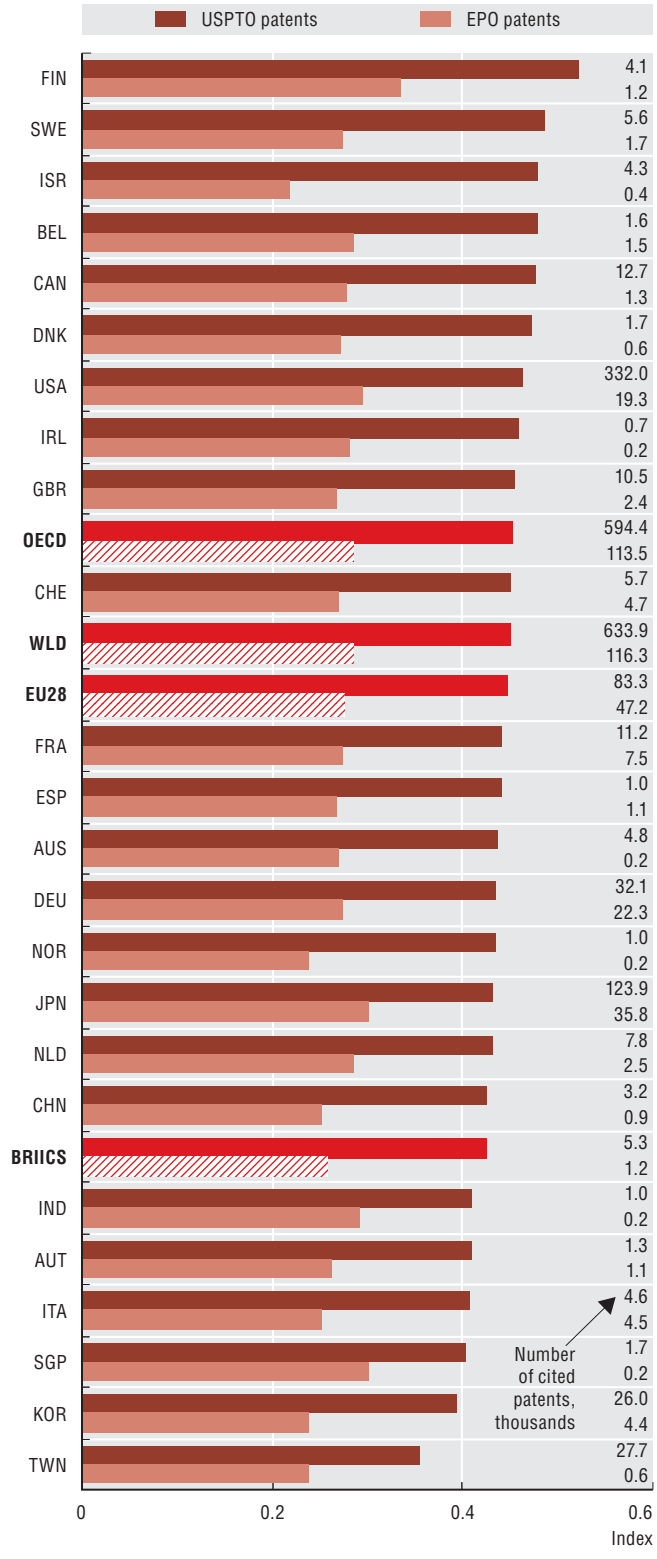
9. Technological strengths

The relevance of patents for later inventions, 2002-06

Average generality index based on patent applications to the EPO and the USPTO



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

StatLink http://dx.doi.org/10.1787/888932893544

The technological and economic value of patented inventions is known to vary widely across patents, firms and sectors, and over time. Many indicators attempt to capture the different meanings that patent value may have for stakeholders such as inventors, firms, attorneys and policy makers.

