Innovation Union Scoreboard 2010 – Methodology report

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1. Introduction

The European Innovation Scoreboard (EIS) has been revised following the adoption of the Innovation Union Communication[2]. Building on one decade of experience, the new Innovation Union Scoreboard (IUS) has been adapted to help monitor the implementation of the Europe 2020 Innovation Union flagship by providing a comparative assessment of the innovation performance of the EU27 Member States and the relative strengths and weaknesses of their research and innovation systems.

Integrating the IUS more closely as a monitoring tool of the Innovation Union required a number of adaptations to the list of indicators used in the EIS 2009. The list of 29 indicators used in the EIS 2009 has been replaced with a new list of 25 indicators, which better capture the performance of national research and innovation systems considered as a whole.

This Methodology report will discuss the definitions and rationale for the indicators included in the IUS 2010, will provide more details about the changes compared to the EIS 2009 and will provide a detailed discussion of the methodology used for calculating the composite innovation index.

This report draws on the results from previous unpublished work on the indicators for the new performance scoreboard for research and innovation (H. Hollanders, "Indicators for the Performance Scoreboard for Research and Innovation – Discussion and methodology", September 2010). The EC's Joint Research Centre has made a significant contribution to the section explaining the methodology for calculating the composite innovation index.

2. Innovation indicators used in the IUS 2010 – defnitions, rationale and comparison with the EIS 2009

2.1 The innovation indicators

The IUS 2010 largely follows the methodology of previous editions in distinguishing between 3 main types of indicators and 8 innovation dimensions, capturing in total 25 different indicators. The indicators included in each of the dimensions are listed in Table 1.

The **Enablers** capture the main drivers of innovation performance external to the firm and it differentiates between 3 innovation dimensions. The Human resources dimension includes 3 indicators and measures the availability of a high-skilled and educated workforce. The new Open, excellent and attractive research systems dimension includes 3 indicators and measures the international competitiveness of the science base. The Finance and support dimension includes 2 indicators and measures the availability of finance for innovation projects and the support of governments for research and innovation activities.

Firm activities capture the innovation efforts at the level of the firm and it differentiates between 3 innovation dimensions. The Firm investments dimension includes 2 indicators of both R&D and non-R&D investments that firms make in order to generate innovations. The Linkages & entrepreneurship dimension includes 3 indicators and measures entrepreneurial efforts and collaboration efforts among innovating firms and also with the public sector. The Intellectual assets dimension captures different forms of Intellectual Property Rights (IPR) generated as a throughput in the innovation process.

Outputs capture the effects of firms' innovation activities and it differentiates between 2 innovation dimensions. The Innovators dimension includes 3 indicators and measures the number of firms that have introduced innovations onto the

[2] See http://ec.europa.eu/research/innovation-union/pdf/innovation-union-communication_en.pdf

market or within their organisations, covering both technological and non-technological innovations and the presence of high-growth firms. The indicator on innovative high-growth firms corresponds to the new EU2020 headline indicator, which will be completed within the next two years. The Economic effects dimension includes 5 indicators and captures the economic success of innovation in employment, exports and sales due to innovation activities.

2.2 Definitions and discussion of the IUS 2010 innovation indicators

The IUS 2010 is introducing several new and some slightly changed indicators as compared to the EIS 2009 (cf. Table 1). In this section the indicators will be discussed in more detail providing more details on the definitions.

1.1.1 New doctorate graduates (ISCED6) per 1000 population aged 25-34

Numerator: Number of doctorate graduates (ISCED 6).

Denominator: The reference population is all age classes between 25 and 34 years inclusive.

Rationale: The indicator is a measure of the supply of new second-stage tertiary graduates in all fields of training. For most countries ISCED 6 captures PhD graduates only, with the exception of Finland, Portugal and Sweden where also non-PhD degrees leading to an award of an advanced research qualification are included.

Data source: Eurostat

Comparison with EIS 2009: The comparable EIS 2009 indicator focuses on doctorate graduates in science and engineering (S&E) and social sciences and humanities (SSH) following the recommendations received from Member States and experts during the revision of the EIS in 2008 (cf. the EIS 2008 Methodology report). The IUS 2010 indicator correlates highly with the EIS 2009 indicator on doctorates suggesting that both indicators measure performance similarly.

1.1.2 Percentage population aged 30-34 having completed tertiary education

Numerator: Number of persons in age class with some form of post-secondary education (ISCED 5 and 6).

Denominator: The reference population is all age classes between 30 and 34 years inclusive.

