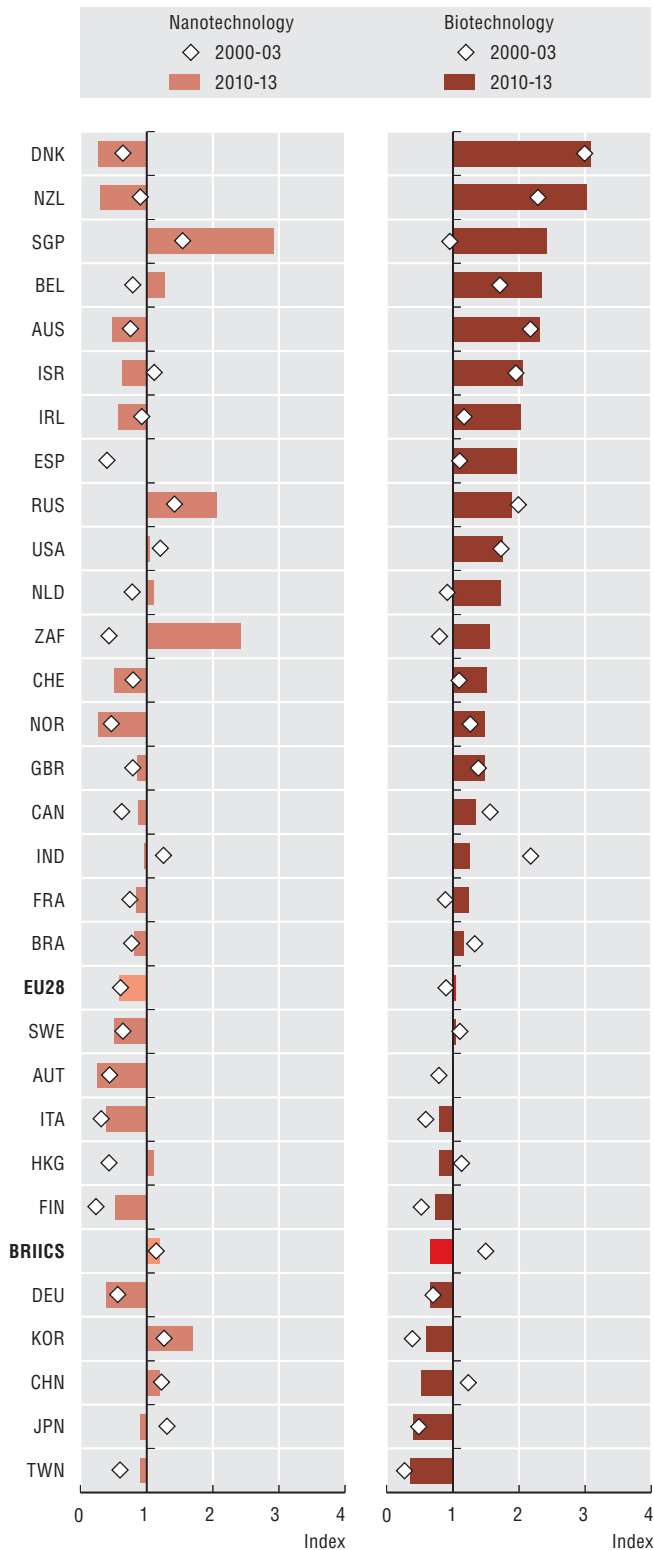# 5. Technological advantage

Revealed technological advantage in biotechnology and nanotechnology, 2000-03 and 2010-13

Index based on IP5 patent families

Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, June 2015. StatLink contains more data. See chapter notes.
StatLink 🔗 http://dx.doi.org/10.1787/888933274511

Some of information contained in patent documents, such as the technology class to which an invention belongs and the location of inventors, can be used to assign patented inventions to technology fields, and thus identify areas in which economies are relatively specialised and those in which they lag behind. The revealed technological advantage (RTA) index applied to data from the International Patent Classification (IPC) is used here to provide an indication of the relative specialisation of economies in nanotechnology, biotechnology, and information and communication technologies (ICT). An index value greater than 1 denotes relative specialisation in a particular field.

