

OECD Science, Technology and Industry Scoreboard 2011

INNOVATION AND GROWTH IN KNOWLEDGE ECONOMIES

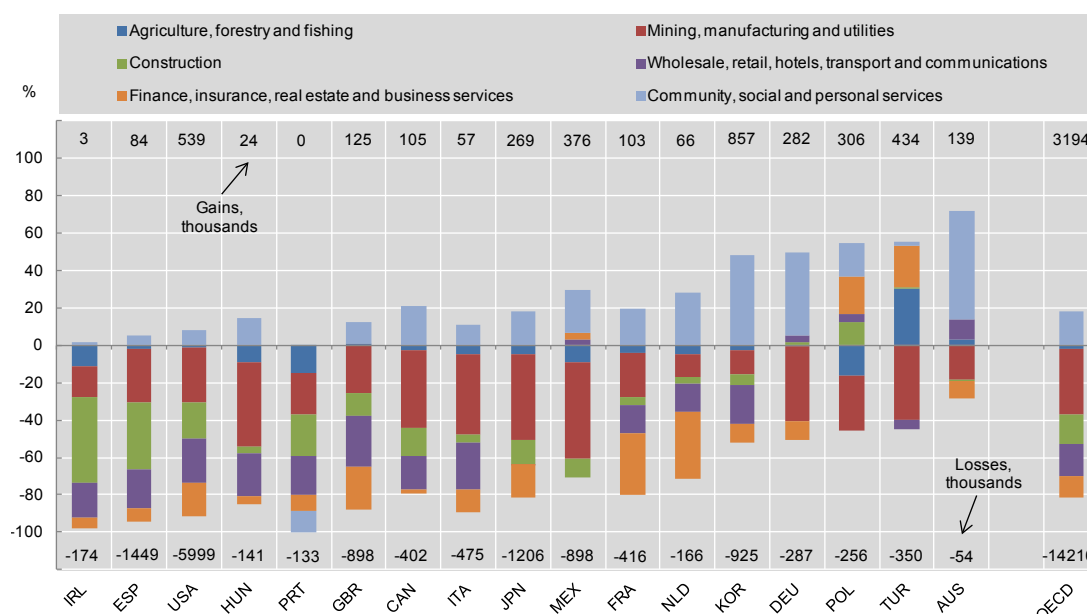
Highlights

Today, the world's economies are facing some extraordinary challenges. The effects of the recent economic downturn are still being felt, with national debt levels rising and unemployment remaining high. Accompanying this is continued globalisation of economic activities. Its distinctive features are increasing international trade, deepening economic integration – especially in emerging economies – and greater geographic fragmentation of production processes generating ever more complex global value chains. In this new geography of growth, international competition from new players is eroding the lead of more established economies. Environmental pressures challenge the sustainability of our existing growth models and longer life expectancy is putting a greater strain on the capability of health systems to meet the needs of an ageing population. Innovation is increasingly seen as being critical for effectively meeting these challenges. It will play a major role in lifting economies out of the economic crisis and finding new and sustainable sources of growth and competitiveness.

The new geography of growth

Where people lost their jobs, selected countries, 2008-09

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



Source: OECD, Structural Analysis (STAN) Database, OECD National Accounts (SNA) Database and national statistical institutes, June 2011.

StatLink <http://dx.doi.org/10.1787/888932484797>

Between 2008 and 2009, in the immediate aftermath of the crisis, the OECD as a whole suffered a net loss in employed persons of about 11 million, a 2% drop. Half of these losses occurred in the United States. Manufacturing as a sector lost most jobs, although construction (Ireland, Spain) and finance and business services (France, Netherlands) were also strongly impacted. For many OECD countries, significant losses in employment continued well into 2010.

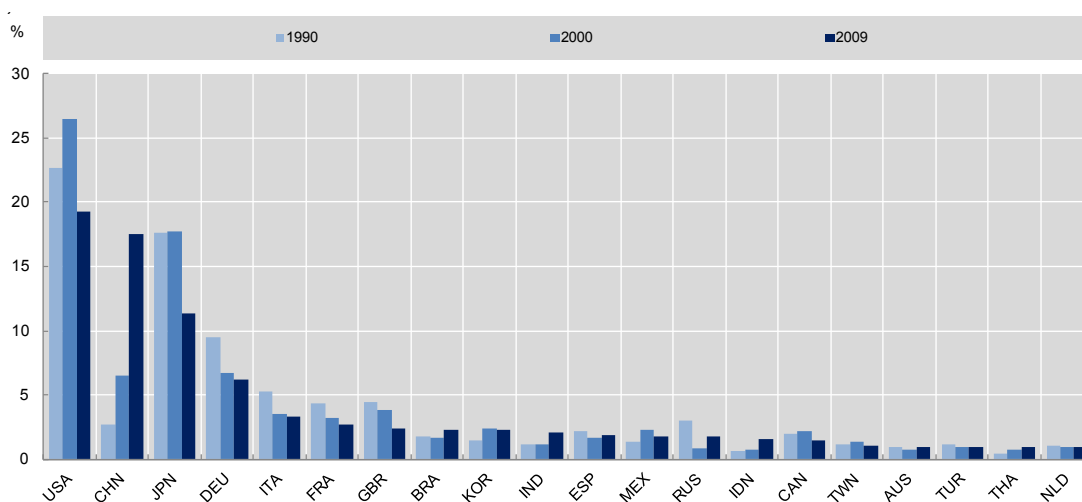
In 1990 the G7 countries accounted for two-thirds of world manufacturing value added but they now account for less than half

The decline in manufacturing production in many OECD countries occurred against the backdrop of longer-term growth trends in emerging economies and increasing international competition. By 2009, the People’s Republic of China had almost caught up with the United States in manufacturing production, and the share of Brazil and India among world manufacturers is now similar to that of Korea.

Declining manufacturing production means that, on average, services now account for about 70% of OECD gross domestic product (GDP). In addition, over 35% of employees in manufacturing in the OECD area perform services-related occupations, with percentages ranging between 17 % and 52% across economies.

Top manufacturers in the last 20 years, 1990, 2000 and 2009

Percentage share of total world manufacturing value added



Source: United Nations Statistical Division, National Accounts Main Aggregates Database, May 2011.

