil, China and Indonesia rely increasingly on domestic production to satisfy domestic demand for electronic products.

Definitions

Sectors are defined according to the following ISIC Rev.3 economic activities: Agriculture (Divisions 01-05), Mining (10-14), Food products (15-16), Textiles and apparel (17-19), Wood and paper (20-22), Chemicals and minerals (23-26), Basic metals (27-28), Machinery (29), Electrical equipment (30-33), Transport equipment (34-35), Other manufactures (36-37), Utilities (40-41), Construction (45), Wholesale and retail (50-55), Transport and telecoms (60-64), Finance and insurance (65-67), Business services (70-74) and Other services (75-99).

Foreign value added embodied in domestic final demand, by sector, OECD average, 1995 and 2009

As a percentage of final expenditure on sectors' products

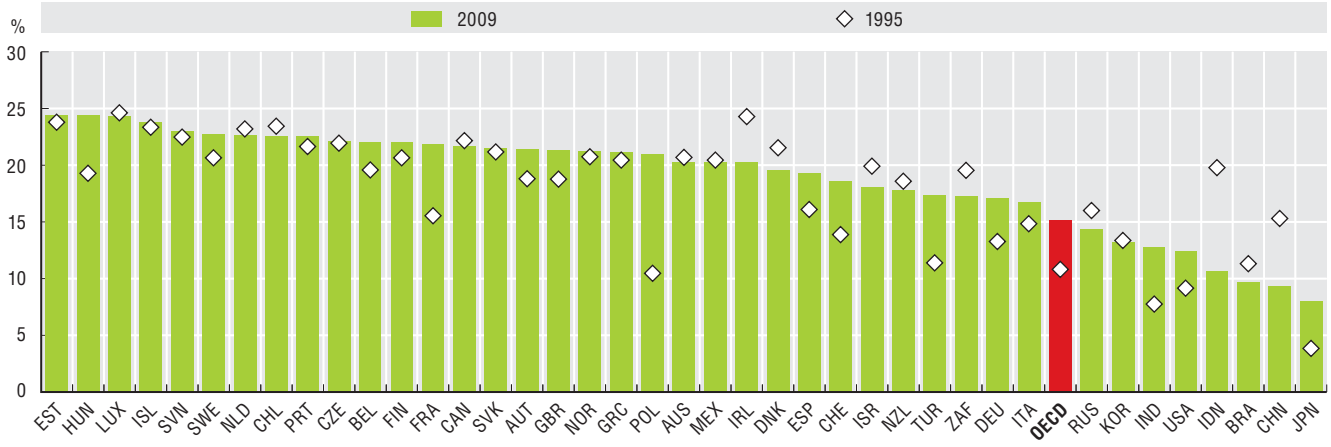


Source: OECD Inter-Country Input-Output (ICIO) Database, May 2013. StatLink contains more data.

StatLink http://dx.doi.org/10.1787/888932904431

Foreign value added embodied in domestic final demand for electrical equipment, 1995 and 2009

As a percentage of final expenditure on electrical equipment



Source: OECD Inter-Country Input-Output (ICIO) Database, May 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904450

Measurability

In an input-output framework of n_1 countries and n_2 industries, value added from country *a* embodied in foreign final demand can be shown to be equal to

$v\,(I\text{-}A)^{-1}y$

Where, if $n = n_1 \times n_2$, v is a $1 \times n$ vector with value added to output ratios in industry *i* of country *a*, zero otherwise; y is a $1 \times n$ vector of final demand with zero entries for the final demand of country *a*; and A is an input-output coefficient matrix with dimension $n \times n$.