Overall, nanotechnology patenting grew by 43% during the last decade. Singapore remained the most specialised economy, while economies such as Japan and South Africa reversed their trends becoming less specialised and more specialised, respectively. Patenting in biotechnology decreased by almost 10% over the same period, with Denmark remaining the most specialised economy and Singapore, Ireland and Spain showing the highest increases in specialisation. Patenting in ICT technologies grew by 40% overall. Although ICT-related specialisation did not increase in most economies, patenting increased six fold in India and by more than 16 times in China, the latter becoming the second most specialised ICT economy after Korea.

RTA values for 2010-13 suggest that while most economies do not seem specialised in specific technology fields (i.e. the median RTA is equal to or less than 1), differences in technological specialisation do emerge across economies and fields. RTA values range between 0.03 and 12.3 across technology fields and top-scoring economies exhibit values up to 60 times higher than bottom-scoring ones in the same field. Examples of high specialisation include Norway in civil engineering (7.4), Turkey in thermal devices and other consumer goods (5.8 and 12.3, respectively), and the Netherlands in food chemistry (5.3).

Definitions

The *revealed technological advantage* (RTA) index measures the share of an economy's patents in a specific technology relative to the share of total patents owned. The index is equal to zero when the economy has no patents in a given field, equals 1 when the economy's share in the technology field is equivalent to its share in all fields (no specialisation), and rises above 1 when specialisation is observed. The index is calculated on the basis of patents filed at the European Patent Office (EPO) or the US Patent and Trademark Office (USPTO), which belong to patent families within the *Five IP offices (IP5)*, by earliest filing date and inventor's location (see Dernis et al., 2015, about IP5 patent families).

## Revealed technological advantage in ICT, 2000-03 and 2010-13

Index based on IP5 patent families
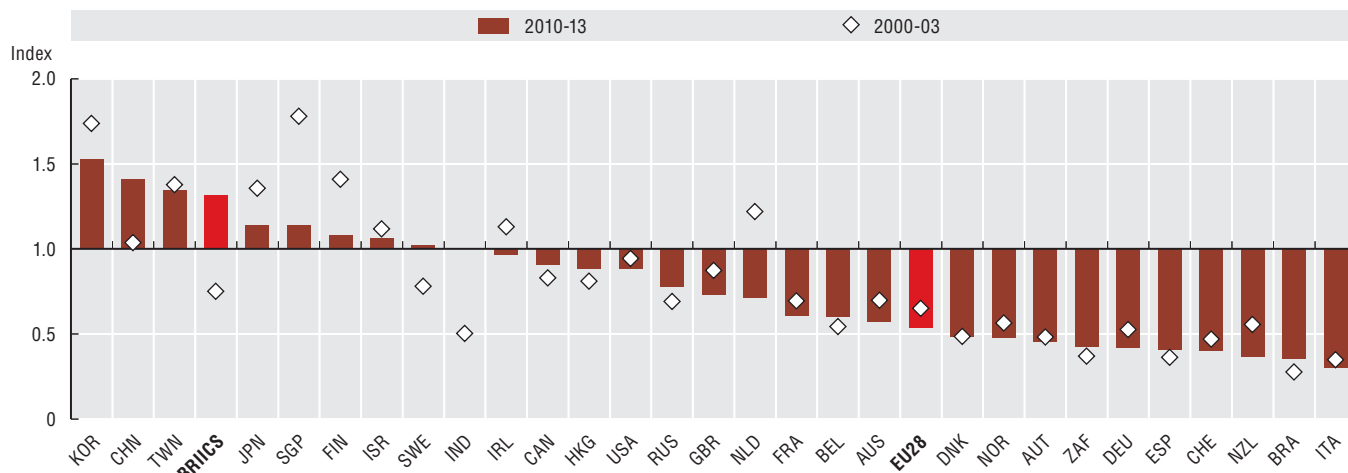
Source: OECD, *STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats,* June 2015. StatLink contains more data. See chapter notes.