The generality index uses information on the citations received by a patent to assess the extent to which later inventions in a variety of technology fields have benefited from the patent. It gives an indication of how important a patent is for subsequent developments and in how wide an array of technology fields.

The scope of a patent, i.e. the number of distinct International Patent Classification (IPC) classes a patent is registered in, is associated with an invention's technological and economic value and relates positively to the valuation of the firm and to a patent's importance for later inventions.

Breakthrough inventions are high-impact innovations, i.e. highly cited patents. They are associated with entrepreneurial strategies and further technological developments.

The differences observed in the value of patents filed at the United States Patent and Trademark Office (USPTO) and at the European Patent Office (EPO) are likely to reflect differences in the type, nature and number of patents applied for at the two offices, as well as differences in the practices and regulations of these patent authorities, and possible home biases. The number and distribution of breakthrough inventions also differs between EPO and USPTO patents. For instance, the United States own 1% of breakthrough inventions filed at USPTO, and less than 0.2% of those filed at EPO.

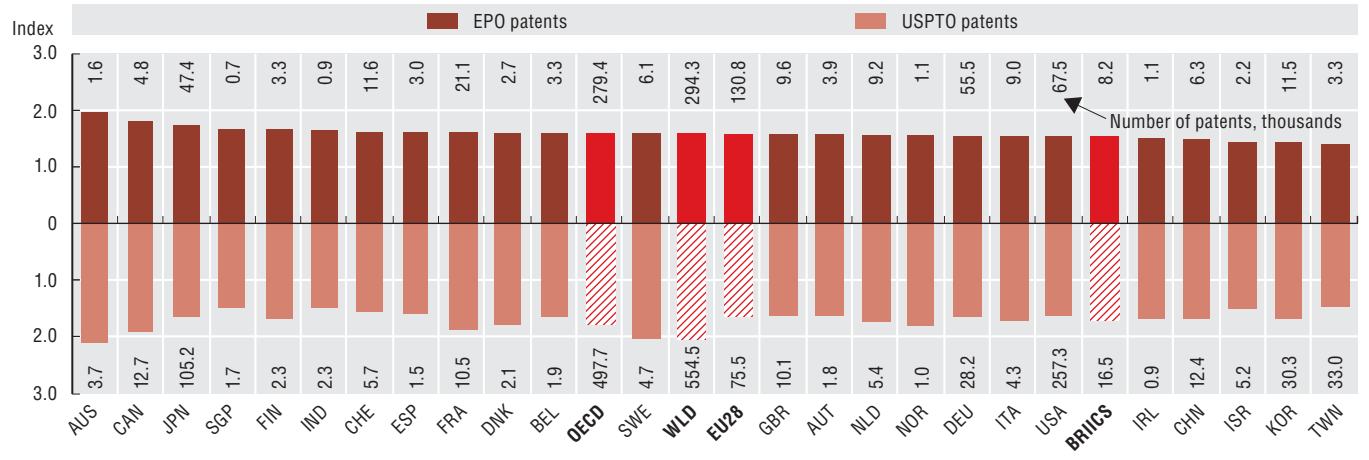
Definitions

The generality index relies on information about the number and distribution of citations received (forward citations) and the IPC classes of the patents these citations come from. All IPC classes in the citing patents are considered. The indicator accounts for the distribution of both 4-digit and *n*-digit IPC classes in citing patents, where *n* is the highest level of disaggregation possible. See Squicciarini, Dernis and Criscuolo (2013) for a formal definition.

The scope indicator is based on Lerner (1994) and corresponds to the number of IPC classes to which a patent is assigned. Breakthrough inventions are defined following Ahuja and Lampert (2001) as the top 1% of cited patents in each technology field and year cohort. Technology fields are defined according to the classification of Schmoch (WIPO, 2008, revised in 2013) and rely on the IPC codes of the patent document. Patent indexes are built by normalising patent-specific values over the maximum value of any patent in the same cohort.