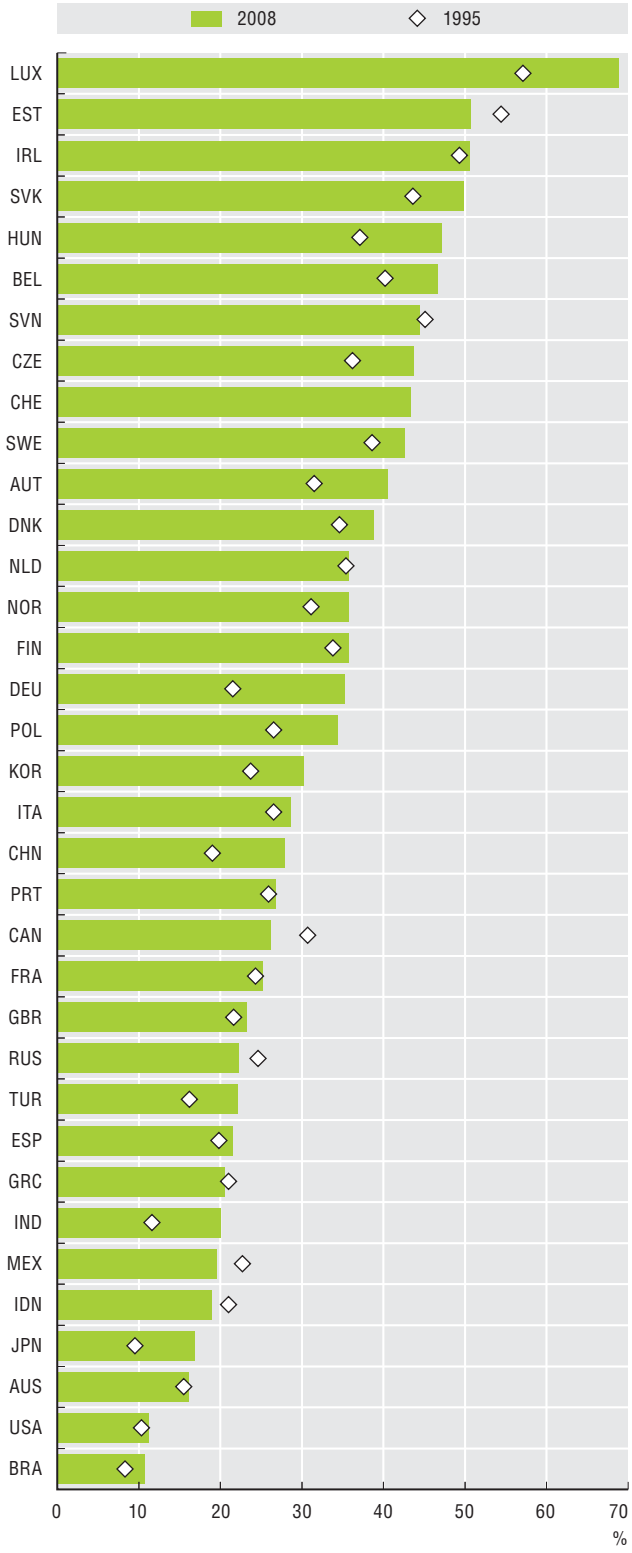
A matrix can be built showing the inputs from industry *i* of country *a* required to produce outputs from industry *j* in country *b* for domestic consumption or export. Aggregating can yield indicators of domestic value added in foreign final demand and foreign value added embodied in domestic final demand as presented here.

A "proportionality" assumption is used when official data on imports by industry are unavailable. It assumes that for a given product, the proportion of intermediates purchased by an industry from abroad is equal to that of imports to total domestic demand in that product. Where this assumption is used, refinements are introduced by using estimates of bilateral trade that differentiate between imports of goods for intermediate use and for final demand.

8. Trade and jobs

Jobs in the business sector sustained by foreign final demand, 1995 and 2008

As a percentage of total business sector employment



Source: OECD, Inter-Country Input-Output (ICIO) Database, May 2013; EC, World Input-Output Database (WIOD), April 2012.

StatLink http://dx.doi.org/10.1787/888932904469

As global value chains have proliferated, firms have specialised in stages of production. This has increased dependencies among economies, with job creation increasingly determined by a country's ability to access foreign markets. Traditional statistics do not show the extent of these interdependencies. In particular, they do not reveal how consumers in one country drive and sustain jobs in countries further up the value chain. Experimental and preliminary indicators, based on the OECD's Inter-Country Input-Output (ICIO) Database, show that these relationships are significant and growing.