StatLink ⬛ᵐˢᴸ *http://dx.doi.org/10.1787/888933274529*

Range of revealed technological advantage in economies by field, 2010-13

Index by technology field based on IP5 patent families
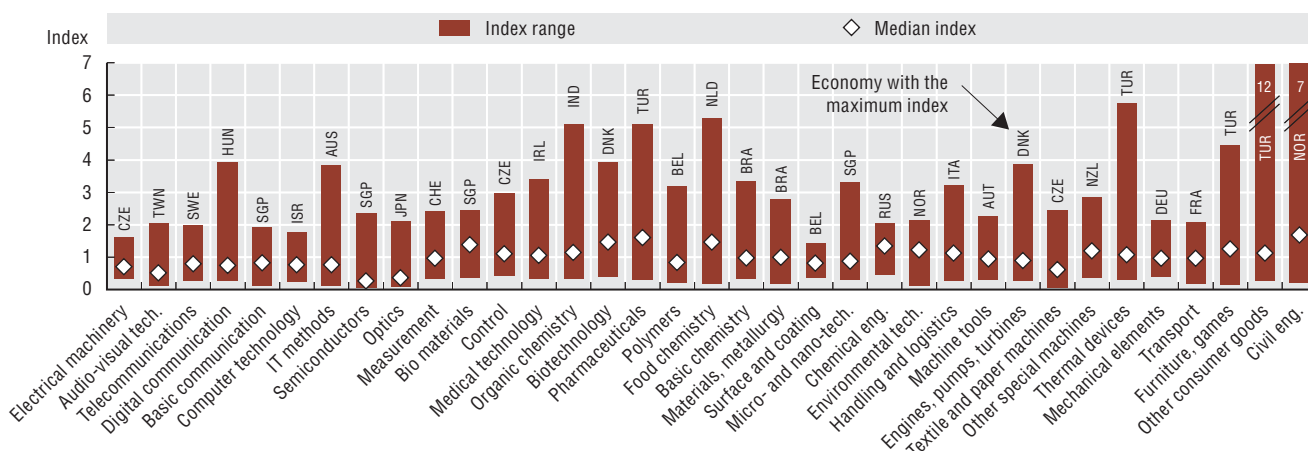
Source: OECD, *STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats,* June 2015. StatLink contains more data. See chapter notes.

StatLink ⬛ᵐˢᴸ *http://dx.doi.org/10.1787/888933274534*

Measurability

International Patent Classification (IPC) codes attributed by patent examiners during the examination process identify the technological domains to which inventions belong. IPC classifications are revised periodically to account for the emergence of new technologies and the evolution of existing ones. This may lead to the reclassification of patents into different classes. Biotechnology and nanotechnology patents are defined according to lists of IPC classes compiled by experts in the respective fields while ICT patents are identified from a new experimental classification (see also Chapter 6, Section 9). The last figure is based on a classification proposed by WIPO (2013) which groups all IPC classes into 35 technology fields, identified on the basis of their content. The use of data from other patent offices may change the patterns observed, as companies within and across technology fields may behave differently and pursue different innovative strategies in different markets. Given the way the RTA is compiled, economies with relatively low levels of patenting may appear highly specialised in certain technologies as their activities are more likely to be concentrated in only a few fields.

Cyprus

The following note is included at the request of Turkey:

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

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

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

Israel

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

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

5.1. R&D specialisation

Business R&D intensity adjusted for industrial structure, 2013

A country's industrial structure-adjusted indicator of R&D intensity is a weighted average of its sectoral R&D intensities (ratio of R&D to value added), using the OECD industrial structure – sectoral share in OECD value added for 2013 – as adjusted, common weights across all countries. The unadjusted measure of BERD intensity is by definition an average based on each country's actual sector shares.

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

Figures are based on estimates of business R&D by sector reported on a main activity basis, in ISIC Rev. 4.

For Austria, Belgium, Canada, Greece, Ireland, Mexico and Portugal, data refer to 2011.

For Denmark, France, Germany, Hungary, Italy, the United Kingdom and the United States, data refer to 2012.

