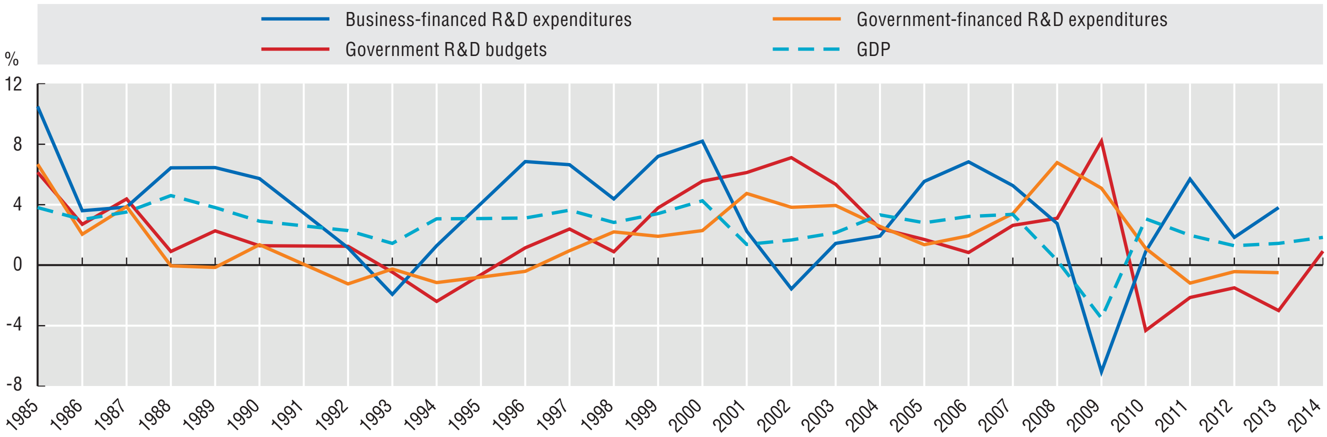
R&D trends

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

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

Average annual real growth rate, percentage

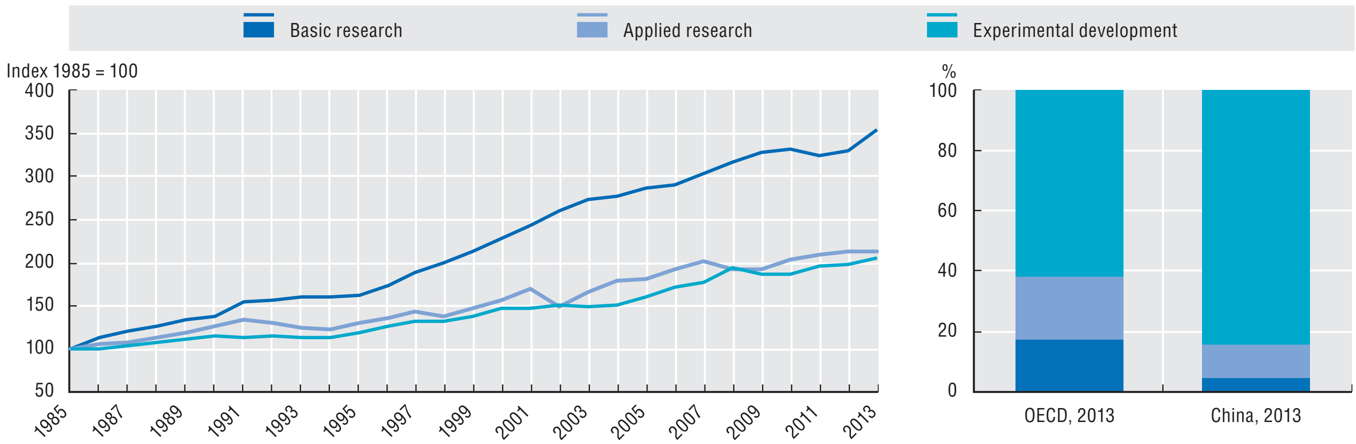


Source: OECD, *Main Science and Technology Indicators Database*, *www.oecd.org/sti/msti.htm*, June 2015. See chapter notes.

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

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

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



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

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

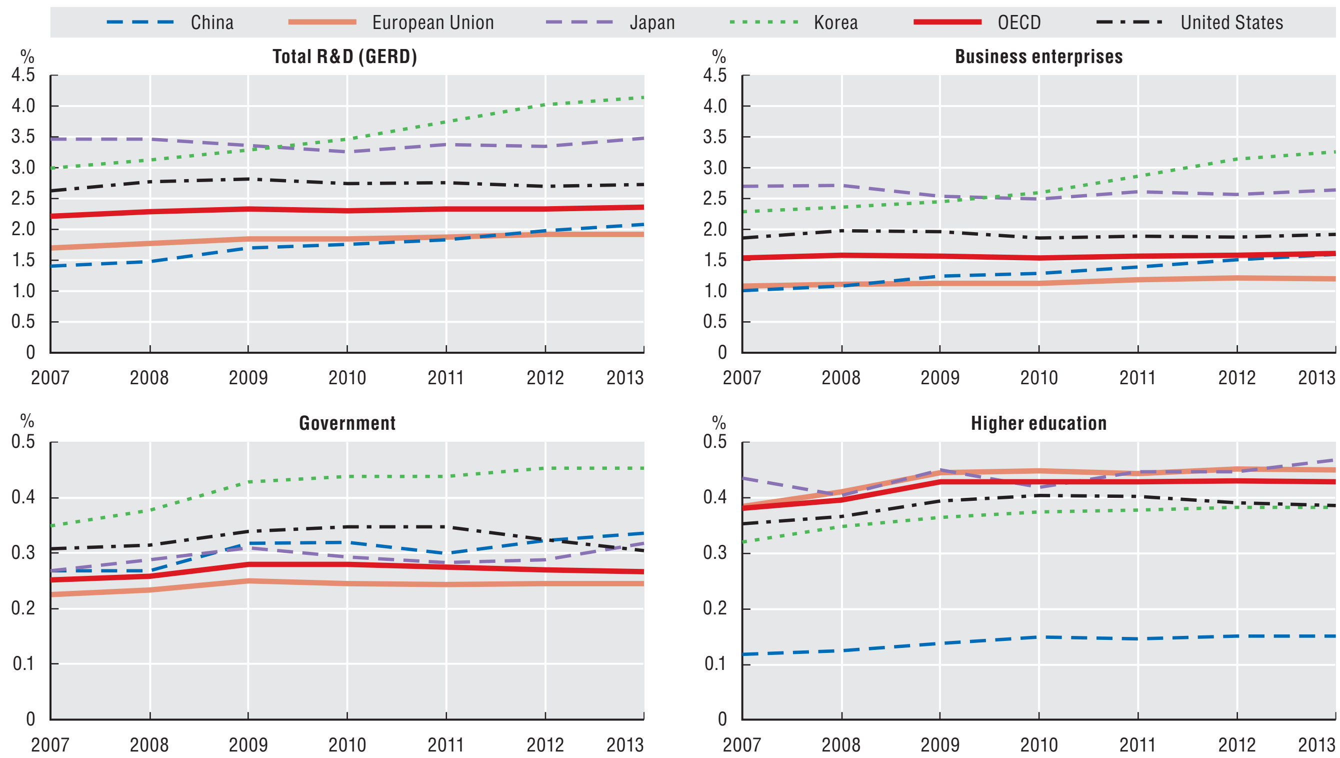
StatLink http://dx.doi.org/10.1787/888933273241

R&D trends

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

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

Totals and sector estimates, as a percentage of GDP



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

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

Measuring R&D and its components

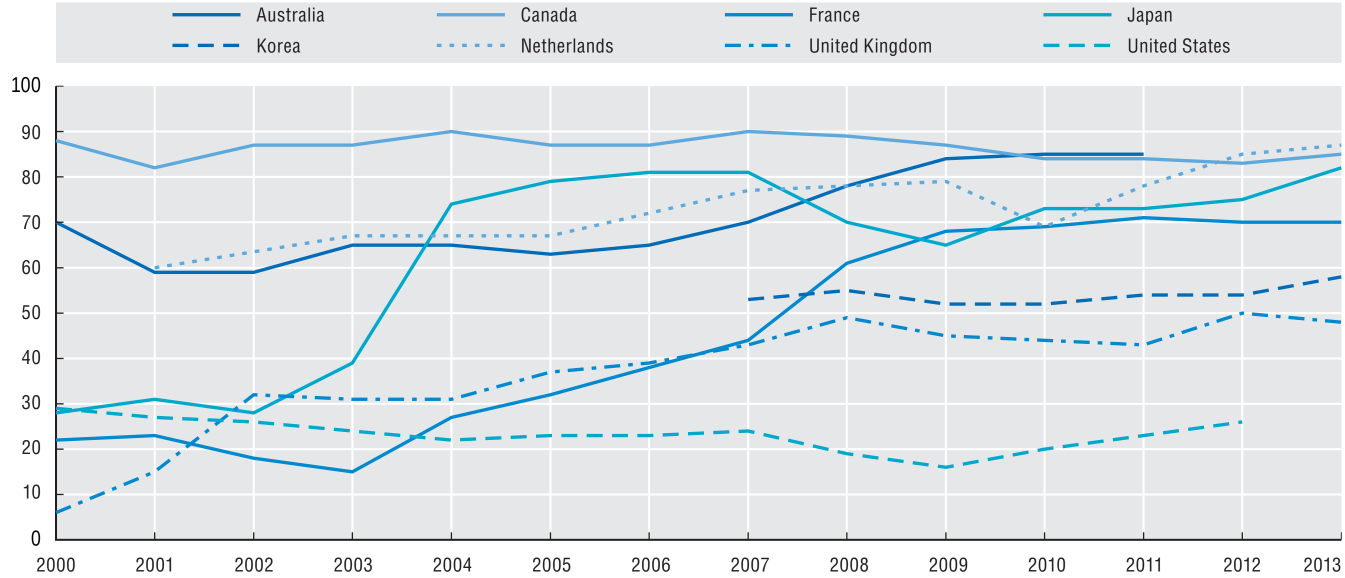
As defined in the *Frascati Manual* (OECD, 2015e), R&D comprises basic research (aimed at creating new knowledge with no specific application in view), applied research (new knowledge towards a specific practical aim) and experimental development (to develop new products or processes). For some countries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