Preliminary estimates suggest that in 2008, 20% to 45% of business sector jobs in most European economies were sustained by final consumers in foreign markets. Compared to 1995, these shares increased in all countries; in Germany it rose more than 10%. Greece and Spain had the lowest shares in Europe. Shares are smaller in Japan and the United States owing to their relatively large size and lower dependency on exports/imports. Nonetheless, initial estimates for 2008 suggest that over 10 million US business sector jobs were sustained by foreign consumers.

Brazil, China and India saw significant increases in the number of jobs sustained by foreign demand. By 2008, over 25% of business sector jobs in China were sustained by foreign demand. Preliminary indicators also reveal the importance of emerging markets for OECD countries. In the United States for example, over a fifth of all jobs sustained by foreign demand in 2008 can be attributed to final consumers in East and Southeast Asia.

In OECD countries, most jobs sustained by foreign demand are in manufacturing; services contribute from 20% to 40%. This is less than the contribution of the services sector to value added in exports, partly owing to higher labour productivity in services exposed to global markets.

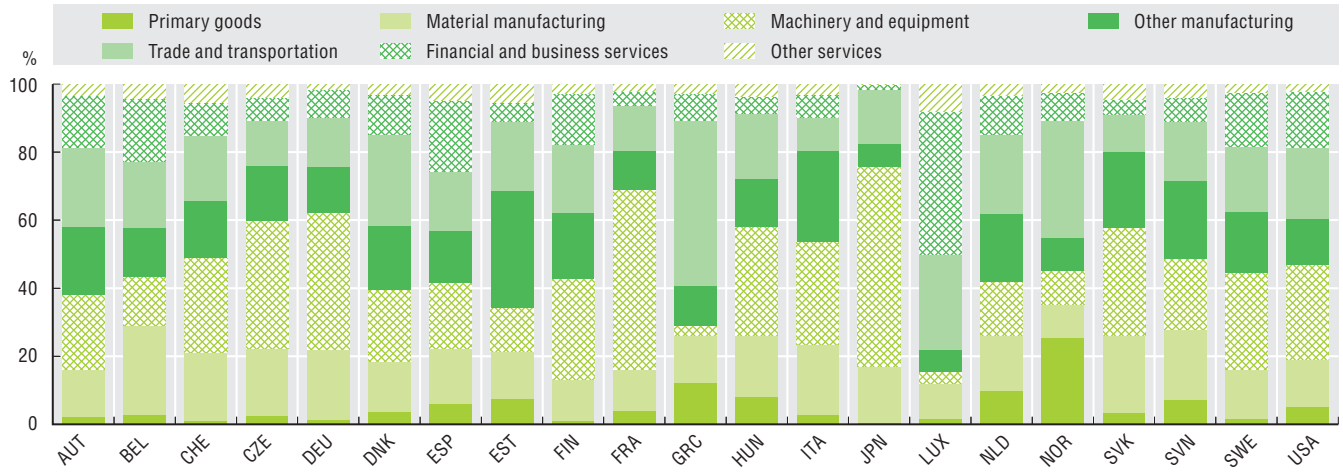
Definitions

Jobs refer to the total number of persons employed. *Final demand* refers to the sum of final consumption expenditure by *households*, *government* and *non-profit institutions serving households* (*NPISHs*) and *gross fixed capital* expenditures as defined in the 1993 System of National Accounts (SNA 93).

The aggregate sectors are based on ISIC Rev.3 activities. The business sector is defined as Divisions 10 to 74, i.e. total economy *excluding* Agriculture, forestry and fishing (Divisions 01-05), Public administration (75), Education (80), Health (85) and Other community, social and personal services (90-95). Primary goods consists of Divisions 01-05, 10-14; Material manufacturing: 23-25, 26, 27-28; Machinery and equipment: 29-33, 34-35; Other manufacturing: 15-16, 17-19, 20, 21-22 and 36; Trade and transportation: 50-64; Financial and business services: 65-74; Other services: 40-41, 45 and 75-95.