Value added is measured at basic prices except for Japan and the United States (factor cost and purchasers' prices respectively).

Data on value added come from the OECD, Annual National Accounts database except for Canada and Japan (national sources).

Business R&D in manufacturing, by R&D intensity group, 2013

The R&D intensity groups are defined in OECD (2015, forthcoming), "The R&D Intensity of Economic Activities in OECD Countries: Proposal for a new classification for industry and services".

High and medium-high R&D intensive manufacturing includes "chemicals and pharmaceutical products" (ISIC Rev. 4 Divisions 20 and 21) and "computer, electronic and optical products, electrical equipment, machinery, motor vehicles and other transport equipment" (ISIC Rev. 4 Divisions 26 to 30).

Figures are based on estimates of business R&D by sector reported on a main activity basis, in ISIC Rev. 4.

For Australia, Austria, Belgium, Greece, Ireland and Mexico, data refer to 2011.

For Denmark, France, Germany, Hungary, Israel, Italy, Portugal, Switzerland, the United Kingdom and the United States, data refer to 2012.

For Israel, Norway, Sweden and Switzerland, "chemicals and chemical products" (ISIC Rev. 4 Division 20) are included in the "other manufacturing industries".

R&D in services, 2013

Figures are based on estimates of business R&D by sector reported on a main activity basis, in ISIC Rev. 4.

For Australia, Austria, Belgium, Greece, Ireland and Mexico, data refer to 2011.

For China, data refer to 2000 and 2012.

For Denmark, France, Germany, Hungary, Israel, Italy, Portugal and the United Kingdom, data refer to 2012.

For Estonia, data refer to 2005 and 2013.

For France and the United Kingdom, 2003 data on main activity basis have been backcasted by the OECD using historical series reported on a product field basis.

For Switzerland and the United States, data refer to 2004 and 2012.

5.2. E-business uptake

Enterprises engaged in sales via e-commerce by size, 2013

Unless otherwise stated, only enterprises with ten or more persons employed are considered. Size classes are defined as: SMEs (10 to 249) and large (250 and more).

For countries in the European Statistical System, sector coverage consists of all activities in manufacturing and non-financial market services.

For Australia, data refer to any transaction where the commitment to purchase was made via the Internet, including via email, for the fiscal years 2008/09 and 2013/14, ending 30 June. Data for the fiscal year 2013/14 include agriculture, forestry and fishing activities.

For Canada, data refer to 2007 and 2013 and to small businesses (from 10 to 49 employees) instead of SMEs. In 2013, data refer to sales online over the Internet. Large enterprises have 300 or more employees.

For Colombia, data refer to enterprises with ten or more persons employed in the manufacturing sector (excluding ISIC Rev. 4 Divisions 12-14, 17, 21 and 33) and enterprises with 75 or more persons employed in the non-financial market services (excluding Divisions 49-51, 58, 75 and 77). For industry G – Wholesale and retail trade, data refer to enterprises with 20 or more persons employed; for industries H – Transportation and storage (Divisions 52 and 53), I – Accommodation and food service activities and J – Information and communication (Divisions 59-61), data refer to enterprises with 40 or more persons employed.

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

For Mexico, data refer to 2008 and 2012 and to orders received via the Internet. For 2008, data refer to businesses with 20 or more persons employed. For 2012, data refer to establishments with ten or more persons employed. Size categories refer to establishments with 10 to 250, and 251 and more persons employed.

For New Zealand, data refer to orders received via the Internet for the fiscal years 2007/08 and 2013/14, ending 31 March.

For Switzerland, data refer to 2008 and 2011. For 2008, data refer to businesses with five or more persons employed.

For Turkey, data refer to small businesses instead of SMEs.

Diffusion of selected ICT tools and activities in enterprises, 2014

Broadband includes both fixed and mobile connections with an advertised download rate of at least 256 Mbps.

E-purchases and e-sales refer to the purchase and sales of goods or services conducted over computer networks by methods specifically designed for the purpose of receiving or placing of orders (i.e. webpages, extranet or EDI but not orders by telephone calls, fax or manually typed e-mail). Payment and delivery are not considered.