Rationale: This is a general indicator of the supply of advanced skills. It is not limited to science and technical fields because the adoption of innovations in many areas, in particular in the service sectors, depends on a wide range of skills. International comparisons of educational levels however are difficult due to large discrepancies in educational systems, access, and the level of attainment that is required to receive a tertiary degree. The indicator focuses on a narrow share of the population aged 30 to 34 and it will more easily and quickly reflect changes in educational policies leading to more tertiary graduates.

Data source: Eurostat

Comparison with EIS 2009: The comparable EIS 2009 indicator is more broadly defined as it takes the share of population aged 25-64 with tertiary education. The EIS 2009 indicator is less likely to change rapidly over time given the size of the age group and for policy perspectives the IUS 2010 indicator may be more relevant as it reflects a younger age group and it should more easily and quickly reflect changes in educational policies leading to more university graduates.

Table 1: A comparison of the indicators in the EIS 2009 and IUS 2010

European Innovation Scoreboard (EIS) 2009 **MAIN TYPE / Innovation dimension /** indicator	Innovation Union Scoreboard (IUS) 2010 **MAIN TYPE / Innovation dimension /** indicator	COMMENT	Data source	Reference year(s) – latest year used for IUS 2010
ENABLERS	**ENABLERS**			
Human resources	**Human resources**			
1.1.1 S&E and SSH graduates (1st stage) per 1000 population aged 20-29	---	EIS 2009 indicator no longer used		
1.1.2 S&E and SSH doctorate graduates (2nd stage) per 1000 population aged 25-34	1.1.1 New doctorate graduates (ISCED 6) per 1000 population aged 25-34	Broader definition than that used in the EIS 2009	Eurostat	2004 – 2008
1.1.3 Population with tertiary education per 100 population *aged 25-64*	1.1.2 Percentage population *aged 30-34* having completed tertiary education	Age group more narrowly defined than in EIS 2009	Eurostat	2005 – 2009
1.1.4 Participation in life-long learning per 100 population aged 25-64	---	EIS 2009 indicator no longer used		
1.1.5 Youth education attainment level	1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education	Different names but identical	Eurostat	2005 – 2009
---	**Open, excellent and attractive research systems**			
---	1.2.1 International scientific co-publications per million population	New indicator	Science Metrix / Scopus	2004 – 2008
---	1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	New indicator	Science Metrix / Scopus	2003 – 2007
---	1.2.3 Non-EU doctorate students as % of all doctorate students	New indicator	Eurostat	2003 – 2007
Finance and support	**Finance and support**			
1.2.1 Public R&D expenditures as % of GDP	1.3.1 Public R&D expenditures as % of GDP	Identical	Eurostat	2005 – 2009
1.2.2 Venture capital as % of GDP	1.3.2 Venture capital (early stage, expansion and replacement) as % of GDP	Identical	Eurostat	2005 – 2009
1.2.3 Private credit as a % of GDP	---	EIS 2009 indicator no longer used		
1.2.4 Broadband access by firms	---	EIS 2009 indicator no longer used		

European Innovation Scoreboard (EIS) 2009 **MAIN TYPE / Innovation dimension /** indicator	**Innovation Union Scoreboard (IUS) 2010** **MAIN TYPE / Innovation dimension /** indicator	**COMMENT**	**Data source**	**Reference year(s) – latest year used for IUS 2010**
FIRM ACTIVITIES	**FIRM ACTIVITIES**			
Firm investments	**Firm investments**			
2.1.1 Business R&D expenditures as % of GDP	2.1.1 Business R&D expenditures as % of GDP	Identical	Eurostat	2005 – 2009
2.1.2 IT expenditures as a % of GDP	---	EIS 2009 indicator no longer used		
2.1.3 Non-R&D innovation expenditures as % of turnover	2.1.2 Non-R&D innovation expenditures as % of turnover	Identical	Eurostat	2004, 2006, 2008
	Linkages & entrepreneurship			
2.2.1 SMEs innovating in-house as % of SMEs	2.2.1 SMEs innovating in-house as % of SMEs	Identical	Eurostat	2004, 2006, 2008
2.2.2 Innovative SMEs collaborating with others as % of SMEs	2.2.2 Innovative SMEs collaborating with others as % of SMEs	Identical	Eurostat	2004, 2006, 2008
2.2.3 Firm renewal rate (SMEs entries and exits as a % of all SMEs)	---	EIS 2009 indicator no longer used		
2.2.4 Public-private co-publications per million population	2.2.3 Public-private co-publications per million population	Identical	CWTS / Thomson Reuters	2004 – 2008
Throughputs	**Intellectual Assets**			
2.3.1 EPO patent applications million population	---	EIS 2009 indicator no longer used		
---	2.3.1 PCT patent applications per billion GDP (in PPS€)	New indicator	Eurostat	2003 – 2007
---	2.3.2 PCT patent applications in societal challenges per billion GDP (in PPS€) (climate change mitigation; health)	New indicator	OECD / Eurostat	2003 – 2007
2.3.2 Community trademarks *per million population*	2.3.3 Community trademarks *per billion GDP* (in PPS€)	Different denominator	OHIM / Eurostat	2005 – 2009
2.3.3 Community designs *per million population*	2.3.4 Community designs *per billion GDP* (in PPS€)	Different denominator	OHIM / Eurostat	2005 – 2009
2.3.4 Technology Balance of Payments flows as % of GDP	---	Receipts captured in IUS 2010 indicator 3.2.5		