Jobs sustained by foreign final demand, by sector, 2008

As a percentage of total jobs embodied in foreign final demand

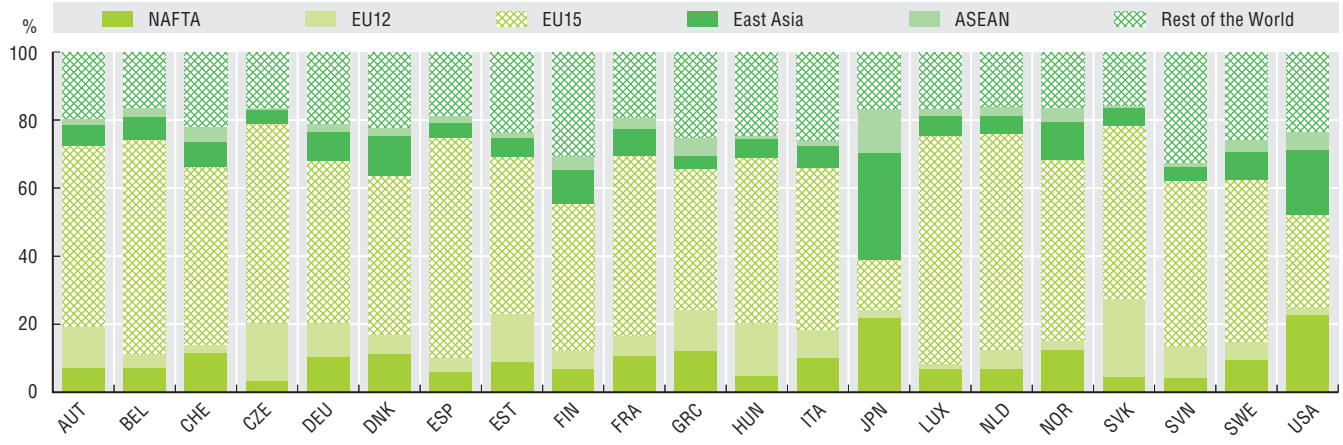


Source: OECD, Inter-Country Input-Output (ICIO) Database, May 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904488

Jobs sustained by foreign final demand, by region of demand, 2008

As a percentage of total jobs embodied in foreign final demand



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

StatLink http://dx.doi.org/10.1787/888932904507

Measurability

Calculations of jobs sustained by foreign final demand are similar to those used to estimate domestic value added in foreign final demand except that a vector, *e*, of jobs to output ratios is applied (rather than a vector, *v*, of value added to output ratios): $e\ (I\text{-}A)^{-1}y$.

Estimates derived using an input-output accounting framework are sensitive to certain assumptions, mainly that exporting firms have the same labour productivity as firms producing goods and services for domestic markets and the same share of imports, in relation to output, as domestic firms.