Scope of patent applications, 2009-11

Average number of IPC classes per patent application to the EPO and to the USPTO

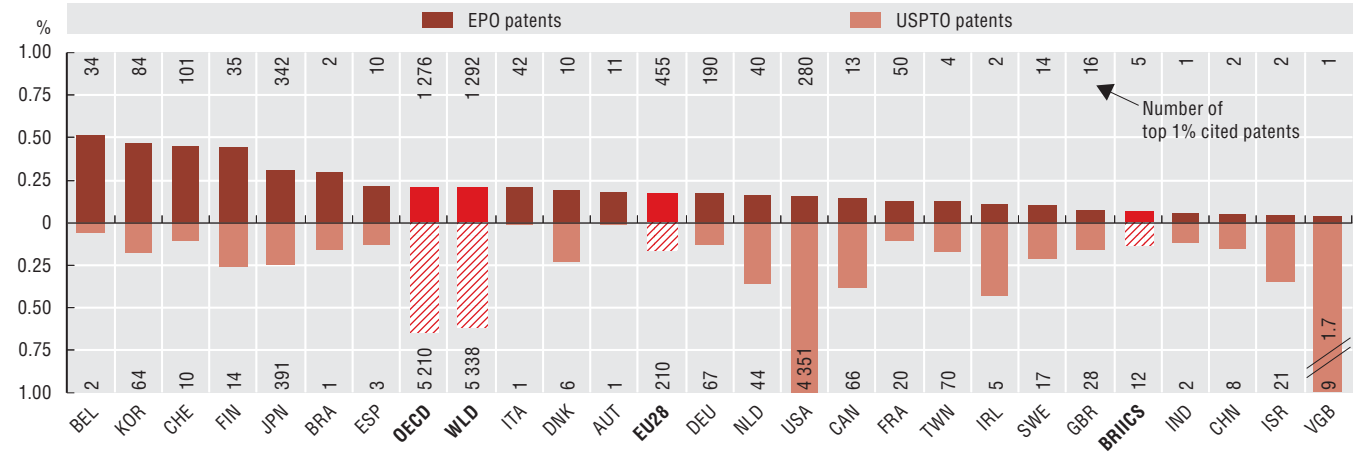


Source: OECD calculations based on the Worldwide Patent Statistical Database, EPO, April 2013. See chapter notes.

StatLink http://dx.doi.org/10.1787/888932893563

Highly cited patent applications, 2002-06

Top 1% of cited patent applications, as a share of total EPO and USPTO patents



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

StatLink http://dx.doi.org/10.1787/888932893582

Measurability

The generality measure is high when a patent is cited by subsequent patents belonging to a wide range of fields, i.e. the patented invention is relevant for a number of later inventions, not only in its own technology class. If most citations are concentrated in a few fields the generality index is low and close to zero (see Squicciarini, Dernis and Criscuolo, 2013). Citations are consolidated and take patent equivalents into account. Forward citations cover all categories of citations and relate to a 5-year citation window after publication. The top 1% of cited patents is identified for cohorts defined by filing date and technology field. Patents belonging to more than one technology field are assigned to the field accounting for the majority of its 4-digit IPC subclasses. Indicators based on data from different patent authorities are built and shown separately. As different intellectual property offices comply with different legislations and administrative regulations, their practices differ, e.g. in their propensity to cite prior art or to assign patents to different technology fields. This hinders the comparability of the proposed measures.