The policy mix for R&D

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

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

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



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

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

How to measure R&D tax incentives

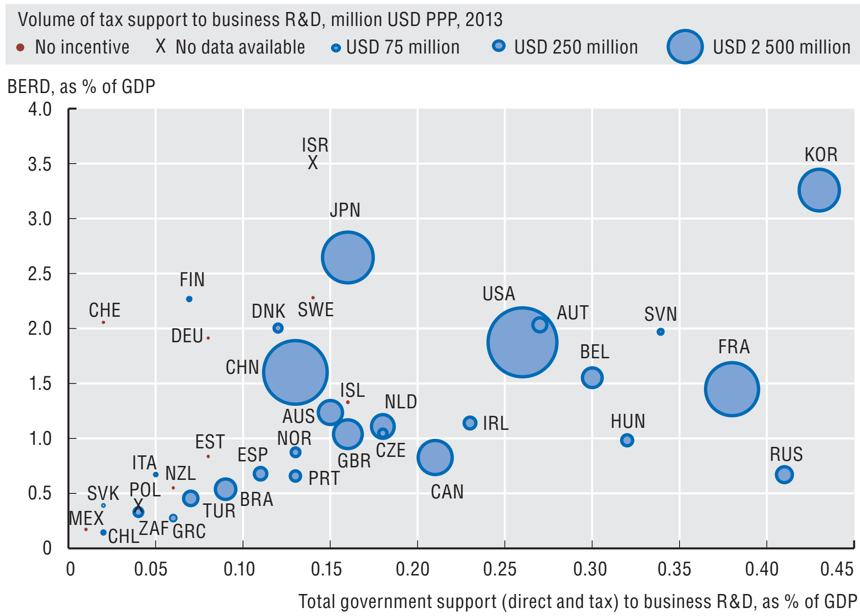
OECD estimates of the cost of R&D tax incentives are combined with data on direct R&D funding, as reported by firms through R&D surveys, to provide a more complete picture of government efforts to promote business R&D. These efforts can now be mapped over time. The OECD data collection on R&D tax incentives,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

The policy mix for R&D

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

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

As a percentage of GDP



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

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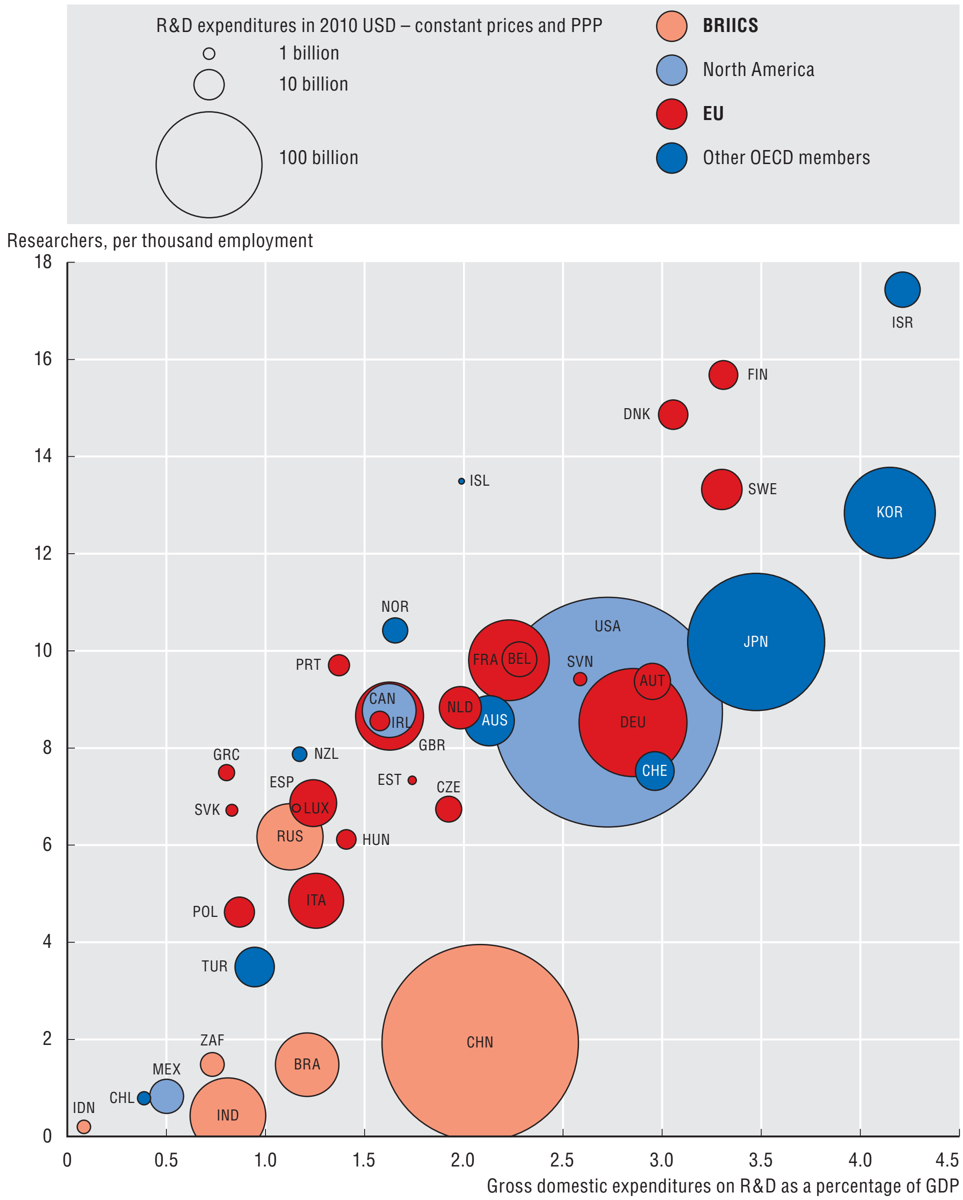
How to read this figure

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

R&D and top science

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

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



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

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

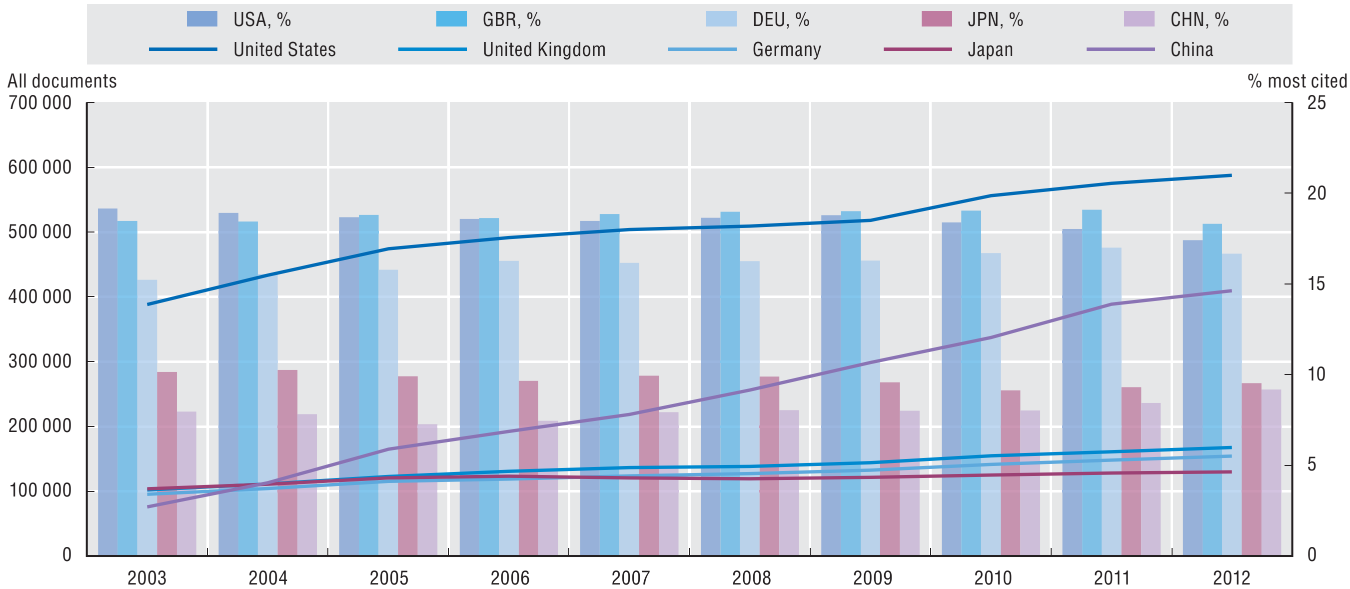
StatLink *http://dx.doi.org/10.1787/888933273287*