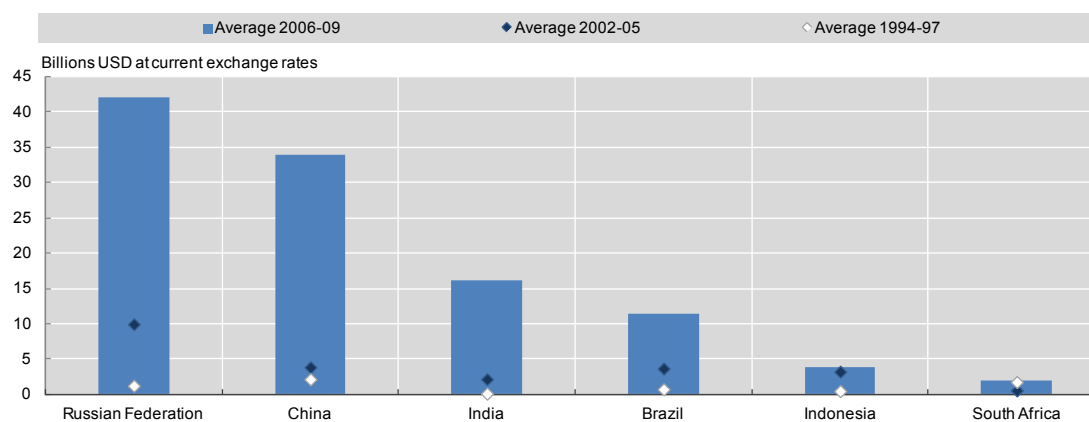
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Average outward investment flows from China increased ninefold between the early and late 2000s; those from India increased more than sevenfold

The BRIICS economies (Brazil, the Russian Federation, India, Indonesia, China and South Africa) have become more integrated in the global economy. China is set to become the second largest recipient of foreign direct investment. During the period 2003-09, EU countries invested four times as much in the BRIICS economies as the United States or Japan. Direct investment in China from Europe, which partly includes flows from non-EU multinationals located in Europe, averaged USD 6.5 billion a year, 75% more than that from the United States, and over USD 9 billion a year in Brazil, four times that from the United States.

Foreign direct investment outward flows from BRIICS, 1994-97, 2002-05 and 2006-09

Yearly averages



Source: IMF, Balance of Payments Statistics, June 2011.

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China's role as an exporter of high-end intermediates and capital goods has increased over the past 15 years

While OECD countries' export volume has nearly doubled over the past 15 years, their share of world exports declined from 75% to 60%. In 1995 the value of China's exports was USD 148 billion, of which 60% was destined for final consumption. By 2009, the value of China's exports had increased more than tenfold from USD 148 billion to USD 1 529 billion and the composition of its exports had changed substantially. In the BRIICS, high-technology manufacturing trade now represents about 30% of their total manufacturing trade, compared to 25% for the OECD area.

Competing in the global economy

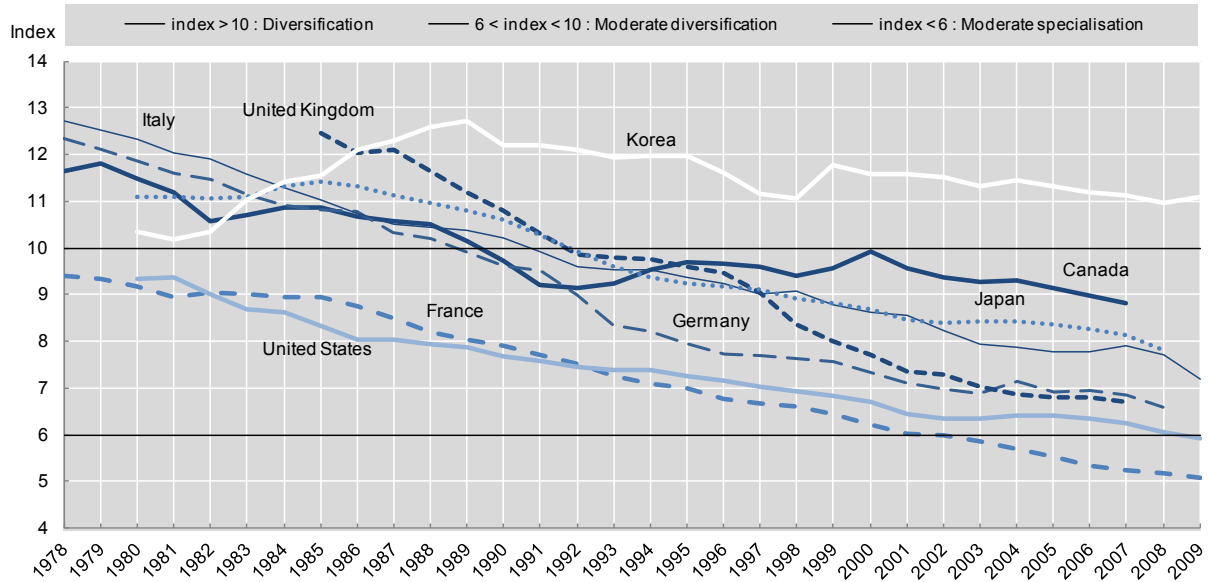
As economic activities become more global, economies tend to become more specialised. The degree of industrial specialisation, for example a strong reliance on mining, construction or financial services, has important impacts on economies' long-run productivity, their resilience to a crisis, investment patterns, innovativeness and performance of firms and sectors. A new OECD indicator shows rising economic specialisation since the 1970s, with Canada the only G7 country to experience periodic bursts of diversification. In contrast, Korea's specialisation patterns partially reflect the development path previously travelled by G7 countries – early increasing diversification (into industry and services), peaking in the late 1980s, before gradual specialisation as comparative advantages became more pronounced.

In the G7 countries, the four largest sectors represent on average 55% of total value added

A few broad sectors, typically "Wholesale and retail" and "Business services", are consistently among the top four in terms of their share of value added. The size of the two leading sectors differs considerably across countries: in Norway, "Mining and quarrying" is three times the size of the second largest sector but in Spain, the largest sectors are of more similar size.