Enterprise resource planning (ERP) systems are software-based tools that can integrate the management of internal and external information flows, from material and human resources to finance, accounting and customer relations. Here, only sharing of information within the firm is considered.

Cloud computing refers to ICT services used over the Internet as a set of computing resources to access software, computing power, storage capacity and so on.

Supply chain management refers to the use of automated data exchange (ADE) applications.

Social media refers to applications based on Internet technology or communication platforms for connecting, creating and exchanging content online with customers, suppliers or partners, or within the enterprise. Social media might include social networks (other than paid advertisement), blogs, file sharing and wiki-type knowledge sharing tools.

Radio Frequency Identification (RFID) is a technology that enables contactless transmission of information via radio waves. RFID can be used for a wide range of purposes, including personal identification or access control, logistics, retail trade and process monitoring in manufacturing.

Unless otherwise stated, only enterprises with ten or more persons employed are considered.

For countries in the European Statistical System, sector coverage consists of all activities in manufacturing and non-financial market services.

For countries in the European Statistical System, data on e-purchases and e-sales refer to 2013.

For Australia, data refer to the fiscal year 2013/14, ending 30 June and include agriculture, forestry and fishing activities.

For Canada and Japan, data refer to 2013 except cloud computing (2012).

For Korea, data refer to 2013.

For Mexico, data refer to 2012 and to establishments with ten or more persons employed.

For New Zealand, data refer to the fiscal year 2013/14, ending 31 March.

For Switzerland, data refer to 2011.

Enterprises using cloud computing services by size, 2014

Cloud computing refers to ICT services used over the Internet as a set of computing resources to access software, computing power, storage capacity and so on.

Data refer to manufacturing and non-financial market services enterprises with ten or more persons employed, unless otherwise stated.

Size classes are defined as: small (from 10 to 49 persons employed), medium (50 to 249) and large (250 and more).

For Canada, data refer to 2012 and to enterprises that have made expenditures on software as a service (e.g. cloud computing). Medium-sized enterprises have 50-299 employees. Large enterprises have 300 or more employees.

For Japan, data refer to 2012 and to businesses with 100 or more employees. Medium-sized enterprises have 100-299 employees. Large enterprises have 300 or more employees.

For Korea, data refer to 2013.

For Switzerland, data refer to 2011.

5.3. Start-up dynamics

General notes for all figures:

The figures for the period are constructed as averages of observations gathered over three-year reference periods (2001-04, 2004-07, 2007-10). The period covered is 2001-10 for all countries except Portugal and Turkey, for which the period covered is 2007-10, and Spain, for which the period covered is 2004-10.

Sectors covered are: manufacturing, construction, and non-financial business services.

Figures report the unweighted average of each country-period value, conditional on their availability.

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

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

5.4. Creative by design

Top ten design applicants by main field of application, 2011-13

Data refer to designs registered, by filing date, applicant's residence and Locarno classes using fractional counts.

The following aggregated fields based on the Locarno Classification are used: Furniture and household goods: Classes 6, 7 and 30; Clothes, textiles and accessories: Classes 2, 3, 5 and 11; Tools and machines: Classes 4, 8, 10 and 15; Health, pharma and cosmetics: Classes 24 and 28; Leisure and education: Classes 17, 19, 21 and 22; Agricultural and food products: Classes 1, 27 and 31; Construction: Classes 23, 25 and 29; ICT and audio-visual: Classes 14, 16 and 18; Electricity and lightning: Classes 13 and 26; Advertising: Classes 20 and 32; Transport: Class 12 and Packaging: Class 9.

Residence of designers active on the Japanese market, by field of design, 2004-14

Data refer to designs registered at the JPO, by filing date, creator's residence and Locarno classes using fractional counts.