R&D and top science

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

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

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



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

StatLink http://dx.doi.org/10.1787/888933273291

How to read this figure

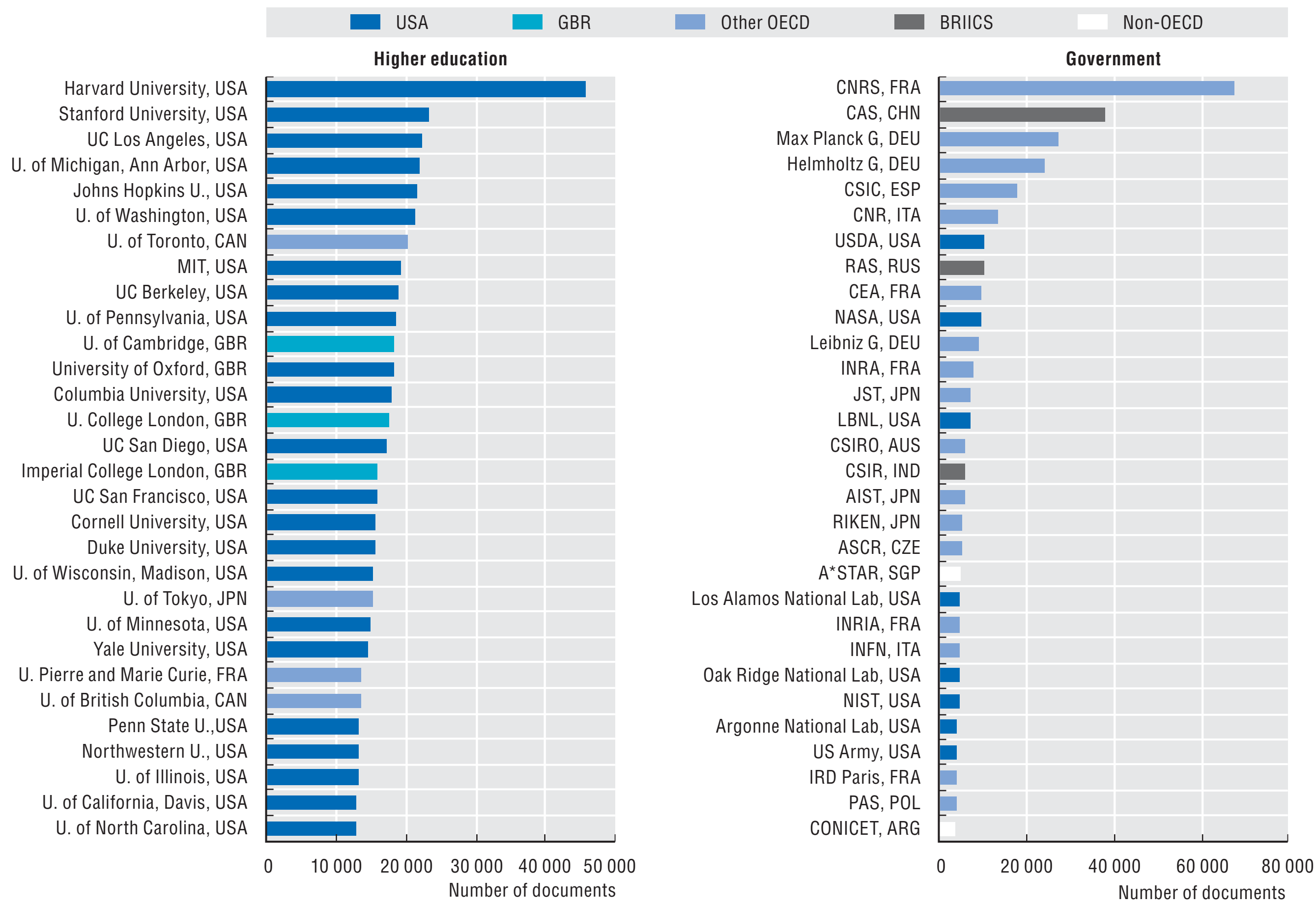
Lines depict absolute scientific publication output levels, but are not adjusted on a quality basis. *Excellence rates* – the proportion of publications within a country that feature within the global 10% most-cited publications – are represented by the bars and the values feature on the right hand scale.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

Scientific excellence

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

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

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



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

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

Analysing publications by sector

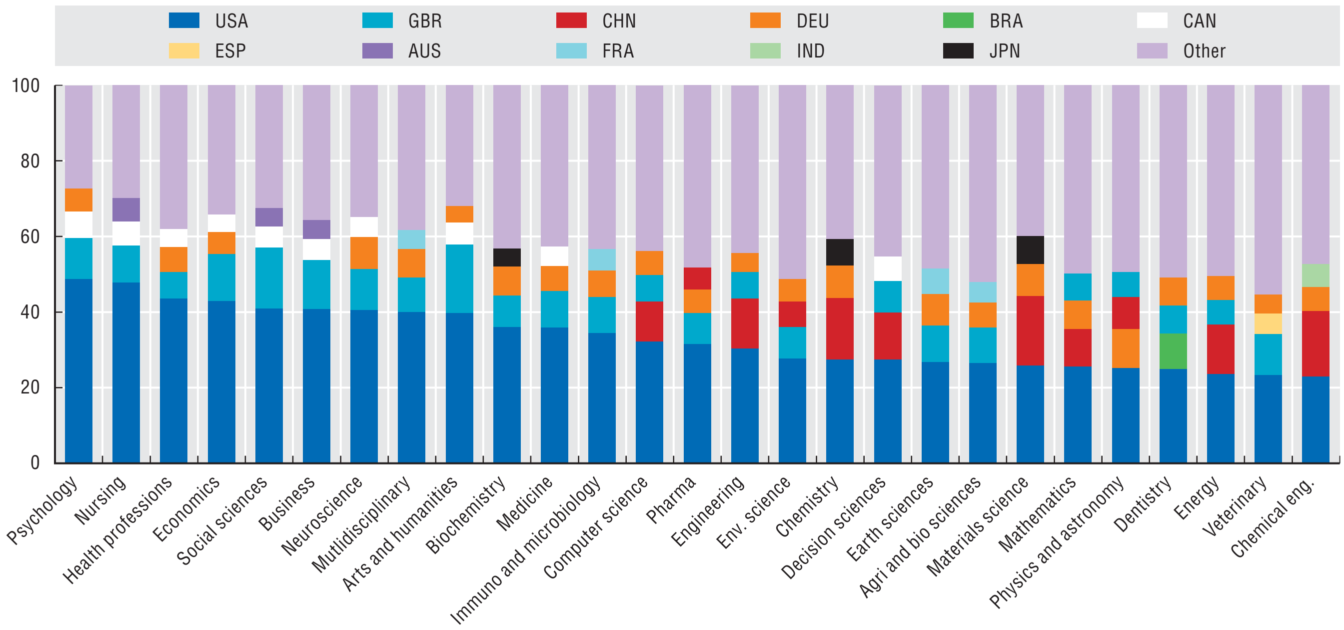
The analysis of top-cited publications is normalised by science domains, but the aggregation of these publications within institutions may give a larger weight to institutions that excel in specific fields. The definition of HE and government sectors used in this bibliometric analysis does not fully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

Scientific excellence

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

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

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



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

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

Interpreting these indicators

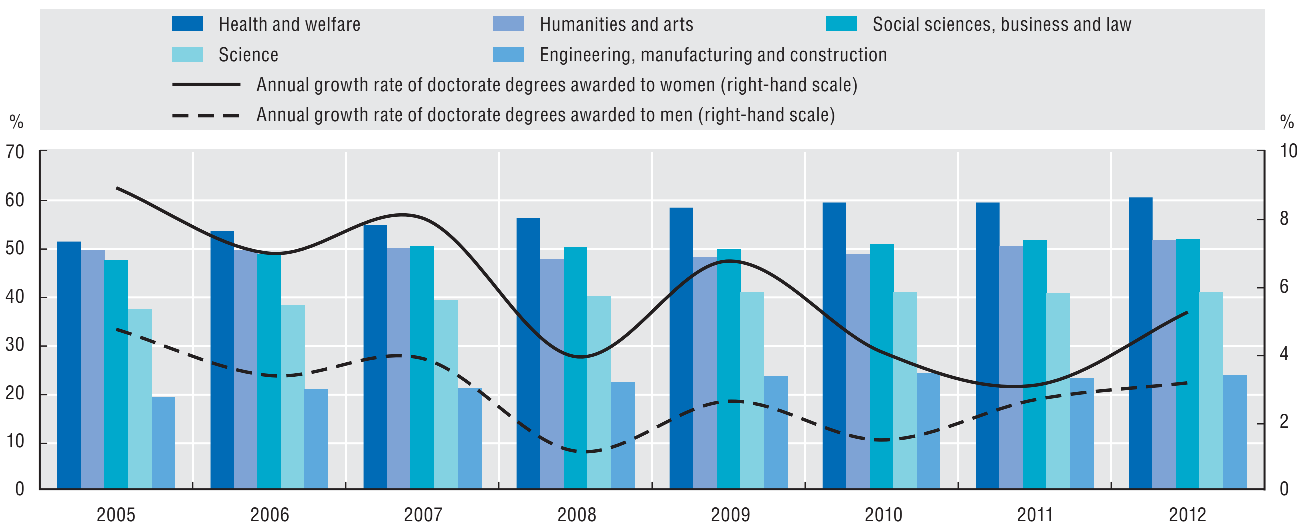
The top-10% most-cited publications are defined by reference to a subject-based norm, so as to take into account different citation patterns by field. The indicators show which institutions or countries account for the largest number of publications in the field-normalised 10% "high impact" group. They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