Notes and References

Cyprus

The following note is included at the request of Turkey:

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

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

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

Israel

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

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

6.1. Industry specialisation

General notes for all figures:

The sectors considered cover the following ISIC Rev.4 activities 01-03 (Agriculture, forestry and fishing), 05-09 (Mining and quarrying), 10-12 (Food products, beverages and tobacco), 13-15 (Textiles, wearing apparel, leather and related products), 16-18 (Wood and paper products, and printing), 19-23 (Chemical, rubber, plastics, fuel products and other non-metallic mineral products), 24-25 (Basic metals and fabricated metal products, except machinery and equipment), 26-28 (Machinery and equipment), 29-30 (Transport equipment), 31-33 (Furniture; other manufacturing; repair and installation of machinery and equipment), 35 (Electricity, gas, steam and air conditioning supply), 36-39 (Water supply; sewerage, waste management and remediation activities), 41-43 (Construction), 45-47 (Wholesale and retail trade, repair of motor vehicles and motorcycles), 49-53 (Transportation and storage), 55-56 (Accommodation and food service activities), 58-63 (Information and communication), 64-66 (Financial and insurance activities), 69-75 (Professional, scientific and technical activities), 77-82 (Administrative and support service activities).

Industrial specialisation, 2000 and 2010

The HK index is specified as:

$$HK(\theta) = \left(\sum_{i=1}^{N} s_i^{\theta}\right)^{1/(1-\theta)}$$

where s_i is the relative output of the i^{th}sector, N the total number of sectors in an economy, and θ measures the extent to which the index is influenced by large sectors. The HK(2) is calculated for a value of θ (theta) equal to 2, value for which it corresponds to the inverse of the Herfindahl Index.

Information for Australia, Canada, Japan and New Zealand refer to 2009.

General notes:

Value added of the top four economic activities, 2008-10 and;

Employment of the top four economic activities, 2008-10

The sector concentration ratio index shown is analogous to the K-firm concentration ratio and is defined as the cumulative share of the K^{th} sector, where s_i is the relative output of the i^{th} sector. CR(4) is calculated for a value of K equal to 4.

$$CRK = \sum_{i=1}^{K} s_i$$

The denominator "total value added" excludes Real estate activities (ISIC Rev.4, Section L, Division 68) and Community, social and personal services (Divisions 84-99).

Information for Australia, Canada, Japan and New Zealand is based on the average value of 2008 and 2009 only.

Additional notes:

Value added of the top four economic activities, 2008-10

The colour palette on the figure is reduced to highlight the two industries with the largest value added shares in each country. The shades of grey correspond to the shares (in descending intensity) of each country's other two main industries, in terms of value added.

6.2. ICT industry specialisation

Information industries in OECD economies, 2000 and 2011

For Germany, Poland, Portugal, Switzerland and the United Kingdom, data refer to 2010.

For Canada, data refer to 2009.

For Japan, data refer to 2008.

Unweighted means exclude Canada.

Global trade in ICT goods and top ten exporters, 2000 and 2011

China and World data are computed net of China's re-imports and Hong Kong, China re-exports. Gross of these components, world exports of ICT products totalled USD 985 billion in 2000 and USD 1 813 billion in 2011, while China's exports totalled USD 44 billion in 2000 and USD 508 billion in 2011, with no substantial change in its shares. Netting for the flows of goods mediated by Hong Kong, China, and for Chinese re-imports removes two key intertwined elements of distortion in ICT trade statistics. Indeed, re-exports sum up to 99% of Hong Kong, China, exports of ICT goods, while China extensively uses East Asian logistics hubs (including Hong Kong, China) for internal trade. Estimates do not consider similar flows for other countries owing to a lack of exhaustive data.

OECD and major exporters of ICT services, 2000 and 2012

For Canada, Finland, Iceland, Israel, Mexico, Norway, Slovenia, Turkey and the United States, data refer to 2011 instead of 2012.

For Luxembourg and Kuwait, data refer to 2002 instead of 2000.

For Denmark, data refer to 2004 instead of 2000.

For Mexico and Kuwait, exports of computer and information services are not included.