Industrial diversification index for selected countries, 1978-2009

Sectoral concentration measured by shares of sectors in total value-added, current prices

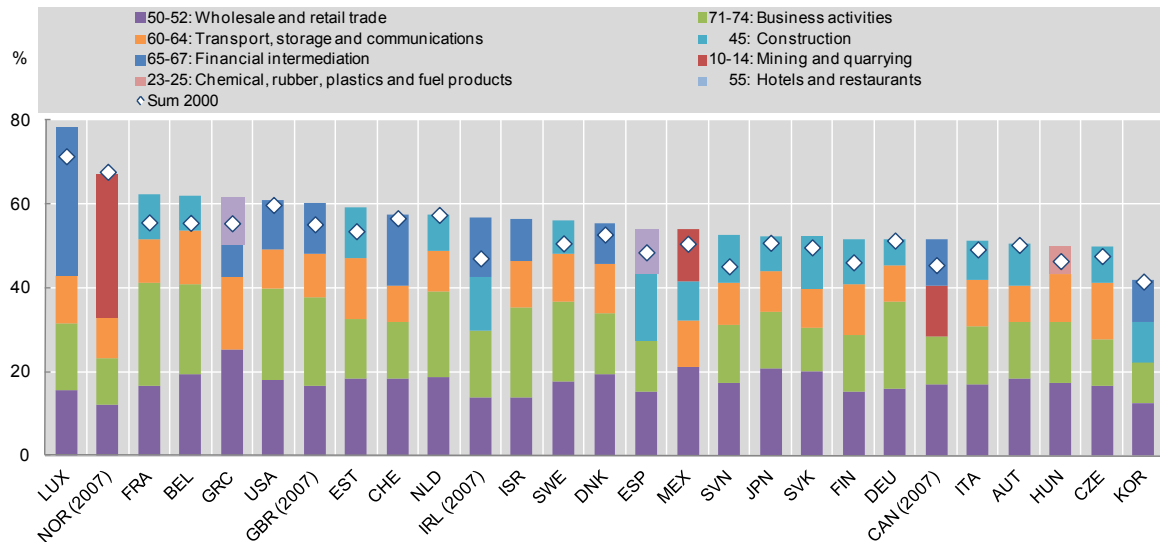


Source: OECD, Structural Analysis Database (STAN), May 2011.

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Value added of the top four industries, 2008

As a percentage of total value added (excluding real estate and the public sector)



Source: OECD, Structural Analysis Database (STAN), May 2011.

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Universities are among the three top sectors in the commercialisation of key enabling technologies such as biotechnology and nanotechnology

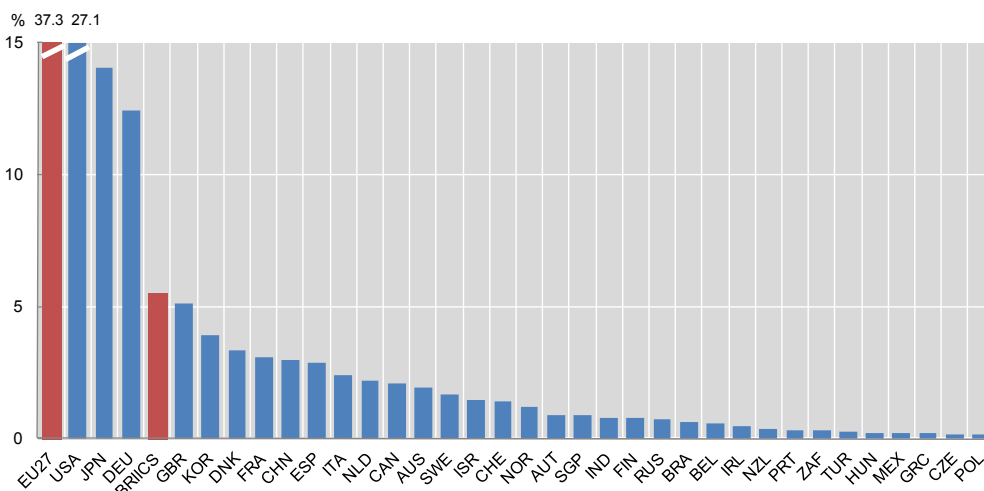
One way to measure technological innovation is through the commercialisation of inventions as reflected in patenting. While countries “specialise” in certain economic activities, new OECD indicators based on linking patents with companies’ information reveal the benefits of a broad industrial base and a strong university sector for the development of key enabling technologies. Chemical firms, for example, contribute to the advancement of pharmaceuticals and biotechnologies, and to a lesser extent also to nanotechnologies. Institutions such as universities are also essential to these fields with 10-12% of patents originating from the education sector. Similarly important are research and development service providers. New information and communication technologies are concentrated in computer and communications industries, while environmental technologies are shaped by the patenting activity of specialised machinery manufacturers and certain technical and engineering service activities.

Europe is targeting and leading in “clean” energy technologies – the EU27 represented 37% of all PCT filings in this field in the late 2000s

Countries are building technological capabilities in new fields. Revealed technology advantage indexes show that in the past decade China went from having no area of specialisation to being one of the top 3 countries specialised in ICT innovation. Denmark, Belgium and Spain are among the top specialised countries in biotechnology; the Czech Republic, Ireland and the Netherlands are relatively specialised in nanotechnologies and Finland in ICT innovation. Europe is targeting and leading in clean energy technologies, mainly thanks to Germany’s lead. The EU27 represented 37% of all PCT filings in this field in the late 2000s, followed by the United States and Japan. China’s share in such patents now ranks eighth worldwide. The United States maintains the lead in health-related technologies, while Japan leads innovative efforts in environmental technologies including innovation for climate change mitigation.

Countries’ share of patents for energy generation from renewable and non-fossil sources, 2007-09

Patent applications filed under the PCT



Source: OECD, Patent Database, May 2011.