Women in science

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

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

Percentage shares of all doctoral degrees and annual growth rates



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

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How to read this figure

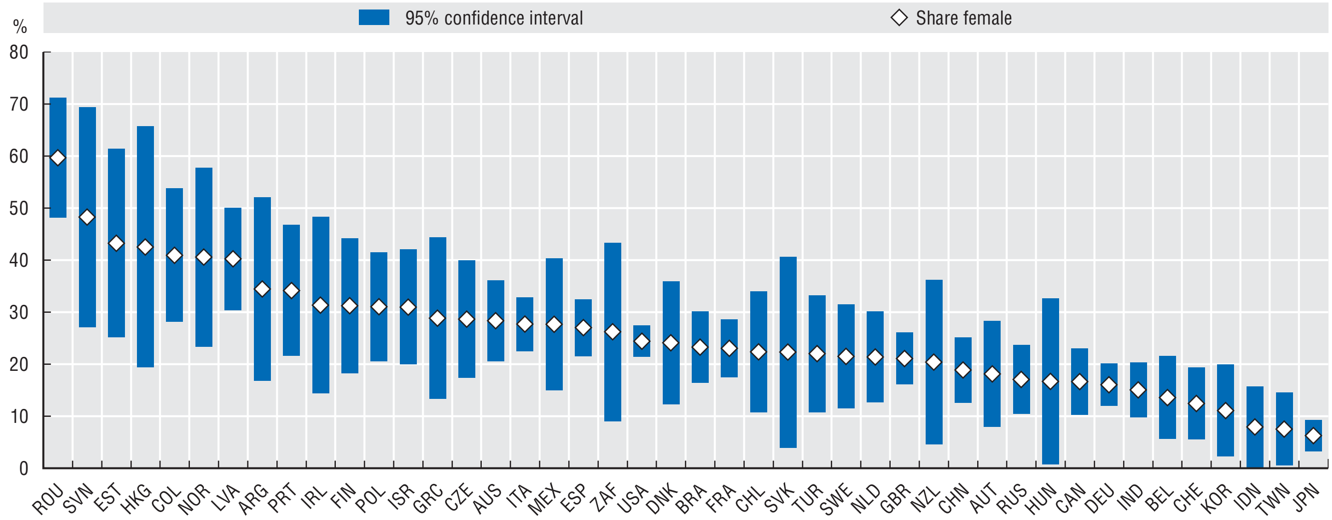
In 2012, women accounted for 60% (left-hand scale) of new doctoral degrees in Health and welfare disciplines were awarded to women, but only 20% of new doctoral degrees in Engineering, manufacturing and construction. The growth rate in the number of female new doctorates (right-hand scale) was larger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

Women in science

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

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

As a percentage of corresponding authors, estimated shares



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

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

How were these estimates derived?

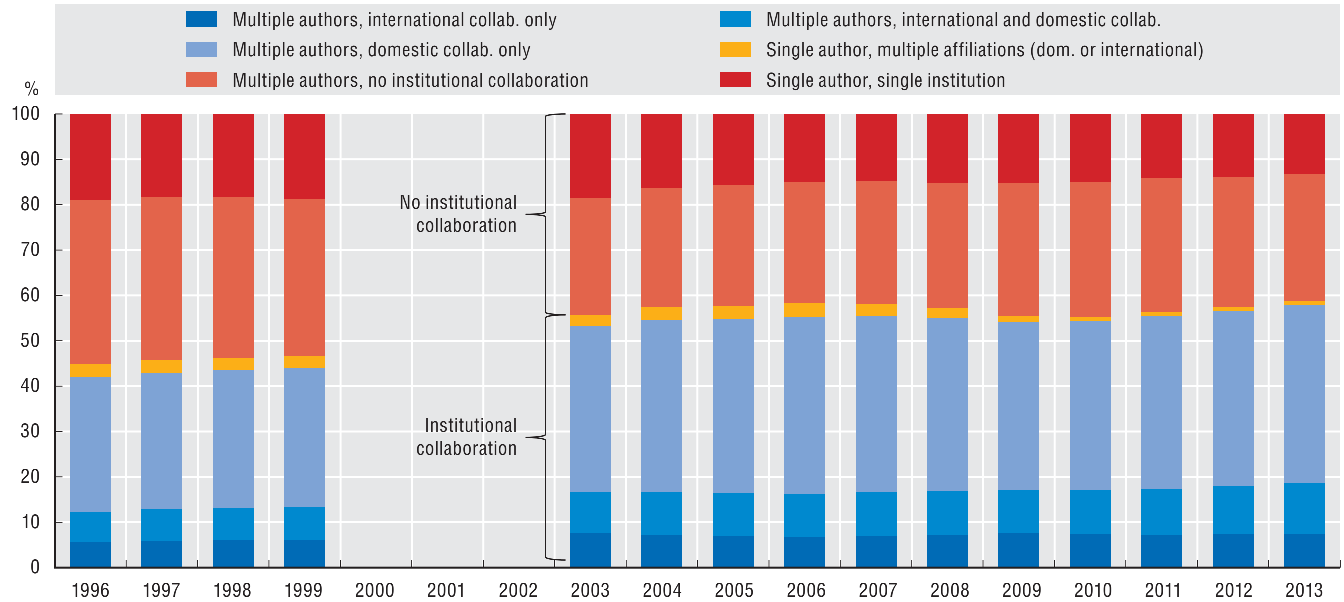
Estimates were based on the authors' self-reported gender in the OECD Pilot Survey of Scientific Authors carried out in January 2015 (*www.oecd.org/science/survey-of-scientific-authors.htm*). Samples were drawn from documents published in 2011 and indexed in the Scopus database, focusing on the document's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

Knowledge flows and collaboration in science

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

59. Global scientific collaboration trends, 1996-2013

As a percentage of all publications, fractional counts



Note: Results for 2000-02 not displayed because of incomplete indexation in the Scopus database of authors for publications in those years. Estimates based on available data would understate the true extent of scientific collaboration.
Source: OECD calculations based on *Scopus Custom Data*, Elsevier, Version 4.2015, July 2015. See chapter notes.
StatLink http://dx.doi.org/10.1787/888933273347

How to measure scientific collaboration?

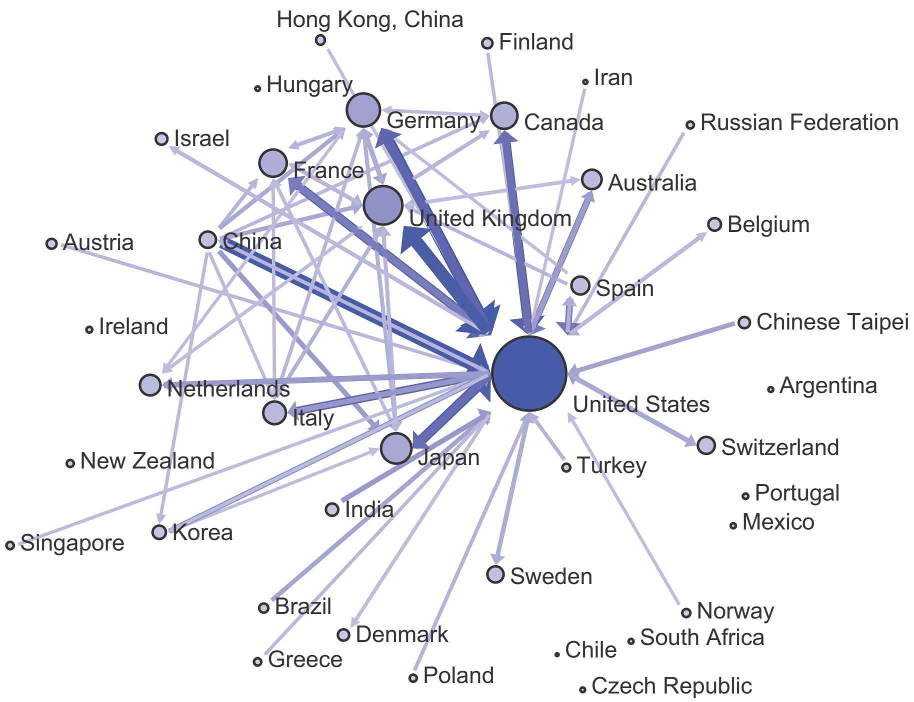
Scientific collaboration can be measured from an individual or institutional perspective. Scientists within the same institution may co-author a publication, however such cases do not entail inter-institutional collaboration. Collaboration across different institutions is often deemed a stronger form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