The following aggregated fields based on the Locarno Classification are used: Furniture and household goods: Classes 6, 7 and 30; Clothes, textiles and accessories: Classes 2, 3, 5 and 11; Tools and machines: Classes 4, 8, 10 and 15; Health, pharma and cosmetics: Classes 24 and 28; Leisure and education: Classes 17, 19, 21 and 22; Agricultural and food products: Classes 1, 27 and 31; Construction: Classes 23, 25 and 29; ICT and audio-visual: Classes 14, 16 and 18; Electricity and lightning: Classes 13 and 26; Advertising: Classes 20 and 32; Transport: Class 12 and Packaging: Class 9.

JPO registered design data cover the period up to June 2014.

Designs on the Japanese market created abroad, 2004-14

Data refer to designs registered at the JPO, by filing date, applicant's and creator's residence using fractional counts. The share of registered designs created abroad corresponds to the share of applications where the residence of the "creator" (designer) is different from the applicant's residence.

Only economies with more than 100 designs registered at JPO in 2004-14 are included. JPO registered design data cover the period up to June 2014.

5.5. Technological advantages

General notes for all figures:

The revealed technological advantage index is calculated as the share of patents of an economy in a particular technology area relative to the share of total patents belonging to the economy. Data refer to IP5 patent families with members filed at the EPO or the USPTO, by first filing date and the inventor's residence using fractional counts. Only economies with more than 500 patents in 2010-13 are included.

Additional notes:

Revealed technological advantage in biotechnology and nanotechnology, 2000-03 and 2010-13

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

Data from 2012 are estimates.

Revealed technological advantage in ICT, 2000-03 and 2010-13

Patents in ICT are identified following a new experimental classification based on their International Patent Classification (IPC) codes.

Data from 2012 are estimates.

Range of revealed technological advantage in economies by field, 2010-13

Patents are allocated to technology fields on the basis of their International Patent Classification (IPC) codes, following the concordance provided by WIPO (2013).

5.6. Participation in global value chains

General notes for all figures:

For a given year, foreign value added embodied in final demand or exports of country c can be calculated as:

$$\text{diag}(\mathbf{V}_f) \, (\mathbf{I}\text{-}\mathbf{A})^{-1} \, \mathbf{FD}_c$$
$$\text{diag}(\mathbf{V}_f) \, (\mathbf{I}\text{-}\mathbf{A})^{-1} \, \mathbf{EXGR}_c$$

where $\text{diag}(\mathbf{V}_f)$ is the diagonalised matrix form of vector $\mathbf{V}_f$ with value added to production (gross output) ratios for all industries in countries $f \neq c$, zero for the entries corresponding to c; $\mathbf{A}$ is the global input coefficient matrix derived from the OECD Inter-Country Input-Output (ICIO) table for the target year, and $\mathbf{FD}_c$ and $\mathbf{EXGR}_c$ are vectors of length (number of countries × number of industries) which contain final demand and exports, respectively, by country c and are zero for the elements corresponding to countries $f \neq c$.

Sectors are defined according to ISIC Rev. 3: Manufactures (Divisions 15 to 37); Services: Wholesale, retail trade, hotels and restaurants (50 to 55); Transport, storage and communications (60 to 64); Finance and insurance (65 to 67); Business services (70 to 74) and Other services (75 to 93).

Additional notes:

Foreign value added embodied in exports and in domestic demand, by source region, 2011

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

Domestic value added embodied in partner countries' exports, 1995 and 2011

Domestic value added in partner countries' exports is the sum of the domestic value added in exports to all other countries that is then included in other countries' exports.

5.7. Trade and jobs

General notes for all figures:

For a given year, jobs in country c embodied in (or sustained by) foreign final demand is calculated as:

$$\text{diag}(\mathbf{E}_c)\,(\mathbf{I\text{-}A})^{-1}\,\mathbf{FFD}$$

where $\text{diag}(\mathbf{E}_c)$ is a matrix with sectoral employment to production (gross output) ratios in country c as diagonal elements, zero otherwise; $\mathbf{A}$ is the global input coefficient matrix derived from the ICIO table for the target year, and $\mathbf{FFD}$ is a vector of foreign final demand and includes final expenditure by non-residents in the domestic territory.