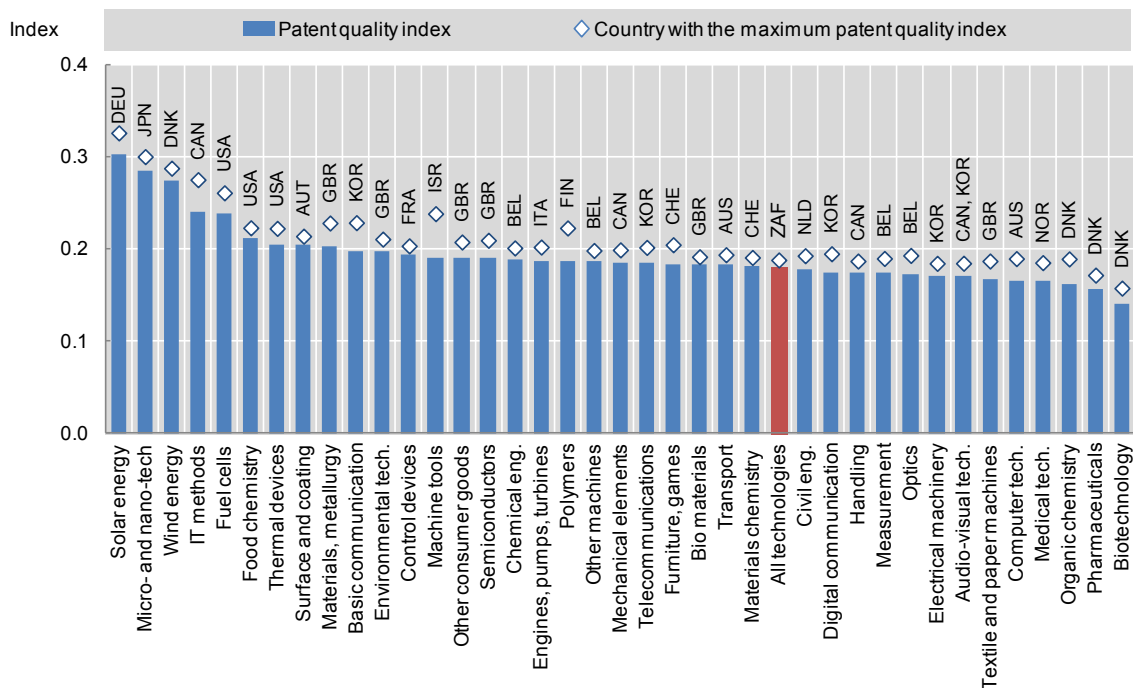
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Between 1996 and 2000, about 70% of the top 1% of highly cited patents were from the United States, Germany and Japan. Five years later, that share had fallen to 60%

Some patents filed are more valuable than others as they may lead to major inventions. Patents from inventors in the United States, Germany and Japan are still among the most highly cited ones, however the Asian powerhouses of China, India and Korea have gained in importance. On average, only under a quarter of all patents filed make it to the market (they are granted by the patent examiner). A new composite index of “quality” of patents granted, based on six dimensions, shows the average quality of patents filed at the European Patent Office. The index suggests that rising patenting activity has been accompanied by an average 20% decline in patent quality over the past two decades. The quality of innovations protected in Europe in the past decade was highest in renewable energy technologies, nanotechnologies and software for business methods. These are less mature markets in which there is more scope for breakthrough inventions. Differences between top performers and the average quality level for a particular sector provides an indication of countries’ innovative advantages. The quality of UK inventions protected on the EU market outperforms average quality on a wide range of technology fields (six fields in the chart), followed by Korea (five fields, mostly related to ICTs).

Patent quality index by technology field, 2000-10

Composite index based on patents granted by the EPO



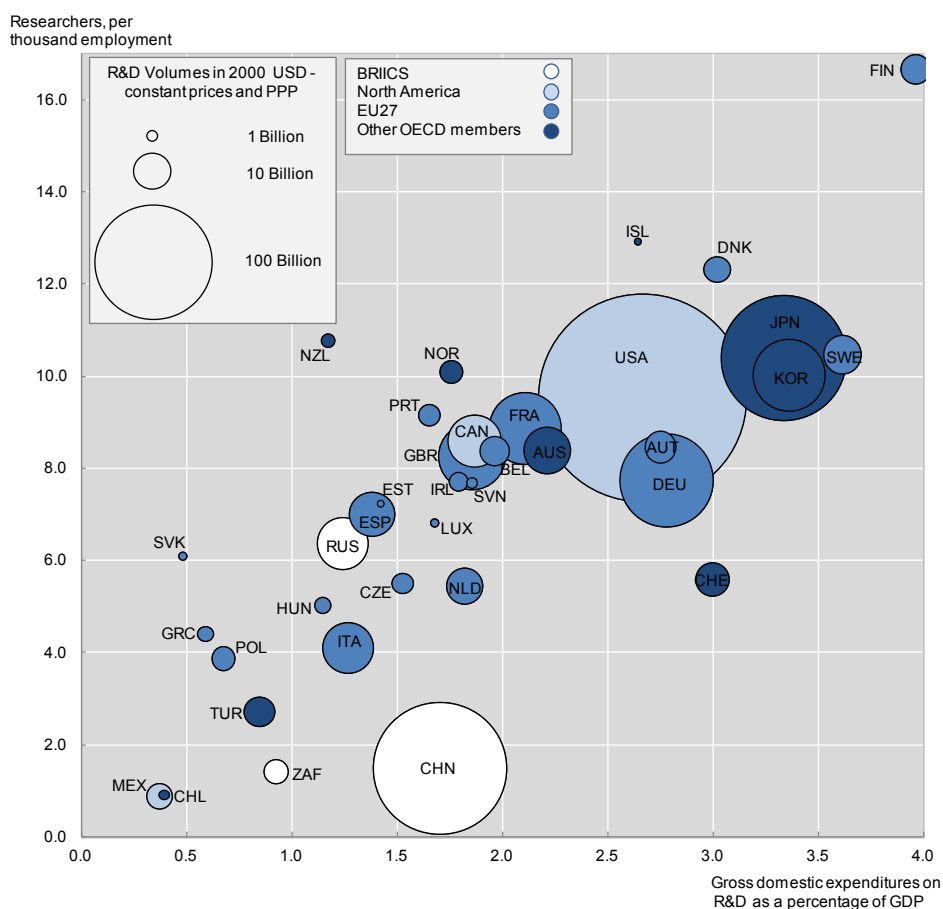
Source: OECD, calculations based on the Worldwide Patent Statistical Database, EPO, April 2011.

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Benefiting from global knowledge at the local level

Scientific production relies on critical mass that supports the creation of networks of knowledge sharing. Many countries are building centres of excellence to create the optimum conditions for raising research quality and impact. While the United States remains the largest performer of research and development (R&D) in the world, non-OECD economies account for a growing share of the world's R&D, measured in terms of both number of researchers and R&D expenditures. In 2009, China became the second largest R&D performer in the world, investing USD 154 billion at current prices purchasing power parity (PPP).

R&D in OECD and non-OECD economies, 2009 or latest available year



Source: OECD, Main Science and Technology Indicators Database, June 2011.