6.3. Export structures

Top 20 exporting economies of primary and manufactured goods by end-use category, 1995 and 2011

Primary goods are defined as those coming from the following ISIC Rev.4 activities: Agriculture, hunting, forestry (01-03) and Mining and quarrying (05-09); Manufactured goods come from the Manufacturing sector (10-33). Exports of Electricity, gas and water (35) and identifiable scrap metal and waste products are not included in this analysis. Products that cannot be allocated to an industry due to confidentiality, or other reasons, are excluded too. On average, in OECD and BRIICS countries, exports of primary and manufactured goods (01-33) represented about 96% of total reported trade in goods in 2011.

Total final goods include the following final demand end-use categories: consumption goods, capital goods and certain mixed end-use goods such as personal computers, personal telephones (including smart phones), passenger cars, precious goods (such as diamonds) and packed medicines. Reported exports that can be allocated to an industry but not to an end-use category are also included. Note that Packed medicines is considered a mixed end-use category as they can be final goods for households or intermediate goods for medical centres.

Exports include re-exports (i.e. imported goods which are subsequently exported with no further transformation). Many countries re-export but few report these flows by commodities. Since, the share of re-exports may vary across countries and products and over time, care should be taken when interpreting this chart. For example, in 2011 about 96% of Hong Kong, China's exports were re-exports to and originating from mainland China, up from 83% in 2005. If re-exports were excluded, Hong Kong, China would not feature in the top 20. Other countries with significant re-exports include Singapore, Belgium, the

Netherlands and Germany, countries that are major regional hubs for goods transported by sea. Including re-exports shows countries with a significant role in international trade who may not necessarily be major producers of goods.

Top four exporting industries by country, 2011

The colour palette on the figure is reduced to highlight the sector with the largest export share in each country. The shades of grey correspond to the shares (in descending intensity) of each country's other three main exporting industries.

The top four industries are chosen from the following ISIC Rev.4 activities: 01-03 (Agriculture, forestry and fishing); 05-09 (Mining and quarrying); 10-12 (Food products, beverages and tobacco); 13-15 (Textiles, wearing apparel, leather and related products); 16-18 (Wood, paper products and printing); 19 (Coke and refined petroleum products); 20 (Chemicals); 21 (Pharmaceuticals); 22-23 (Rubber, plastics and other non-metallic mineral products); 24 (Basic metals); 25 (Fabricated metal products, except machinery and equipment); 26 (Computers, electronic and optical products); 27 (Electrical equipment); 28 (Machinery and equipment); 29 (Motor vehicles, trailers and semi-trailers); 30 (Transport equipment); 31-33 (Furniture; other manufacturing).

Top three exporting services by country, 2011

Countries are divided into two groups, according to whether the share of services in goods and services exports is above or below the world average (about 19.1%). Within each group, they are ranked according to the sum of the percentage shares of the three largest services export categories.

6.4. R&D specialisation

Business R&D intensity adjusted for industrial structure, 2011

A country's industrial structure-adjusted indicator of R&D intensity is a weighted average of its sectoral R&D intensities (ratio of R&D to value added), using the OECD industrial structure – sectoral share in OECD value added for 2011 – as common weights across all countries. The unadjusted measure of BERD intensity is by definition an average based on each country's actual sector shares.

For Denmark, France, Germany, Italy, Poland, Portugal, Slovenia, Spain and the United Kingdom, data refer to 2010.

For Australia, Austria, Belgium, Sweden and the United States, data refer to 2009.

R&D series are presented as a percentage of value added in industry estimated as the value added in all activities except: Real estate activities (ISIC Rev.4 68); Public administration and defence; compulsory social security and education (ISIC Rev.4 84-85); Human health and social work activities (ISIC Rev.4 86-88); and Activities of households as employers (ISIC Rev.4 97-98). R&D performed in these sectors across the OECD is reported to be negligible.

Value added is measured at basic prices except for Japan and the United States (market prices).

Based on estimates of business R&D by sector reported on a main activity basis.