Knowledge flows and collaboration in science

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

60. International citation network, 1996-2013

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



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

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

How to read this figure

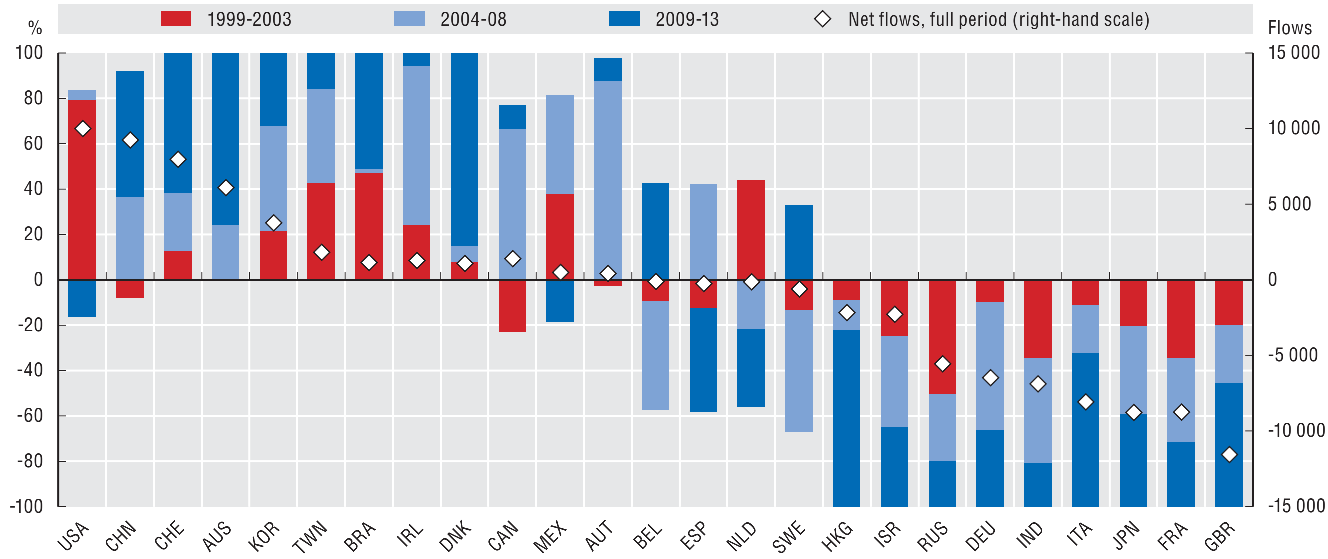
The position of selected economies (nodes) exceeding a minimum number threshold of 200 000 citations received has been determined by the total number of citations across economies from 1996 to 2013. For the arrows (citation flows) a minimum threshold of 100 000 citations was applied. A visualisation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

Researchers on the move

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

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

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



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

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

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

How to read this figure

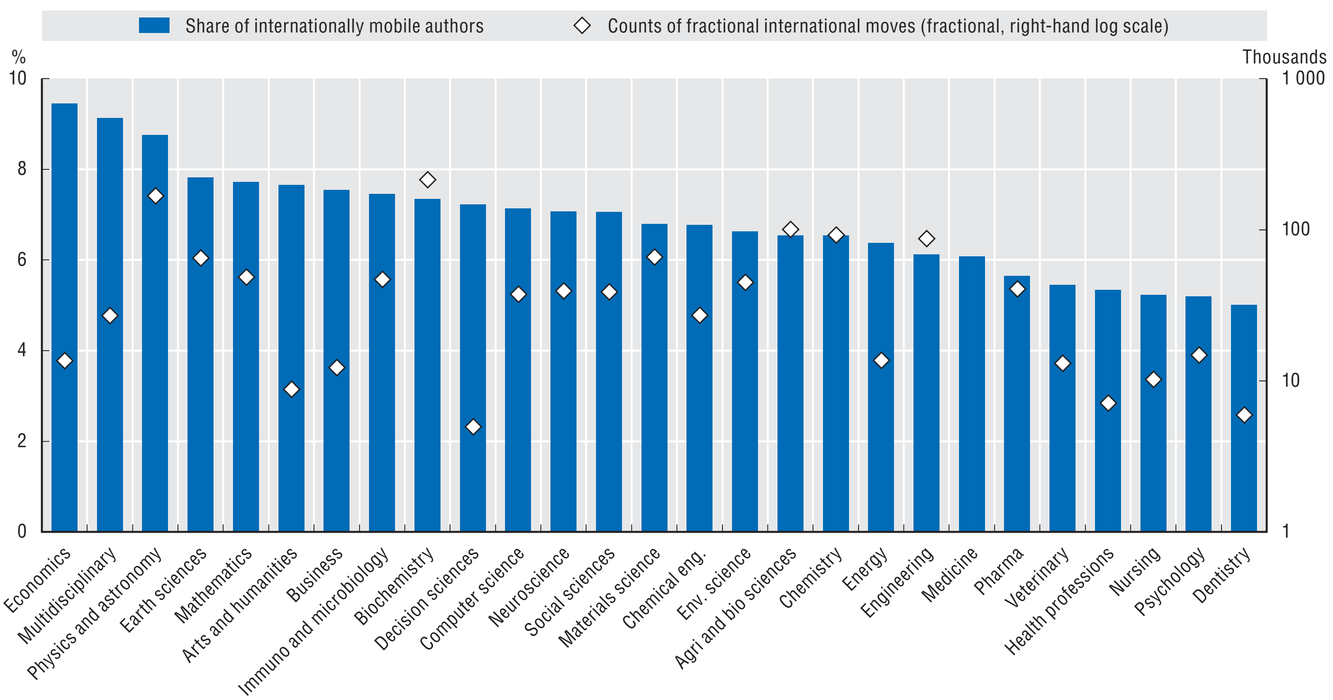
This figure decomposes the overall net flow of scientific authors across different years for economies experiencing the largest flows over the period 1998-2013, expressed in relative terms. This helps to identify the timing and intensity of different phases of net entry and net exit from the perspective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

Researchers on the move

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

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

Based on authors with publications in more than two years



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

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

How to measure scientific author mobility

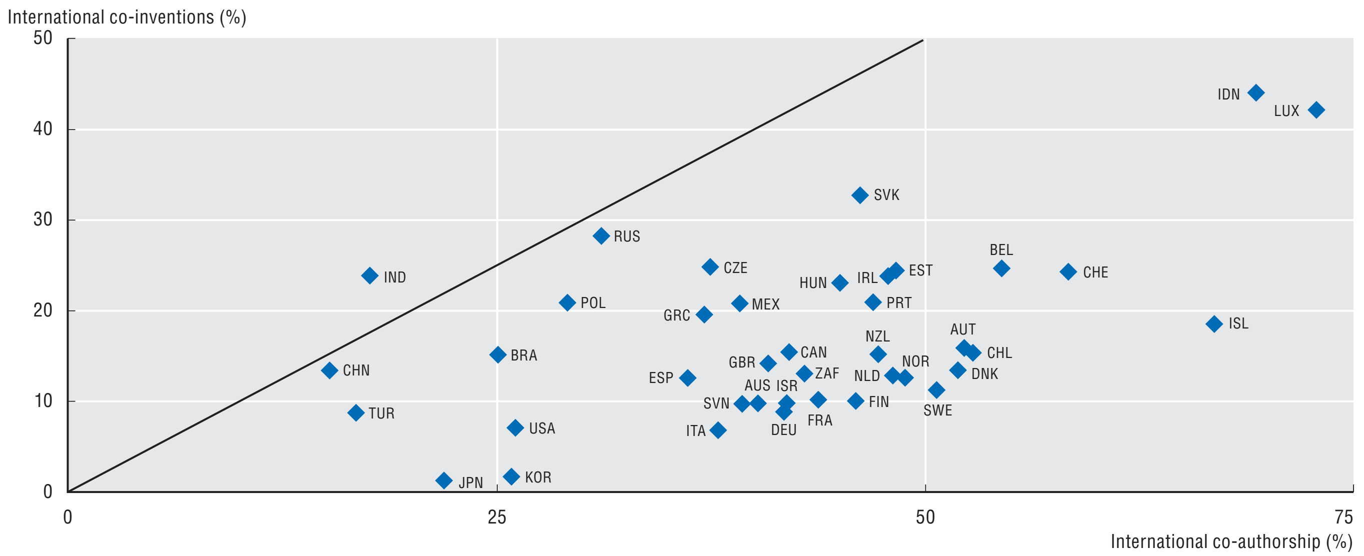
It is difficult to capture consistently the movement of scientists through statistical surveys which are national in scope. Monitoring changes in scientist affiliations in global repositories of publications provides a complementary source of detailed information but these are limited to authors who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