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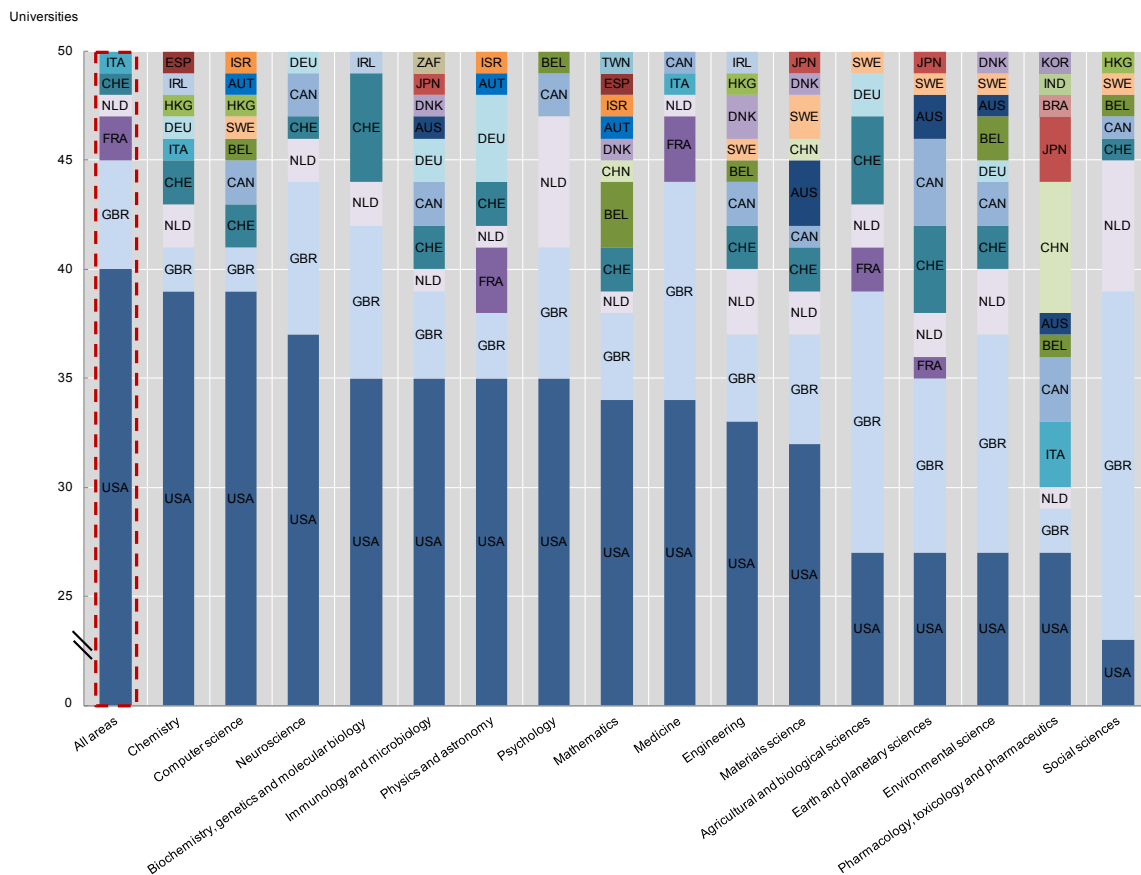
Forty of the world top 50 universities with the highest research impact – are located in the United States, with the rest in Europe

While research efforts are increasing across the globe, top research remains highly concentrated. A new indicator of research impact – measured by normalised citations to academic publications across all disciplines – shows that 40 of the world top 50 universities are located in the United States, with some US universities excelling in a wide range of disciplines. Stanford University features among the top 50 for all 16 subject areas, and 17 other US universities feature in the top 50 in at least 10 scientific fields.

A more diverse picture emerges on a subject-by-subject basis. The United States accounts for less than 25 of the top 50 universities in social sciences, a field in which the United Kingdom plays a key role. The universities producing the top-rated publications in the areas of earth sciences, environmental science and pharmaceuticals are more evenly spread across economies. Universities in Asia are starting to emerge as leading research institutions: China has six in the top 50 in pharmacology, toxicology and pharmaceuticals. The Hong Kong University of Science and Technology is among the top universities in computer science, engineering and chemistry.

University hotspots – geographical distribution of highest impact institutions, 2009

Location of top-50 universities by main subject areas



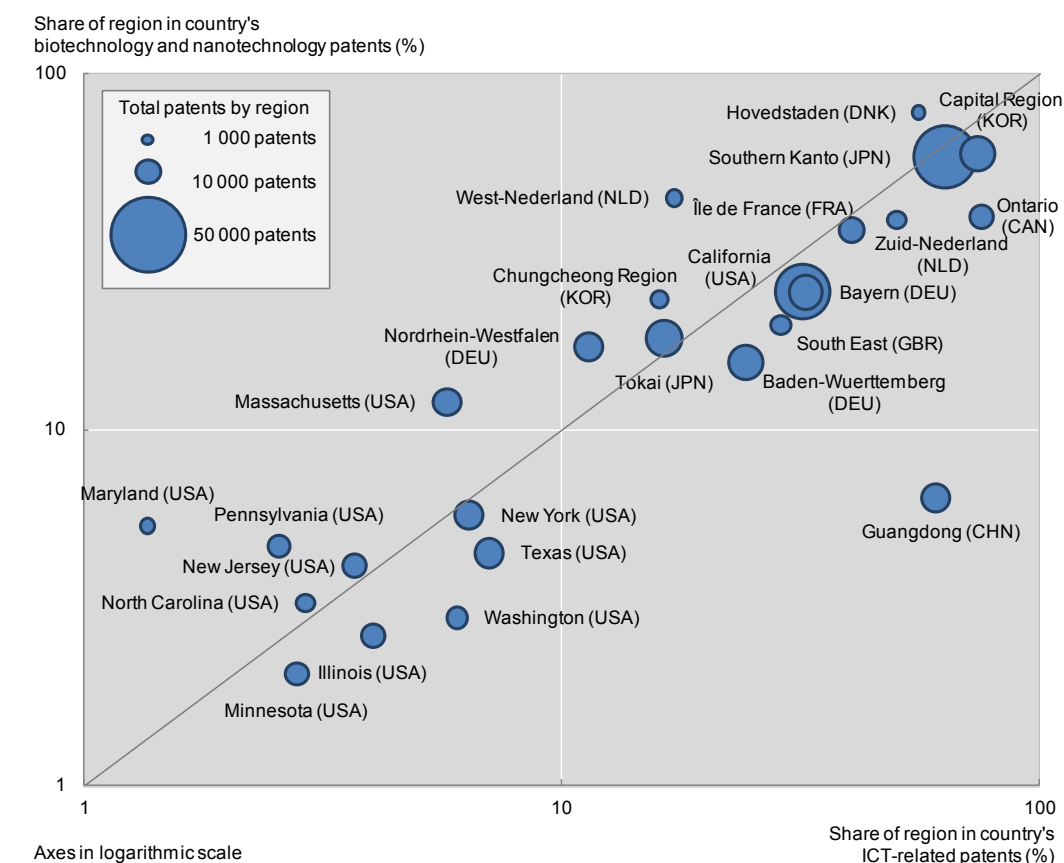
Source: OECD and SCImago Research Group (CSIC) (forthcoming), *Report on Scientific Production*, based on Scopus Custom Data, Elsevier, June 2011.