European Innovation Scoreboard (EIS) 2009 **MAIN TYPE / Innovation dimension /** indicator	Innovation Union Scoreboard (IUS) 2010 **MAIN TYPE / Innovation dimension /** indicator	COMMENT	Data source	Reference year(s) – latest year used for IUS 2010
OUTPUTS	**OUTPUTS**			
Innovators	**Innovators**			
3.1.1SMEs introducing product or process innovations as % of SMEs	3.1.1 SMEs introducing product or process innovations as % of SMEs	Identical	Eurostat	2004, 2006, 2008
3.1.2 SMEs introducing marketing or organisational innovations as % of SMEs	3.1.2 SMEs introducing marketing or organisational innovations as % of SMEs	Identical	Eurostat	2004, 2006, 2008
3.1.3 Resource efficiency innovators as % of all firms	---	EIS 2009 indicator no longer used		
---	3.1.3 High-growth innovative enterprises	New indicator	N/A	N/A
Economic effects	**Economic effects**			
3.2.1 Employment in medium-high & high-tech manufacturing as % of workforce	---	EIS 2009 indicator no longer used		
3.2.2 Employment in knowledge-intensive services as % of workforce	---	EIS 2009 indicator no longer used		
---	3.2.1 Employment in knowledge-intensive activities (manufacturing and services) as % of workforce	New indicator	Eurostat	2008, 2009
3.2.3 Medium and high-tech product exports as % of total product exports	3.2.2 Medium and high-tech product exports as % of total product exports	Identical	UN / Eurostat	2005 – 2009
3.2.4 Knowledge-intensive services exports as % of total services exports	3.2.3 Knowledge-intensive services exports as % of total services exports	Identical	UN / Eurostat	2004 – 2008
3.2.5 Sales of new to market innovations as % of turnover 3.2.6 Sales of new to firm innovations as % of turnover	3.2.4 Sales of new to market and new to firm innovations as % of turnover	Combines EIS 2009 indicators 3.2.5 and 3.2.6	Eurostat	2004 – 2008
---	3.2.5 Licence and patent revenues from abroad as % of GDP	Part of EIS indicator 2.3.4 on TBP flows	Eurostat	2005 – 2009

1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education

Numerator: Number of young people aged 20-24 years having attained at least upper secondary education attainment level, i.e. with an education level ISCED 3a, 3b or 3c long minimum (numerator).

Denominator: The reference population is all age classes between 20 and 24 years inclusive.

Rationale: The indicator measures the qualification level of the population aged 20-24 years in terms of formal educational degrees. It provides a measure for the "supply" of human capital of that age group and for the output of education systems in terms of graduates. Completed upper secondary education is generally considered to be the minimum level required for successful participation in a knowledge-based society and is positively linked with economic growth.

Data source: Eurostat

1.2.1 International scientific co-publications as % of total scientific publications of the country

Numerator: Number of scientific publications with at least one co-author based abroad (where abroad is non-EU for the EU27).

Denominator: Total number of scientific publications.

Rationale: International scientific co-publications are a proxy for the quality of scientific research as collaboration increases scientific productivity. Data availability for this indicator is limited to the EU27 Member States.

Note: This indicator was introduced to better capture research performance.

Data source: Science Metrix / Scopus

1.2.2 Scientific publications among the top-10% most cited publications worldwide as % of total scientific publications of the country

Numerator: Number of scientific publications among the top-10% most cited publications worldwide.

Denominator: number of scientific publications.

Rationale: The indicator is a proxy for the efficiency of the research system as highly cited publications are assumed to be of higher quality. There could be a bias towards small or English speaking countries given the coverage of Scopus' publication data. Countries like France and Germany, where researchers publish relatively more in their own language, are more likely to underperform on this indicator as compared to their real academic excellence.