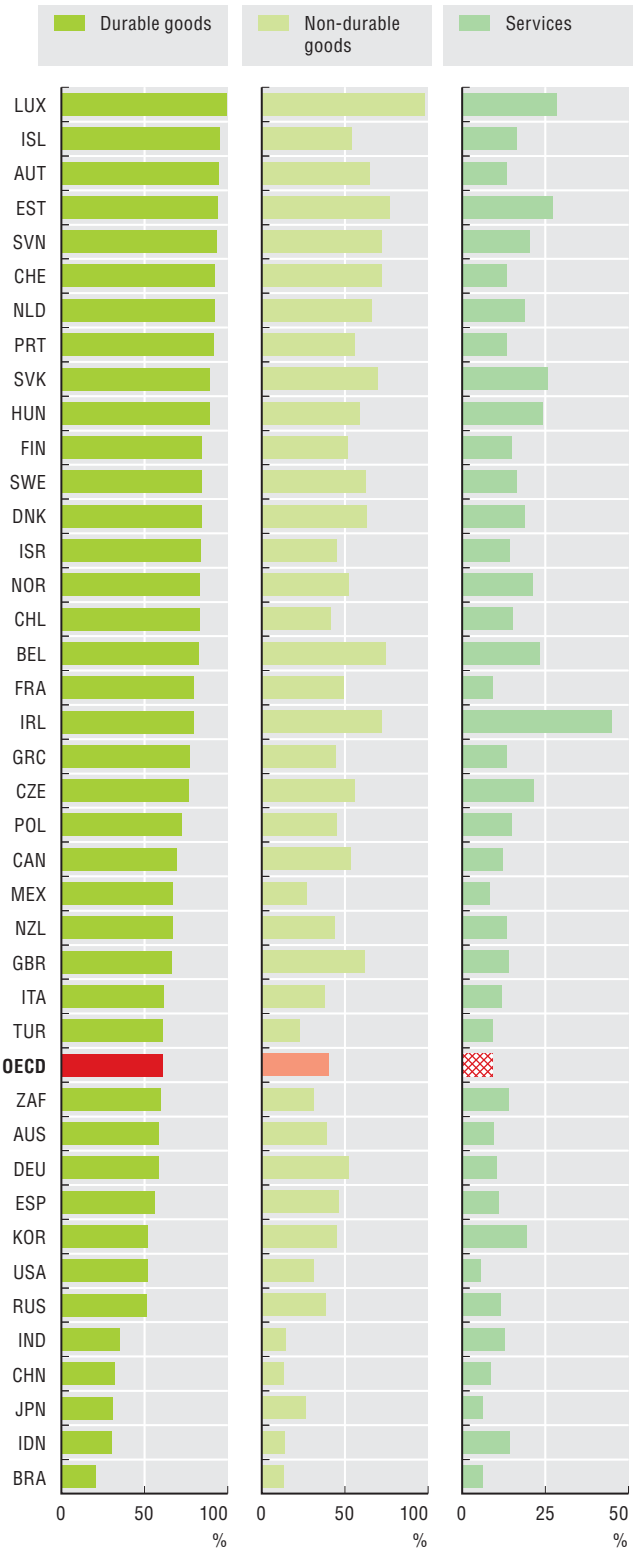
However, exporting firms appear to have higher labour productivity and a higher share of imports for a given output. The results presented may therefore be biased upwards. Efforts are under way to reduce the size of these biases.

Three other issues are worth mentioning. The jobs estimates are not full-time equivalent measures. They relate to jobs *sustained* rather than *created* as they may have previously served domestic consumers. The estimates do not reflect jobs sustained by distributors through sales of imported final goods or upstream jobs created (e.g. via transport and storage industries involved in distribution channels for these goods).

9. Trade and household consumption

Foreign value added in household consumption, by product category, 2009

As a percentage of total household consumption of the product category



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

StatLink http://dx.doi.org/10.1787/888932904526

A focus on household consumption reveals that in most OECD countries shares of foreign value added are higher for durable goods (such as machinery and equipment) than for non-durable goods (food, textiles, chemicals, etc.). For services consumed by households, foreign content is relatively low, averaging below 10% in OECD countries.

Services account for over three-quarters of household spending in many OECD countries. Even in emerging countries, where much household spending is for non-durable goods, over half is for services. As the share of services in household budgets is dominated by regular spending on domestic services, including housing, the foreign value added content in services is, overall, relatively low.

Although durable goods have high foreign value added content, households consume many of these, such as cars, consumer electronics and kitchen appliances, only intermittently. They therefore represent a small share of a country's aggregate household expenditure. Most durable goods are consumed by businesses and government as investment.

On average, about a sixth of OECD-area household consumption consists of foreign value added; in many countries it represents between 20% and 30%. In large OECD economies, such as Japan and the United States, the share may be as low as 10-12%. In some emerging economies such as Brazil, China and India, household consumption is also dominated by locally sourced goods and services. The origin of the foreign content is broadly regional, with European households mainly consuming foreign value added from other European countries and North American households drawing on value added from their neighbours. In 2009 China accounted for less that 2% of value added in household consumption in major OECD economies, including Japan and the United States.