Business R&D in manufacturing, by technology intensity, 2011

High- and medium-high-technology manufacturing includes: Chemicals and chemical products (ISIC Rev.4 20 and 21); Electrical and optical equipment (ISIC Rev.4 26 and 27); Manufacture of machinery and equipment n.e.c. (ISIC Rev.4 28); and Transport equipment (ISIC Rev.4 29 and 30). Low- and medium-low-technology manufacturing includes all other manufacturing industries.

Based on estimates of business R&D by sector reported on a main activity basis, with the exception of the Russian Federation (product basis).

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

For Austria, Belgium, Iceland, the Russian Federation and Sweden, data refer to 2009.

For Chile and Switzerland, data refer to 2008.

For Estonia, the high share of low- and medium-low-technology manufacturing in 2011 is due to an important investment in new technology in the oil industry (ISIC Rev.4 19).

Share of services in business R&D, 2001 and 2011

Figure are based on estimates of business R&D by sector reported on a main activity basis, with the exception of the Russian Federation (product basis).

For Australia, Chile, Denmark, France, Italy, Portugal, Spain and the United Kingdom, data refer to 2010 instead of 2011.

For Austria, Belgium, Iceland, the Russian Federation, South Africa and Sweden, data refer to 2009 instead of 2011.

For China, data refer to 2000 instead of 2001.

For Slovenia, data refer to 2003 instead of 2001.

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

For the United States, data refer to 2004 and 2010 instead of 2001 and 2011.

For Denmark, Norway and Poland, data for 2001 are not reported because of significant breaks in series.

6.5. Technological advantage

Change in revealed technological advantage in biotechnology and nanotechnology, 1998-2000 and 2008-10

Biotechnology and nanotechnology patents are defined on the basis of their International Patent Classification (IPC) codes or European Classification System (ECLA) codes.

Only the top 20 economies with more than 500 biotechnology or nanotechnology patents in 2008-10 are included.

Change in revealed technological advantage in ICT, 1998-2000 and 2008-10

ICT-related patents are defined on the basis of their International Patent Classification (IPC) codes.

Only economies with more than 500 ICT patents in 2008-10 are included.

Countries' range of revealed technological advantage by field, 2008-10

Patents are allocated to technology fields on the basis of their International Patent Classification (IPC) codes, following the classification presented in Schmoch (2008, revised in 2013).

Only countries with more than 1 000 patents in 2008-10 are included.

6.6. Trade competitiveness

Top ten exporting economies in gross and value added terms, 2009

The major activity groups are defined according to the 18 ISIC Rev.3 categories in the TiVA database: Primary products (Divisions 01-05, 10-14, i.e. agriculture and mining); Machinery and equipment and transport equipment (29, 30-33, 34-35: a proxy for high- and medium-high-technology manufactures); Other manufacturing (15-16, 17-19, 20-22, 23-26, 27-28, 36-37: a proxy for low- and medium-low-technology manufactures); Trade, transport and communications (50-55, 60-64); Finance and business services (65-67,70-74); and Other activities (40-41, 45 and 75-99, i.e. utilities, construction and public services).

Revealed comparative advantage in exports of computers, electronic and optical products, 2009

Computers, electronic and optical equipment refers to the ISIC Rev.3 Divisions 30-33.

Revealed comparative advantage in exports of machinery and equipment, 2009

Machinery and equipment corresponds to the ISIC Rev.3 Division 29.

6.7. E-business uptake

General notes for all figures:

Except otherwise stated, the sector coverage consists of all activities in manufacturing and non-financial market services. Only enterprises with 10 or more persons employed are considered. Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249), large (250 and more).

Additional notes:

Enterprises selling on line, by size, 2009 and 2012 and;

Turnover from e-commerce, by enterprise size, 2012

For Australia, data refer to the fiscal year ending 30 June 2011 (2010/11) instead of 2012. Total includes Agriculture, forestry and fishing.

For Mexico, data refer to 2008 instead of 2012 and to businesses with 20 or more persons employed.