Collaboration and competition

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

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

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



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

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

How to read this figure

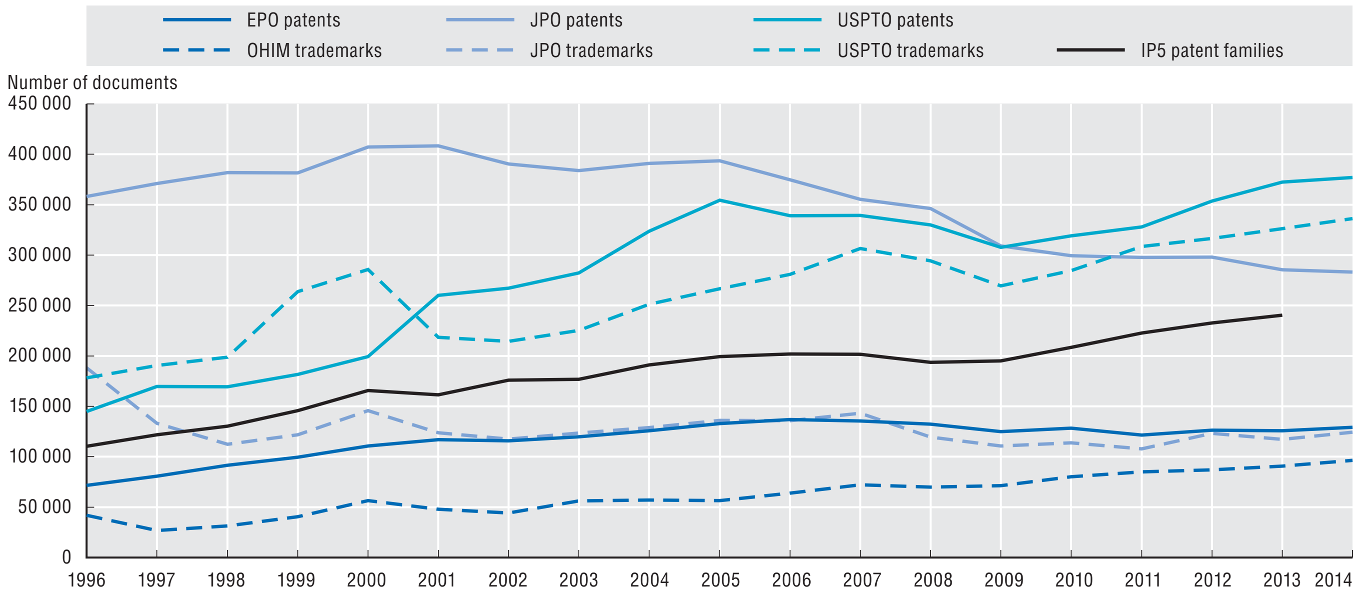
International co-authorship of scientific publications is measured in terms of the share of articles featuring authors affiliated with foreign institutions (from a different country or economy) in total articles produced by domestic institutions. International co-inventions are measured as the share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

Collaboration and competition

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

64. Trends in the IP bundle, 1996-2014

Patent and trademarks applications in selected IP offices



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

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

The geographical scope of IP protection

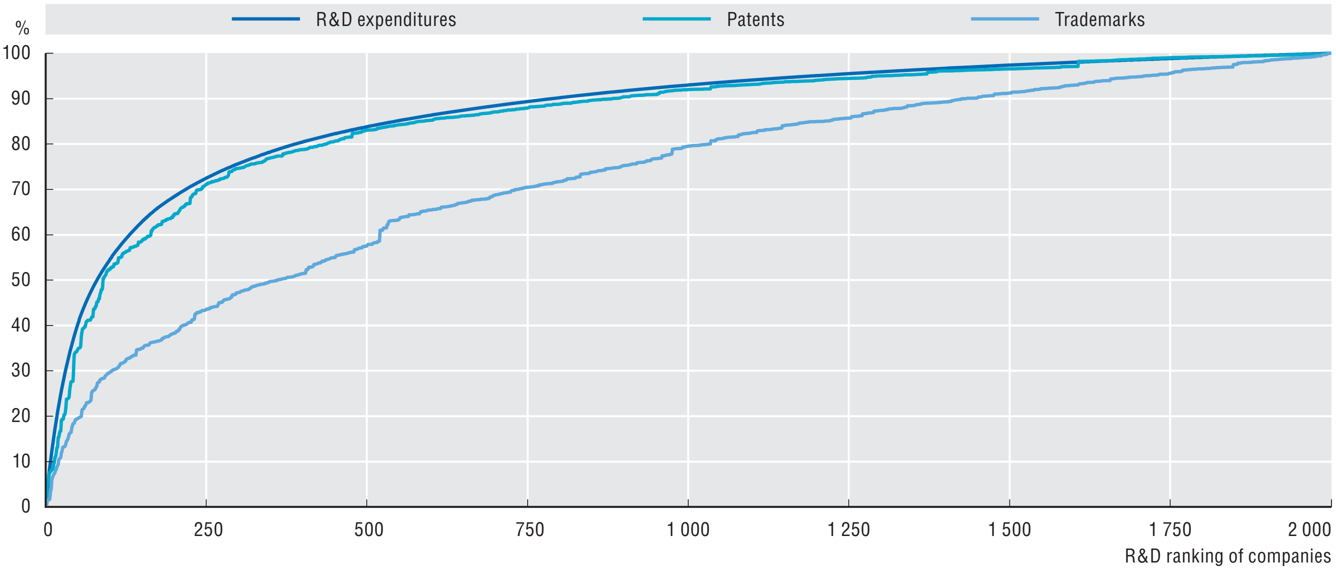
The data series mirror the number of new patent and trademark applications in the various IP offices by filing date. IP5 patent families correspond to patent families filed within the Five IP offices (IP5, i.e. the European Patent Office, EPO; the Japan Patent Office, JPO; the Korean Intellectual Property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

Top R&D corporate players

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

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

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



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

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

Who are the world top corporate R&D investors?

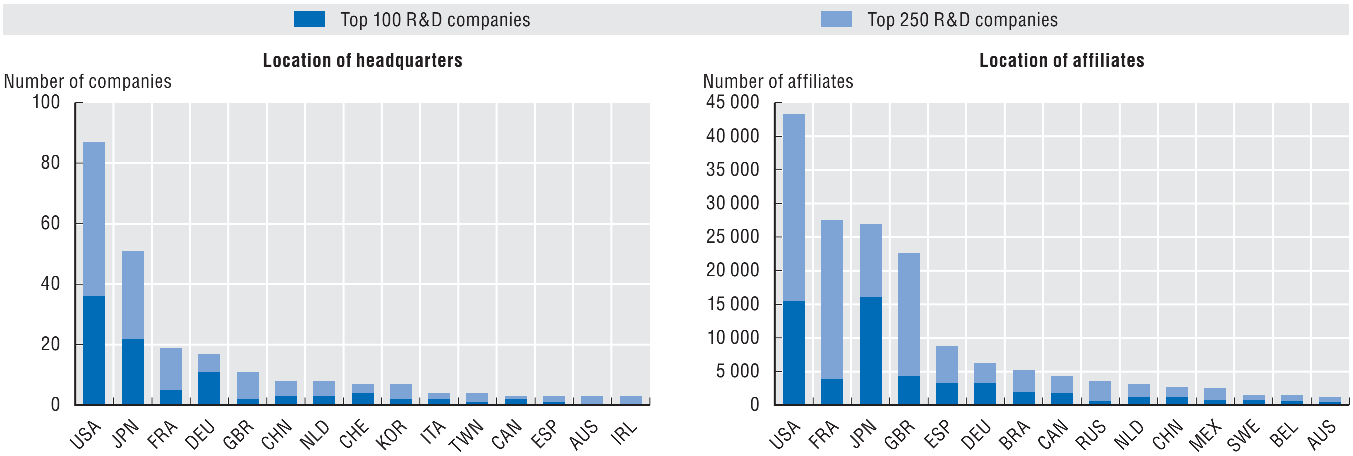
Top R&D investors worldwide are companies that are either parents of (a number of) subsidiaries or independent entities. In the former case, the R&D spending figure used for the ranking is that which appears in consolidated accounts and includes spending made by subsidiaries. In 2012, the top R&D investors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

Top R&D corporate players

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

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

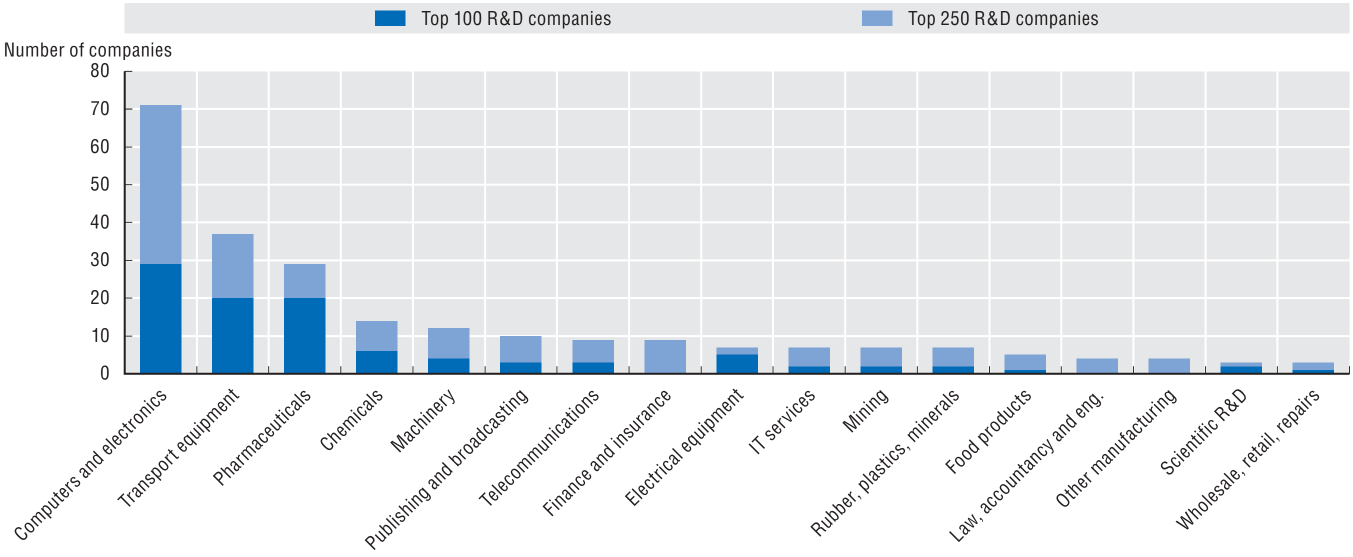
Number of companies and affiliates in the top 100 and top 250 R&D companies