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Like universities, many of the leading firms in knowledge-intensive industries – such as ICT and the life sciences – are also concentrated in a limited number of regions in the world. Innovation in biotechnologies and nanotechnologies appear to be co-located with ICT-related innovation activity. The United States is unique in having a larger number of smaller hot spots from coast-to-coast as opposed to the concentrated activity that characterises many countries.

Innovation hotspots in ICT, biotechnologies and nanotechnologies, 2006-08

Top patenting regions by technology field as a percentage of the country's patents in the field



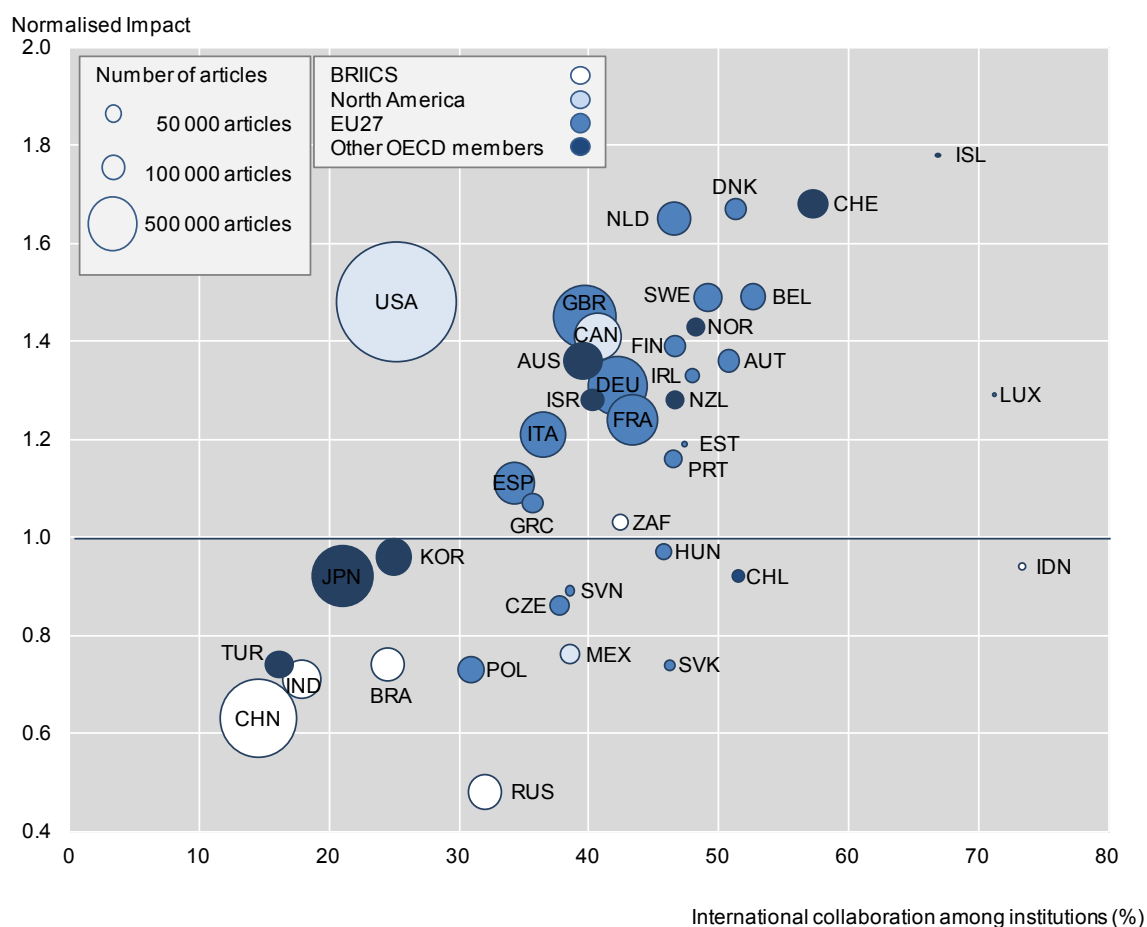
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China has the second largest number of scientific publications, after the United States, but the degree of scientific collaboration and impact of its research are among the lowest

The production of scientific knowledge is shifting from individuals to groups, from single to multiple institutions, and from a national to an international level. Researchers are increasingly networked across national and organisational borders and so are research institutes.

Greater scientific specialisation and cross-border collaboration can result in increased innovation. New *STI Scoreboard* indicators show that international scientific collaboration among institutions results in research with high impact (as measured by normalised citations) – and the broader the collaboration, the higher the impact of the research.

The impact of scientific production and the extent of international scientific collaboration among institutions, 2003-09



Source: OECD and SCImago Research Group (CSIC), *Report on Scientific Production*, based on Scopus Custom Data, Elsevier, June 2011.

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The development of “clean” energy technologies draws on a broad set of scientific disciplines

New technologies often draw on a broad base of scientific knowledge. Focusing on “clean” energy technologies, a new OECD indicator based on citations to scientific publications reveals that material science makes the single largest contribution to clean energy, followed by chemistry and physics; energy and environmental science only account for 10% and 1.7% respectively. The diversity of scientific sources highlights the difficulty of identifying a single major scientific contributor to innovation in this area.

Collaboration is key to innovation processes. In all countries R&D-active firms tend to collaborate more frequently on innovation (usually twice as much) than non-R&D-active firms. In the United Kingdom, collaboration is embedded in the innovation processes of over 50% of non-R&D-active firms.