Enterprises selling on line, by size, 2009 and 2012

For Canada, data refer to 2007 instead of 2009. Medium-sized enterprises have 50-299 employees. Large enterprises have 300 or more employees.

For Korea, Japan and Switzerland, data refer to 2011 instead of 2012.

For Japan, data refer to businesses with 100 or more employees. Medium-sized enterprises have 100-299 employees. Large enterprises have 300 or more employees.

For Mexico, data refer to 2008 instead of 2009 and to businesses with 20 or more persons employed.

For Switzerland, data refer to 2008 instead of 2009. In 2008, data refer to businesses with five or more persons employed.

For Turkey, data refer to 2010 instead of 2012.

Turnover from e-commerce, by enterprise size, 2012

For Denmark and Germany, data refer to 2010.

For Finland, Luxembourg, Mexico, Poland, Slovenia and the United States, data are not available by firm size.

For the United States, data are drawn from the Bureau of the Census. Includes Manufacturing, Merchant wholesale, Retail and Selected services. Selected services includes NAICS 22 (Utilities), NAICS 48-49 (Transportation and warehousing), NAICS 51 (Information), NAICS 52 (Finance and insurance), NAICS 53 (Real estate and rental and leasing), NAICS 54 (Selected professional, scientific and technical services), NAICS 56 (Administrative and support and waste management and remediation services), NAICS 61 (Educational services), NAICS 62 (Health care and social assistance), NAICS 71 (Arts, entertainment and recreation), NAICS 72 (Accommodation and food services), and NAICS 81 (Other services, except public administration).

Enterprises using enterprise resource planning software for internal information sharing, by size, 2012

For Canada, medium-sized enterprises have 50-299 employees. Large enterprises have 300 or more employees.

For Switzerland, data refer to 2011.

6.8. Young innovative firms

General notes for all figures:

Patenting firms were linked to the ORBIS© database, using combinations of string matching algorithms that maximise the precision of the match. The patent portfolio of firms refers to families of patents applied for at the European Patent Office (EPO), at the United States Patent and Trademark Office (USPTO) or using the Patent Cooperation Treaty (PCT) between 2009 and 2011. Only countries with matching rates above 80% of patent filings over 2000-11 are included.

Patenting activity by sector, 2009-11 and;

Patenting activity of young firms by sector, 2009-11

High and medium-high-technology manufactures cover sectors 20, 21, 26, 27, 28 and 29-30; low and medium-low-technology manufactures include 10-12, 13-15, 16-18, 19, 22-23, 24-25 and 31-33; business-sector services, excluding real estate, refer to 45-47, 49-53, 55-56, 58-63, 64-66, 69-82; other sectors comprise 01-03, 05-09, 35, 36-39, 41-43, 68, 84-88, 90-99.

Top three industries patenting in selected technology fields, 2009-11

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

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

Patenting activity of young firms by sector, 2009-11

For Japan, the average number of young patenting firms is overestimated as it includes affiliates of large conglomerates with a recent date of incorporation registered in the ORBIS© database.

6.9. Technological strengths

General note for all figures:

Data refer to patent applications filed at the European Patent Office (EPO) and the US Patent and Trademark Office (USPTO), by filing date and applicant's residence. Only economies with more than 500 patents at the EPO and at the USPTO in 2009-11, or, in the case of the patent generality index, only economies with more than 100 EPO patents and 500 USPTO patents that received forward citations up to five years after publication, are included.

Additional notes:

The relevance of patents for later inventions, 2002-06

The patent generality index is a modified version of a market concentration index, the Hirschman-Herfindahl Index (HHI), which relies on the number and distribution of citations received (forward citations) and the technology classes (International Patent Classification, IPC) of the patents these citations come from.

Scope of patent applications, 2009-11

The scope of a patent application is calculated as the number of distinct International Patent Classification (IPC) subclasses (i.e. 4-digit IPC codes) the application is assigned to by the patent office.

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