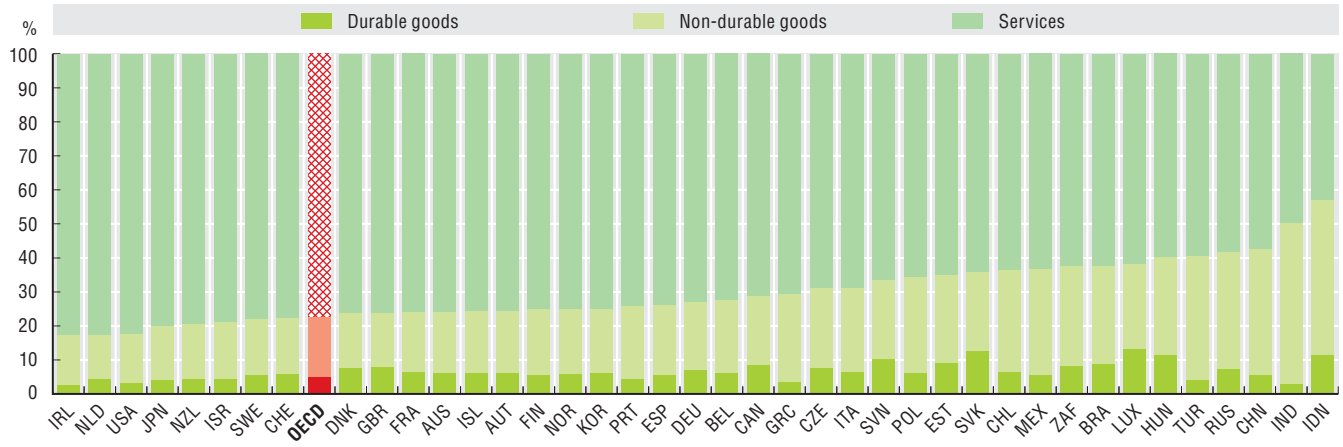
Definitions

Household final consumption expenditure covers all purchases made by resident households to meet their everyday needs: food, clothing, housing services, energy, transport, durable goods (notably cars), health, leisure and other services. The concept used here covers direct household expenditure and does not include those (individual) expenditures of general government and non-profit institutions serving households (NPISHs) that directly benefit households, such as health care and education.

Product groups are defined according to ISIC Rev.3. Durable goods includes Divisions 20, 26, 27-28, 29-33 and 34-35; Non-durable goods: 01-05, 10-14, 15-16, 17-19, 21-22, 23-25 and 36; and Services: 45, 50-55, 60-64, 65-67, 70-74, 75-95.

Household consumption, by type of product, 2009

As a percentage of total household consumption

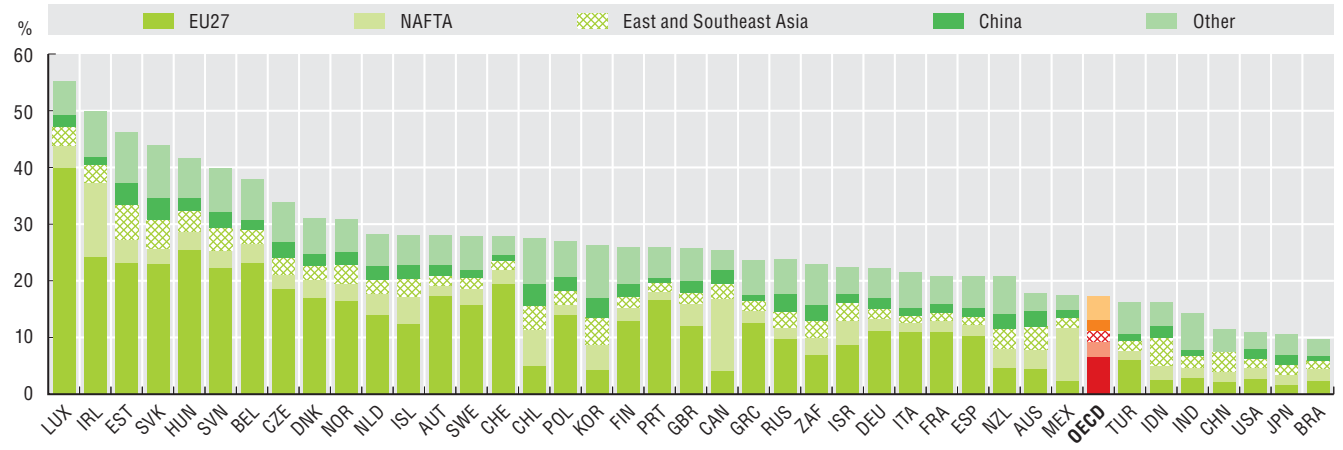


Source: OECD, Inter-Country Input-Output (ICIO) Database, May 2013. StatLink contains more data.