Note: This indicator was introduced by the EC services to capture research performance.

Data source: Science Metrix / Scopus

1.2.3 Non-EU doctorate holders as % of total doctorate holders of the country

Numerator: Number of doctorate students coming from a non-EU country. For non-EU countries the number of non-national doctorate students is used.

Denominator: Total number of doctorate students.

Rationale: The share of non-EU doctorate students reflects the mobility of students as an effective way of diffusing knowledge. Attracting high-skilled foreign doctorate students will add to creating a net brain gain and will secure a continuous supply of researchers.

Note: This is a highly skewed indicator and a square root transformation has been used to reduce the volatility and skewed distribution of this indicator.

Data source: Eurostat

1.3.1 Public R&D expenditures (% of GDP)

Numerator: All R&D expenditures in the government sector (GOVERD) and the higher education sector (HERD). Both GOVERD and HERD according to the Frascati-manual definitions, in national currency and current prices.

Denominator: Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.

Rationale: R&D expenditure represents one of the major drivers of economic growth in a knowledge-based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.

Data source: Eurostat

1.3.2 Venture capital (% of GDP)

Numerator: Venture capital investment is defined as private equity being raised for investment in companies. Management buyouts, management buyins, and venture purchase of quoted shares are excluded. Data are broken down into two investment stages: Early stage (seed + start-up) and Expansion and replacement (expansion and replacement capital). Seed is defined as financing provided to research, assess and develop an initial concept before a business has reached the start-up phase. Start-up is defined as financing provided for product development and initial marketing, manufacturing, and sales. Companies may be in the process of being set up or may have been in business for a short period of time, but have not sold their product commercially. Expansion is defined as financing provided for the growth and expansion of a company which is breaking even or trading profitably. Capital may be used to finance increased production capacity, market or product development, and/or provide additional working capital. It includes bridge financing for the transition from private to public quoted company, and rescue/turnaround financing. Replacement capital is defined as purchase of existing shares in a company from another private equity investment organisation or from another shareholder(s). It includes refinancing of bank debt.

Denominator: Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.

Rationale: The amount of venture capital is a proxy for the relative dynamism of new business creation. In particular for enterprises using or developing new (risky) technologies venture capital is often the only available means of financing their (expanding) business.

Comment: Venture capital is a highly volatile indicator: two-year averages have been used to reduce volatility rates. This is a highly skewed indicator and a square root transformation has been used to reduce the volatility and skewed distribution of this indicator.

Data source: Eurostat (EVCA (European Venture Capital Association) is the primary data source for VC expenditure data)

2.1.1 Business R&D expenditures (% of GDP)

Numerator: All R&D expenditures in the business sector (BERD), according to the Frascati-manual definitions, in national currency and current prices.

Denominator: Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.

Rationale: The indicator captures the formal creation of new knowledge within firms. It is particularly important in the science-based sector (pharmaceuticals, chemicals and some areas of electronics) where most new knowledge is created in or near R&D laboratories.

Data source: Eurostat

2.1.2 Non-R&D innovation expenditures (% of total turnover)

Numerator: Sum of total innovation expenditure for enterprises, in national currency and current prices excluding intramural and extramural R&D expenditures. (Community Innovation Survey: CIS 2008 question 5.2, sum of variables RMACX and ROEKX)

Denominator: Total turnover for all enterprises (both innovators and non-innovators), in national currency and current prices. (Community Innovation Survey: CIS 2008 question 11.1, variable TURN08)

Rationale: This indicator measures non-R&D innovation expenditure as percentage of total turnover. Several of the components of innovation expenditure, such as investment in equipment and machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas.

Data source: Eurostat (Community Innovation Survey)

2.2.1 SMEs innovating in-house (% of all SMEs)

Numerator: Sum of SMEs with in-house innovation activities. Innovative firms are defined as those firms which have introduced new products or processes either 1) in-house or 2) in combination with other firms. This indicator does not include new products or processes developed by other firms.

Data are taken from CIS 2008 questions 2.2 and 3.2, i.e. those SMEs which are either:

- A product innovator who, to the question "Who developed these product innovations", answered Yes to at least one of the following categories of CIS 2008 question 2.2: "Mainly your enterprise or enterprise group" or "Your enterprise together with other enterprises or institutions".
- A process innovator who, to the question "Who developed these process innovations", answered Yes to at least one of the following categories of CIS 2008 question 3.2: "Mainly your enterprise or enterprise group" or "Your enterprise together with other enterprises or institutions".

Denominator: Total number of SMEs (both innovators and non-innovators).