Additional notes:

Jobs in the business sector sustained by foreign final demand, by region of demand, 2011

The Business sector consists of ISIC Rev. 3 Divisions 10 to 74, i.e. total economy excluding Agriculture, forestry and fishing (Divisions 01 to 05), Public administration (75), Education (80), Health (85) and Other community, social and personal services (90 to 95).

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

Jobs sustained by foreign final demand, by sector, 2011

Sectors are defined according to ISIC Rev. 3: Primary goods (Divisions 01 to 05 and 10 to 14); Manufacturing (15 to 37), Trade and transportation (50 to 55 and 60 to 63); Financial and business services (64 to 74) and Other services (40 to 41, 45 and 75 to 95).

Business sector service jobs sustained by final demand of manufactured goods, 2011

Sectors are defined according to ISIC Rev. 3: Wholesale and retail trade (Divisions 50 to 52) Transport and storage (60 to 63); ICT services (64 and 72); Financial and insurance (65 to 67) and Other business services (70, 71, 73 and 74).

5.8. Service-manufacturing linkages

General notes for all figures:

For a given year, domestic services value added embodied in gross exports of country c is calculated as:

$$\text{diag}(\mathbf{V}_c)\,(\mathbf{I\text{-}A})^{-1}\,\mathbf{EXGR}_c$$

where $\text{diag}(\mathbf{V}_c)$ is a matrix with service sector value added to production (gross output) ratios of country c as diagonal elements, zero otherwise; $\mathbf{A}$ is the global input coefficient matrix derived from the ICIO table for the target year, and $\mathbf{EXGR}_c$ is a vector of length (number of countries × number of industries) which contains exports by country c and is zero for the elements corresponding to countries $f \neq c$. For foreign services content $\mathbf{V}_c$ is replaced by $\mathbf{V}_f$ containing service value added to production ratios for all countries except c.

5.9. Industry global value chains

General notes for all figures:

For a given year, foreign value added embodied in final demand in country c can be calculated as:

$$(\mathbf{V}_f)\,(\mathbf{I\text{-}A})^{-1}\,\mathbf{FD}_c$$

where $\mathbf{V}_f$ is a row vector with value added to production (gross output) ratios for all industries in countries $f \neq c$; $\mathbf{A}$ is the global input coefficient matrix derived from the ICIO table for the target year, and $\mathbf{FD}_c$ is a vector of length (number of countries × number of industries) which contains final demand in country c and is zero for the elements corresponding to countries $f \neq c$.

Other East and Southeast Asia comprises Brunei Darussalam, Cambodia, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand and Viet Nam.

5.10. Global consumption patterns

General notes for all figures:

For a given year, foreign value added embodied in domestic final consumption or gross fixed capital formation of country c can be calculated as:

$$\mathrm{diag}(\mathbf{V}_f)\,(\mathbf{I\text{-}A})^{-1}\,\mathbf{CONS}_c$$
$$\mathrm{diag}(\mathbf{V}_f)\,(\mathbf{I\text{-}A})^{-1}\,\mathbf{GFCF}_c$$

where $\mathrm{diag}(\mathbf{V}_f)$ is the matrix form of vector $\mathbf{V}_f$ with value added to production (gross output) ratios for all industries in countries $f \neq c$, zero for the entries corresponding to c; $\mathbf{A}$ is the global input coefficient matrix derived from the ICIO table for the target year, and $\mathbf{CONS}_c$ and $\mathbf{GFCF}_c$ are vectors of length (number of countries × number of industries) which contain domestic consumption and gross fixed capital formation by country c and are zero for the elements corresponding to countries $f \neq c$.

Additional notes:

Foreign value added embodied in domestic consumption, by source region, 2011

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

EU28 foreign origin of value added includes intra-EU flows; OECD foreign origin of value added includes intra-OECD flows.

Origin of value added embodied in final demand for food and beverages, 2011

Sectors are defined according to ISIC Revision 3: Agriculture, forestry and fishing (Divisions 01 to 05); Food and beverages (15 to 16).

EU28 foreign origin of value added includes intra-EU flows; OECD foreign origin of value added includes intra-OECD flows.

Foreign value added content of gross fixed capital formation, 2011

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

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From:

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Innovation for growth and society