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

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

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



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

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

IP bundle of top R&D players

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

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

Revealed technology advantage of companies' patent portfolio

Low specialisation | Average | High specialisation

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

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

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

How to read this figure

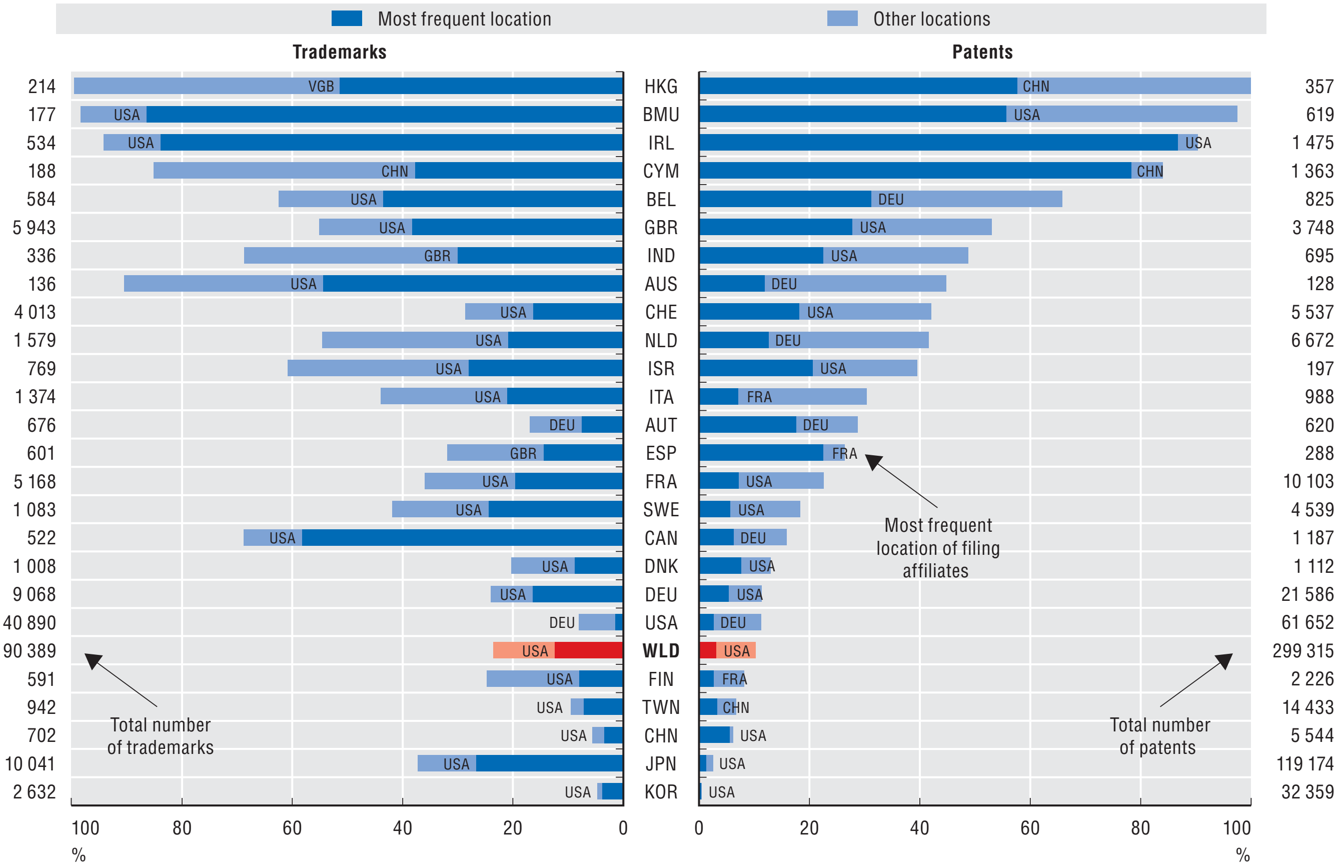
Patent families are sets of patents taken in multiple countries to protect a single invention obtained by means of extending the priority filing, i.e. the first application, to other offices. The revealed technological advantage (RTA) index uses data contained in patent families to provide an indication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

IP bundle of top R&D players

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

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

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



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

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

How to read this figure

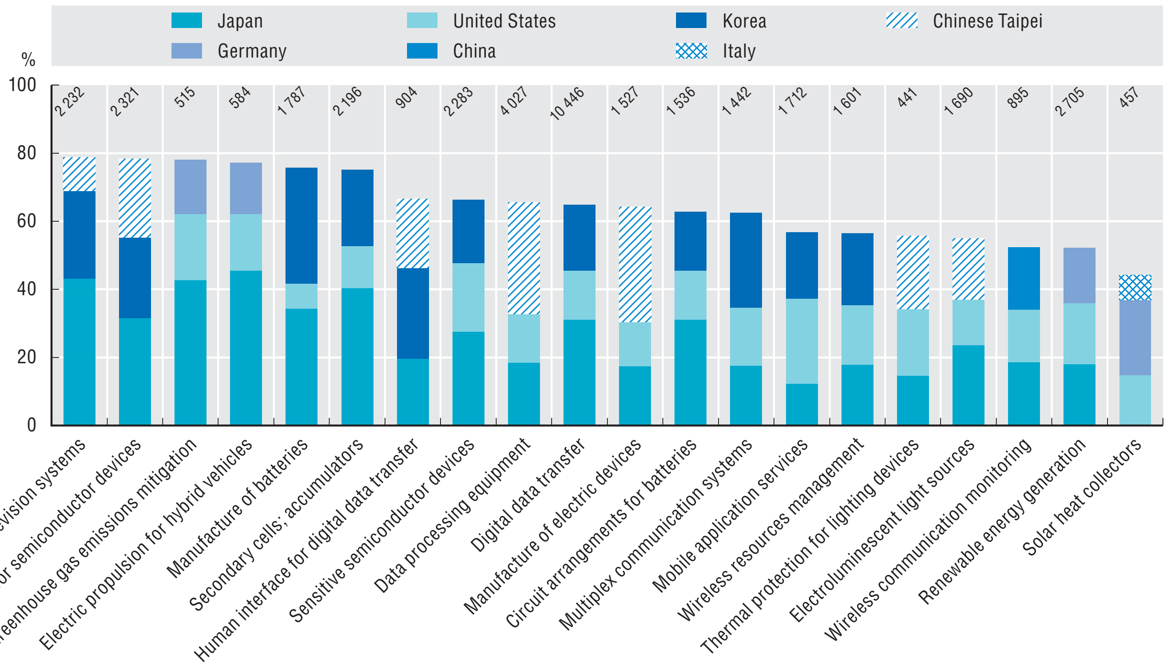
The figure refers only to IP (patents and trademarks) filed by affiliates at USPTO and EPO/OHIM. The bars show the percentage of IP accounted for by foreign affiliates of R&D corporations by location of the headquarters. The dark portion of the bar represents the percentage of IP accounted for by the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

Bursting technological developments

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

70. Top players in emerging technologies, 2010-12

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



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

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

Identifying acceleration in technological development

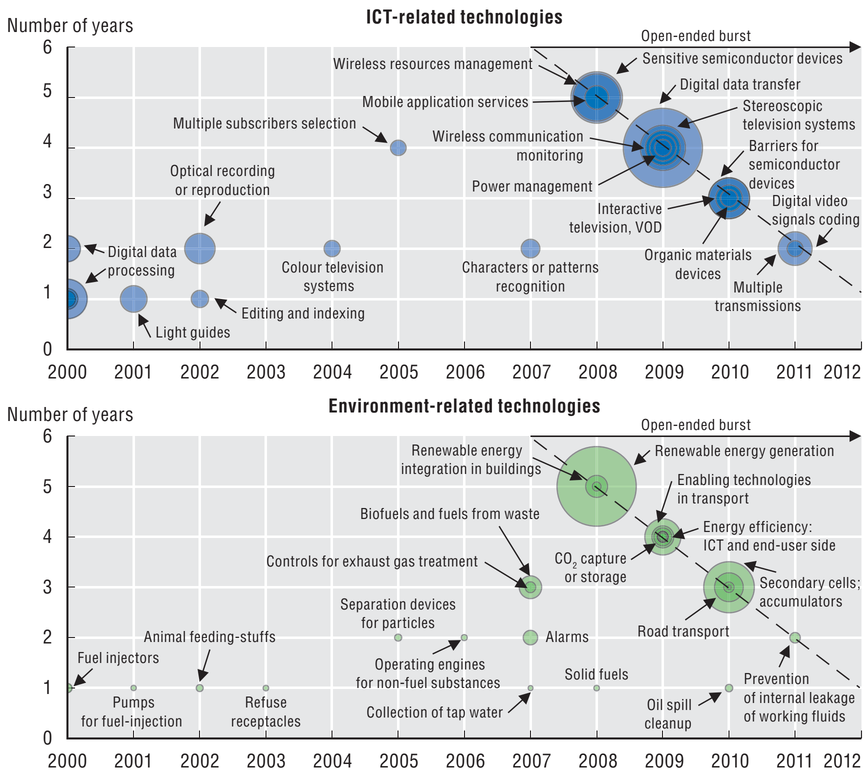
Patents protect novel inventions and technologies and patent data can help investigate the extent to which inventions occur in different technology areas, and the pace at which technologies develop, mature or are abandoned. A new data mining approach, called "DETECTS" (see Dernis, Squicciarini et al.,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