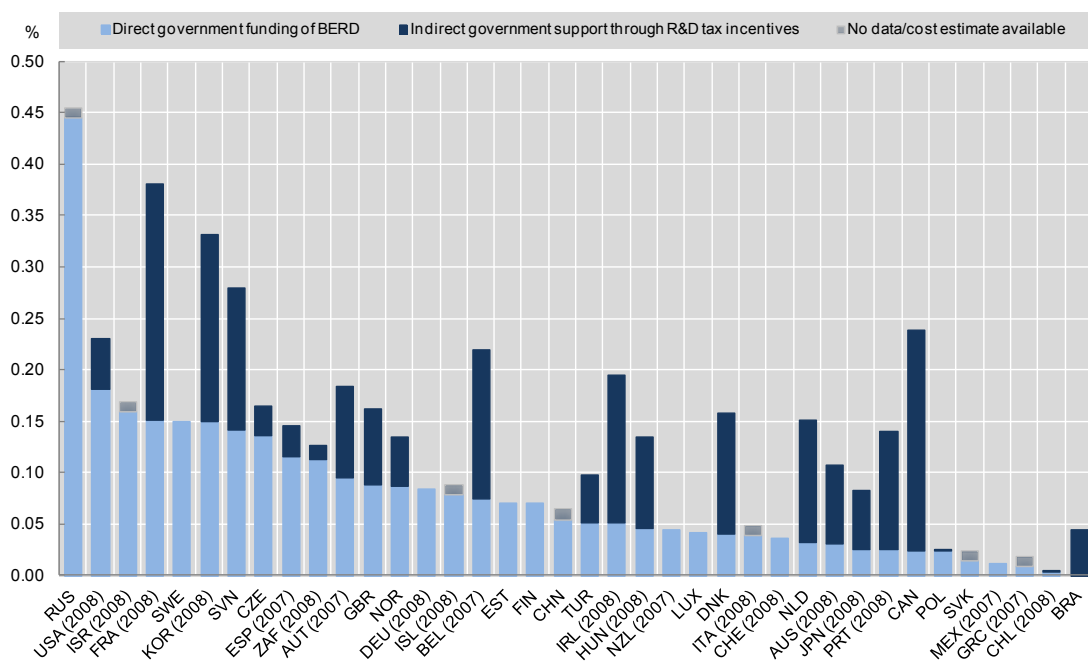
Unleashing innovation

Governments foster business R&D with direct support via grants or procurement and fiscal incentives, such as R&D tax incentives. Today, 26 OECD governments use fiscal incentives to promote business expenditure on R&D. Among those that do not (Germany, Finland, Sweden), some are discussing their introduction. Brazil, China, India, the Russian Federation, Singapore and South Africa also offer incentives for investment in R&D.


The Russian Federation, France and Korea provide the largest combined government support to business R&D relative to GDP

New estimates of the cost of R&D tax incentives and data on the value of direct public funding to support business R&D show that the United States and Spain rely more on direct support, while Canada, the Netherlands, Portugal and Japan mostly use indirect tax support to foster business R&D.

Direct government funding of business R&D and tax incentives for R&D, 2009
As a percentage of GDP



Source: OECD, based on OECD R&D tax incentives questionnaires, January 2010 and June 2011; and OECD, Main Science and Technology Indicators Database, June 2011.

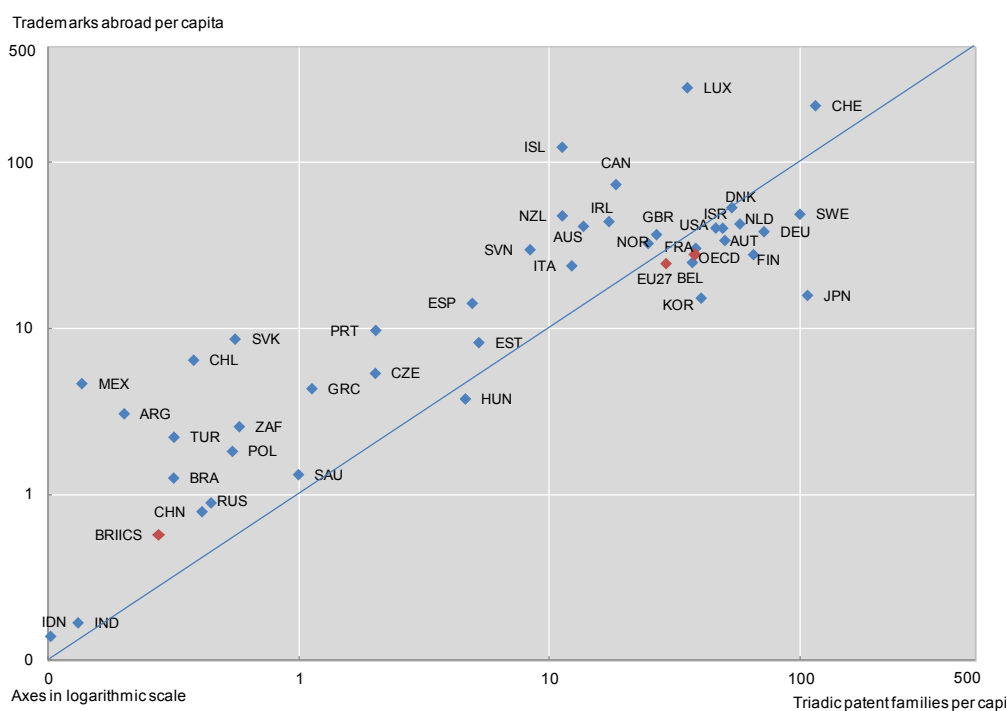
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Countries in the process of catching-up have a lower propensity to seek protection for their innovations (via patents or trademarks) than OECD countries

Indicators based on trademarks – a new measure that also reflects innovations in the service sector – point to the important role of incremental and marketing innovations and confirm that firms perform both technological and non-R&D-based innovation. Countries with a large manufacturing sector or a high degree of ICT specialisation have a greater propensity to patent than to “trademark”. Countries with a large services sector tend to engage more in trademark protection.