StatLink http://dx.doi.org/10.1787/888932904545

Foreign value added in household consumption, by source region, 2009

As a percentage of total household consumption



Source: OECD, Inter-Country Input-Output (ICIO) Database, May 2013. StatLink contains more data. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932904564

Measurability

Timeliness is a major constraint when developing indicators based on an input-output framework. Given the heavy data requirements, national benchmarked input-output (I-O) tables are typically produced every 5 years, often with a lag of 4 to 5 years. Many countries produce more timely annual Supply-Use tables (SUTs), especially in Europe, and these can be used to produce estimated input-output tables. As countries use different benchmark years, some interpolation and extrapolation may be required to develop a set of harmonised input-output tables covering common years for a maximum number of countries. A consequence is that the OECD Inter-Country Input-Output (ICIO) Database, used to derive the indicators in this and preceding sections, currently only covers the years 1995, 2000, 2005, 2008 and 2009. Efforts are under way to improve the timeliness of estimates in OECD's I-O framework, but in the meantime, as certain economic structures do not change rapidly, the figures for 2008 and 2009 can provide some insights into how countries fit into the global economy today.

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 recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the 'Cyprus issue'."

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

"The Republic of Cyprus is 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."

7.1 Employment

General notes:

Employment in services, 2000 and 2011 and;

Employment in knowledge-intensive "market" services, 2000 and 2011

Australia, Iceland and Turkey: Labour Force Survey (LFS) data by industry are used in the absence of employment by activity statistics published in a National Accounts (SNA) context.

Additional notes:

On an industry-based definition, the distinction between market and public services is an approximate one. In OECD countries private education and health services are available to varying degrees while some transport and postal services remain in the public realm.

For Japan, the division of total services employment into market-sector and public-sector employment is an OECD estimate.

For Chile and Israel, estimates are based on SNA employment data provided to the OECD according to ISIC Rev.3 Divisions 50-74 and 75-99.

Employment in high- and medium-high-technology manufacturing, 2000 and 2011

For Germany, Poland, Portugal and Sweden, data refer to 2010.

For Israel, estimates based on SNA employment data provided to the OECD according to ISIC Rev.3, Divisions 24 and 29-35.

7.2 Services-manufacturing linkages

Services-related occupations in manufacturing, 2002 and 2012

For the United States, data refer to March 2012, based on the Current Population Survey (CPS). CPS data were converted from US 2010 census codes to 1-digit ISCO-08 major groups via published correspondences with US 2010 Standard Occupational Classification (SOC) codes.

7.3 Firm size

General notes for all figures:

Data refer to ISIC Rev.4 Divisions 05-82, excluding 64-66 (Financial and insurance activities). For Israel, data refer to ISIC Rev.3 Divisions 10-74, excluding 65-67 (Financial intermediation).

For Australia, data refer to the fiscal year (1 July -30 June).

For Israel and Turkey, data refer to 2009.

For Japan, data refer to 2009. Establishments are the unit of measurement.

Additional notes:

Number of enterprises by size class, 2010

For Australia, the size class "20-49" refers to "20-199" and the size class "250+" refers to "200+".

For Canada, data refer to 2009.

For Japan, data refer the following size classes: 10-49, 50-299 and 300+.

For Korea, data include financial services and refer to the following size classes: 10-49, 50-299, 300+. Establishments are the unit of measurement.

For Mexico, data refer to 2008 and to the following size classes: 11-50, 51-250 and 251+. Establishments are the unit of measurement.

For New Zealand and the Russian Federation, data refer to employees.

For the Russian Federation, data refer to ISIC Rev.3 Divisions 10-74, excluding 65-67 (Financial intermediation).

For Turkey, data for the size class 10-19 are not available.

For the United States, data include the self-employed and refer to the following size classes: 10-19, 20-99, 100-499 and 500+.

Employment by enterprise by size class, 2010 and;

Value added by enterprise by size class, 2010

For Australia, data refer to the following size classes: 0-19, 20-199 and 200+.

For Greece, data refer to 2007.