Bursting technological developments

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

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

Intensity of bursts (bubble size) and duration over time



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

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How to read this figure

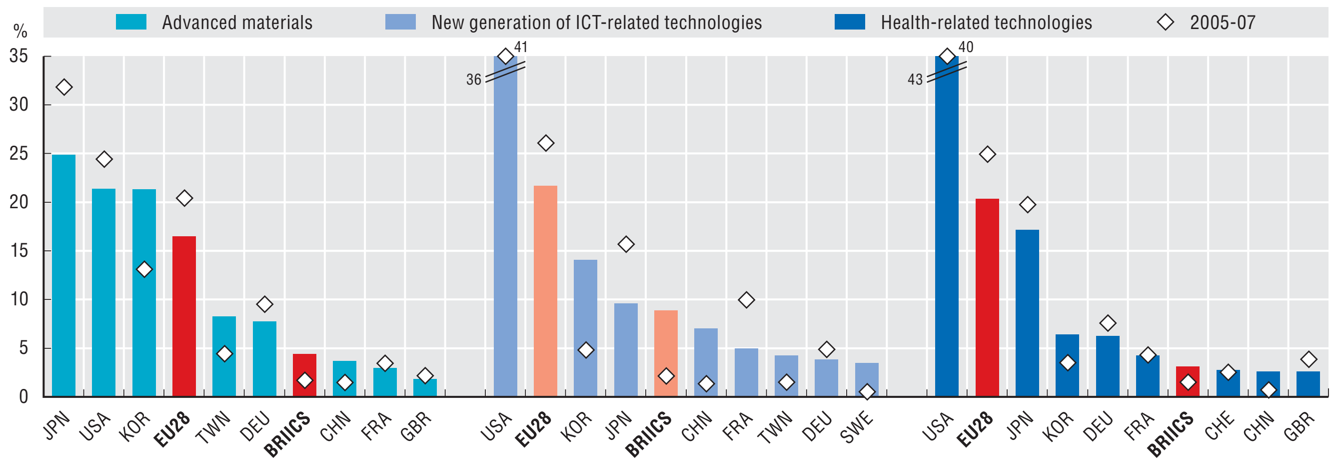
The size of the bubble indicates the "burst" intensity, and different shades indicate the different technologies that burst. The technology bursts in the year are indicated on the X axis and the acceleration of its development ends in t years after the burst, indicated on the Y axis. For example, acceleration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

A new generation of disruptive technologies

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

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

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



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

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

Methodology

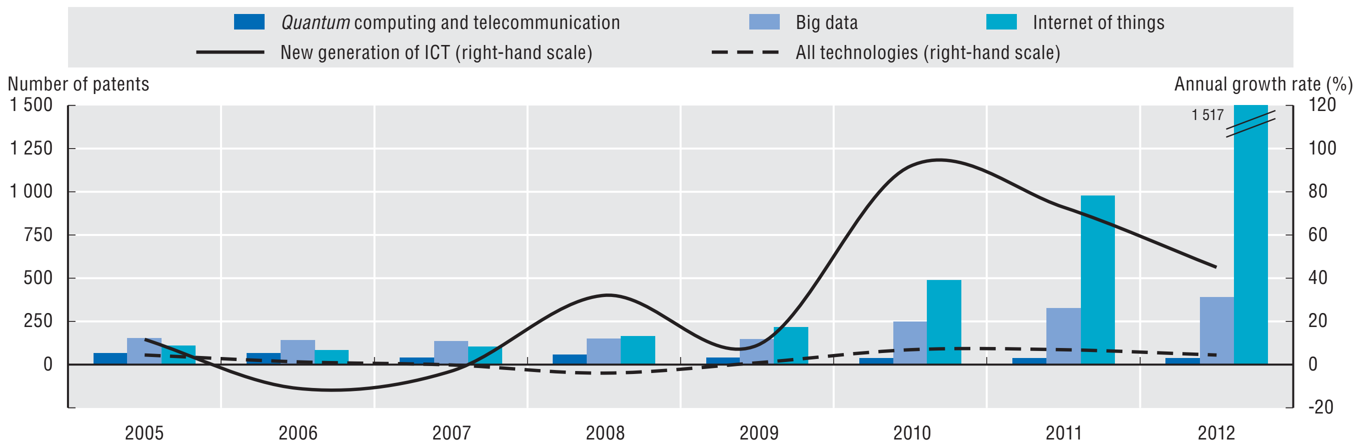
The UK Government has identified a number of technologies as potential sources of future growth. Experts from the UK Intellectual Property Office (IPO) mapped inventive activity in these technologies over the period 2004-13 through examination of patent documents published worldwide. Among the identified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

A new generation of disruptive technologies

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

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

Number of IP5 patent families and annual growth rates

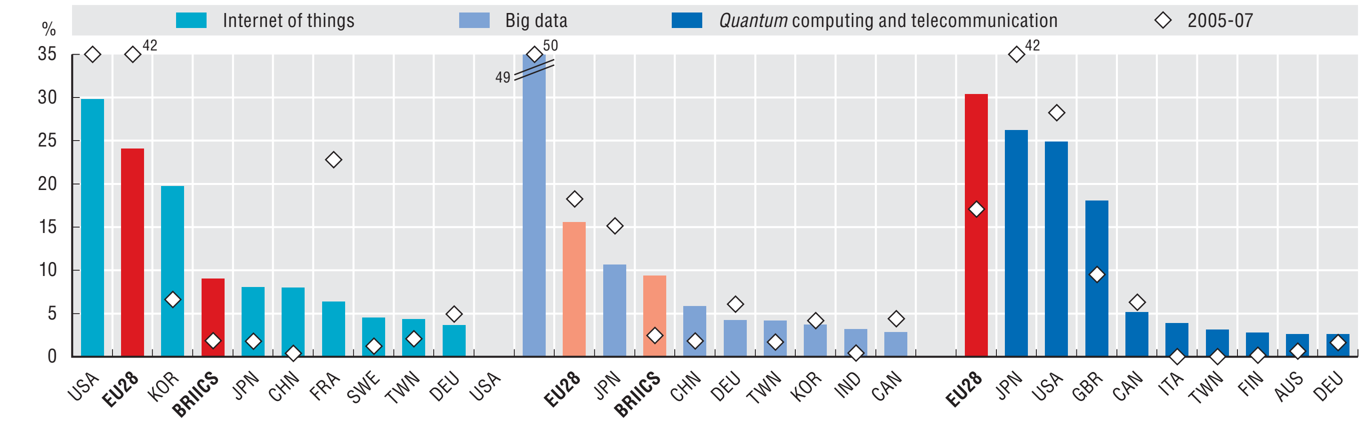


Source: OECD calculations based on IPO (2014), *Eight Great Technologies: the Patent Landscapes*, United Kingdom; and *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats*, June 2015. See chapter notes.

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

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

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



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

StatLink http://dx.doi.org/10.1787/888933273495

Notes and references

Cyprus

The following note is included at the request of Turkey:

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

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

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

Israel

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

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

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

Data for 2014 are provisional.

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

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

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

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

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

Rates are seasonally adjusted.

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

General notes:

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

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

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

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

Data for Japan are limited to the manufacturing sector only.

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

Additional note:

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

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

See general notes under 5.

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

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

See general notes under 5.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

General notes:

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

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

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

Additional notes:

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

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

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

See general notes under 19.

Additional notes:

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

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

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

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

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

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

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

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

Labour productivity is estimated as GDP per person engaged.

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

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

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

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

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

24. Labour productivity in information industries, 2001 and 2013

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

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

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

For Mexico, data refer to 2003.

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

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

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

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

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

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

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

See notes under 25.

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

See notes under 25.

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

General notes:

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

Additional notes:

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

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

See general notes under 28.

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

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

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

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

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

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

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

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

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

For Indonesia, the 2004-07 average is shown.

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

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

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

OECD here does not include Luxembourg and the Slovak Republic.

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

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

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

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

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

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

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

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

See notes under 35.

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

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

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

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

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

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

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

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

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

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

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

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

General notes:

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

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

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

Additional note:

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

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

See general notes under 42.

Additional note:

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

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

See general notes under 42.

Additional note:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

For Indonesia, data refer to 2009.

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

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

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

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

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

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

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

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

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

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

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

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

For Italy, 2008-10 data are OECD estimates.

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

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

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

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

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

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

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

59. Global scientific collaboration trends, 1996-2013

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

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

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

This is an experimental indicator.

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

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

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

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

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

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

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

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

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

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

64. Trends in the IP bundle, 1996-2014

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

70. Top players in emerging technologies, 2010-12

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

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

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

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

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

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

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

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

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

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

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

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

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