Patents and trademarks per capita, 2007-09

Average number per million population, OECD and G20 countries



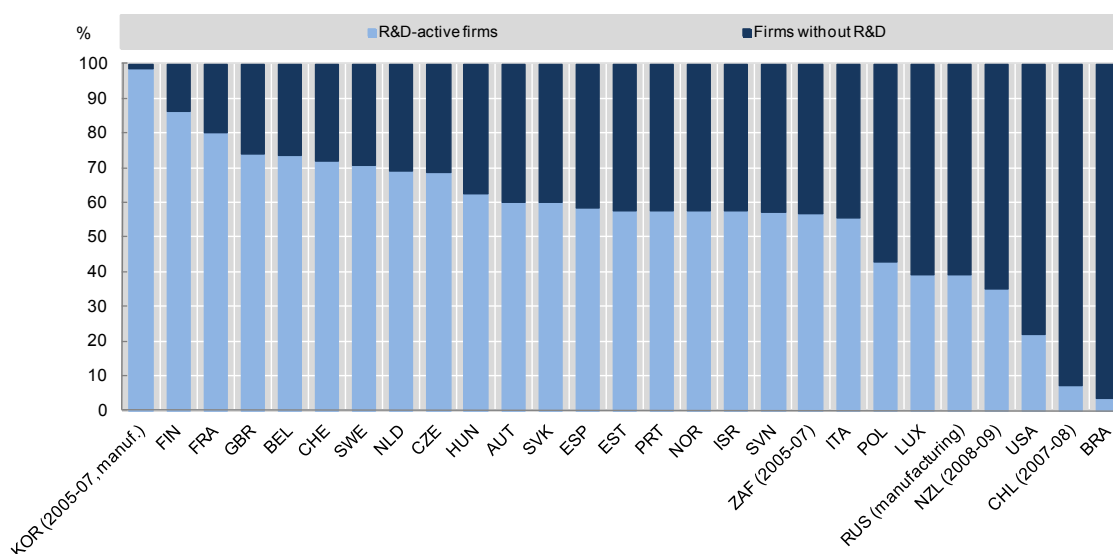
Source: OECD, Patent Database, May 2011; US Patent and Trademark Office (2011), “The USPTO Trademark Casefile Dataset (1884-2010)”; OHIM Community Trademark Database; CTM Download, April 2011; JPO Annual Reports 2008-2010. StatLink <http://dx.doi.org/10.1787/888932485386>

More than 65% of product innovators in the United States and New Zealand and more than 90% in Chile and Brazil do not perform R&D

Analysis of firm-level data on innovation shows that firms follow various innovation strategies and that these are not always based on formal R&D. However, product innovation is often associated with R&D. Indeed, in most countries, more than half of all product-innovating firms also engage in R&D. Remarkably, more than two-thirds of product innovators in New Zealand and the United States are not engaged in R&D as well as more than 90% in Chile and Brazil.

Product innovators by R&D status, 2006-08

As a percentage of product innovators



Source: OECD, based on Eurostat (CIS-2008) and national data sources, June 2011.

StatLink  <http://dx.doi.org/10.1787/888932487134>

Broader innovation is essential for economic growth and social advancement. Innovation entails investment in a range of complementary assets beyond R&D such as software, human capital and new organisational structures. Investment in these intangible assets is rising and even exceeds investment in physical capital (machinery and transport equipment) in Finland, the Netherlands, Sweden, the United Kingdom and the United States. Encouragingly, in some countries, recent estimates of intangible assets explain a significant portion of multi-factor productivity growth.

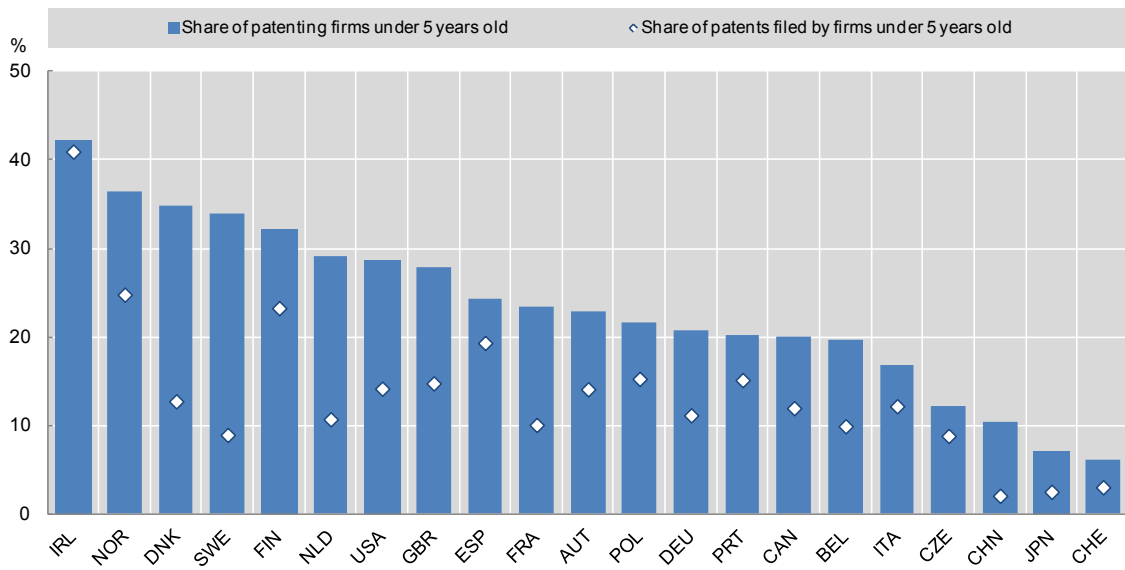
Over 30% of patenting firms in Ireland and in the Nordic countries are less than five years old

A dynamic business sector is a key source of technological and non-technological innovation. The *STI Scoreboard 2011* includes indicators reflecting the business environment for innovation, for example on the availability of venture capital and business angel networks, as well as regulatory and taxation indicators. Among OECD and BRIICS countries, the United Kingdom has the lowest barriers to entrepreneurship, while China has the highest.


New OECD indicators based on linking patents with companies' information reveal that, during 2007-09, firms less than five years old filing at least one patent application represented on average 25% of all patenting firms, and generated 10% of patent applications. The share of young patenting firms varies considerably across countries, led by Ireland (42%) and followed by the Nordic countries.

Patenting activity of young firms, 2007-09

Share of young patenting firms and share of patents filed by young patenting firms, EPO and USPTO



Source: OECD, calculations based on the Worldwide Patent Statistical Database, EPO, April 2011; and ORBIS® Database, Bureau van Dijk Electronic Publishing, December 2010; matched using algorithms in the Imalinker system developed for the OECD by IDENER, Seville, 2011.

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READER'S GUIDE

Abbreviations

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

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

Country groupings

BRIICS	Brazil, the Russian Federation, India, Indonesia, China and South Africa
EA15	Euro area
EU27	European Union
G7	Canada, France, Germany, Italy, Japan, the United Kingdom and the United States
OECD	Total OECD
ROW	Rest of the world
WLD	World