For Japan, data refer to the following size classes: 1-9, 10-49, 50-299 and 300+.

For Turkey, the size class 1-9 corresponds to 0-19.

Employment by enterprise by size class, 2010

Data refer to the number of persons employed, except for New Zealand, the Russian Federation and the United States, which use number of employees and therefore exclude working-proprietors without employees.

For Mexico, data refer to 2008 and to the following size classes: 0-10, 11-50, 51-250 and 251+. Establishments are the unit of measurement.

For the United States, data include information from the Nonemployer Statistics of the Census Bureau and refer to the following size classes: 1-9, 10-19, 20-99, 100-499 and 500+.

Value added by enterprise by size class, 2010

Data refer to value added at factor costs in EU countries and value added at basic prices for other countries.

For Denmark, Germany, Ireland and Norway, data refer to 2009.

For Israel, data refer to the following size classes: 1-9, 10-19, 20-49 and 50+.

For Korea, data include financial services and refer to 2006 and to the following size classes: 1-9, 10-49, 50-99, 100-299, 300+. Establishments are the unit of measurement.

For Mexico, data refer to 2003 and the size class 1-9 corresponds to 1-10.

7.4 Firm dynamics

General notes for all figures:

Calculations are based on preliminary results from the OECD DYNEMP project.

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

Establishments and firms that appear only for one year are excluded.

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

For Austria, data are at the establishment level.

Additional notes:

Three-year survival and growth performance of micro start-ups, 2001-04, 2004-07, 2007-10

For New Zealand, data refer to 2006 instead of 2007.

Average size of firms less than 3 years old and 11 years old or more, 2001-10

For France, data refer to the 2001 and 2004 cohorts.

Average size of firms less than 3 years old and 11 years old or more, by sector, 2001-10

For France, data refer to the 2001 and 2004 cohorts.

For Japan, data are at the establishment level and refer to the 2001 and 2006 cohorts for the manufacturing sector only.

7.5 Foreign affiliates

General notes for all figures:

For Finland, total services excludes real estate.

For Denmark and the United Kingdom, data refer to 2009.

For Poland, data refer to enterprises with 9 or more persons employed.

Additional notes:

Share of foreign affiliates in total enterprises, 2010

For Switzerland, financial intermediation and community, social and personal services are included.

Share of national value added under control of foreign affiliates, 2010 and;

Share of national employment under control of foreign affiliates, 2010

For Estonia, data refer to enterprises with 20 or more persons employed.

Share of national value added under control of foreign affiliates, 2010

For the United States, financial intermediation and community, social and personal services are included.

Share of national employment under control of foreign affiliates, 2010

For Switzerland and the United States, financial intermediation and community, social and personal services are included.

For Israel, data refer to 2009.

For Switzerland, manufacturing includes mining and construction and part of the data refers to minority and majority foreign-controlled affiliates.

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7.6 Trade and global value chains

General note:

Trade linkages in global value chains, 2009 and;

Foreign value added content of exports, 1995 and 2009

EU27 represents the European Union prior to 1 July 2013 and the data cover non-EU content of EU exports.

7.7 Global demand

Foreign value added embodied in domestic final demand, 1995 and 2009

EU27 represents the European Union prior to 1 July 2013 and the data cover non-EU content of EU final demand.

Foreign value added embodied in domestic final demand for electrical equipment, 1995 and 2009

Electrical equipment is defined according to ISIC Rev.3 Divisions 30-33.

7.8 Trade and jobs

Jobs sustained by foreign final demand, by region of demand, 2008

ASEAN includes Brunei Darussalam, Cambodia, Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam.

East Asia includes Japan, Korea, China, Chinese Taipei and Hong Kong, China.

EU12 includes Bulgaria, the Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, the Slovak Republic and Slovenia.

EU15 includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

NAFTA includes Canada, Mexico and the United States.

7.9 Trade and household consumption

Foreign value added in household consumption, by source region, 2009

The region East and Southeast Asia includes Brunei Darussalam; Cambodia; Chinese Taipei; Hong Kong, China; Indonesia; Japan; Korea; Malaysia; the Philippines; Singapore; Thailand; and Viet Nam.

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