Rationale: This indicator measures the degree to which SMEs, that have introduced any new or significantly improved products or production processes, have innovated in-house. The indicator is limited to SMEs because almost all large firms innovate and because countries with an industrial structure weighted towards larger firms tend to do better.

Data source: Eurostat (Community Innovation Survey) (cf. Box 1)

Box 1: Calculation of the indicator on SMEs innovating in-house

Data on product and/or process innovators innovating in-house are not directly available from Eurostat. The indicator has been estimated as follows.

Step 1: From Eurostat data are extracted online from "inn_cis6_prod-Product and process innovation" for size categories "between 10 and 49" and "between 50 and 249" (i.e. SMEs) for the following types of innovators:

(1) Product, developed by enterprise or group
(2) Product, developed in cooperation with enterprises or institutions
(3) Product, developed mainly by other enterprises or institutions
(4) Process, developed by enterprise or group
(5) Process, developed in cooperation with enterprises or institutions
(6) Process, developed mainly by other enterprises or institutions

Step 2: Calculate the share of product innovators innovating in-house as:

(7) = ((1) + (2)) / ((1) + (2) + (3))

Step 3: Calculate share of process innovators innovating in-house as:

(8) = ((4) + (5)) / ((4) + (5) + (6))

Step 4: From Eurostat data are extracted online from "inn_cis6_type-Enterprises by type of innovation activity" for SMEs on:

(9) Total enterprises
(10) Novel innovators, product only
(11) Novel innovators, process only
(12) Novel innovators, product and process innovators

Data on (9) Total enterprises are used for the denominator.

Step 5: The numerator is estimated as the sum of:

- Novel innovators with only product innovations innovating in-house
- Novel innovators with only process innovation innovating in-house
- Novel innovators with product and process innovations innovating in-house

(7)*(10) + (8)*(11) + (((7)+(8)) / 2)*(12)

For "Novel innovators with product and process innovations" the average between (7) and (8) has been used as a proxy for the share of firms innovating in-house.

2.2.2 Innovative SMEs co-operating with others (% of all SMEs)

Numerator: Sum of SMEs with innovation co-operation activities. Firms with co-operation activities are those that had any co-operation agreements on innovation activities with other enterprises or institutions in the three years of the survey period (i.e. those SMEs who replied Yes to CIS 2008 question 6.2).

Denominator: Total number of SMEs (both innovators and non-innovators).

Rationale: This indicator measures the degree to which SMEs are involved in innovation co-operation. Complex innovations, in particular in ICT, often depend on the ability to draw on diverse sources of information and knowledge, or to collaborate on the development of an innovation. This indicator measures the flow of knowledge between public research institutions and firms and between firms and other firms. The indicator is limited to SMEs because almost all large firms are involved in innovation co-operation.

Data source: Eurostat (Community Innovation Survey)

2.2.3 Public-private co-publications per million population

Numerator: Number of public-private co-authored publications. The "public-private co-publications" are defined as all research-related papers (document types: 'research articles', 'research reviews', notes' and 'letters') published in the Web of Science database. These co-publications have been allocated to one or more countries according to the geographical location of the business enterprise (or enterprises) that are listed in the authors affiliate address(es); as a result the geographical location of the public sector research partner(s) in those addresses is not relevant. Each co-publication is counted as one publication for each country, irrespective of the number of co-authors and (parent) organisations listed in the author affiliate address(es). The definition of the "private" sector excludes te private medical and health sector.

Denominator: Total population as defined in the European System of Accounts (ESA 1995).

Rationale: This indicator captures public-private research linkages and active collaboration activities between business sector researchers and public sector researchers resulting in academic publications.

Comment: Data are two-year averages.

Data source: CWTS / Thomson Reuters database. All data manipulations have been done by CWTS (Leiden University, http://www.cwts.nl).

2.3.1 PCT patent applications per billion GDP (in PPP€)

Numerator: Number of patents applications filed under the PCT, at internationational pase, designating the European Patent Office (EPO). Patent counts are based on the priority date, the inventor's country of residence and fractional counts.

Denominator: Gross Domestic Product in Purchasing Power Parity Euros.

Rationale: The capacity of firms to develop new products will determine their competitive advantage. One indicator of the rate of new product innovation is the number of patents. This indicator measures the number of PCT patent applications.

Data source: OECD / Eurostat

Comparison with EIS 2009: This indicator replaces the EIS 2009 indicator on number of EPO patent applications per million population. Given the home advantage bias in favour of EPO contracting states in international comparisons it seems straightforward to replace EPO patents with PCT patents following the methodology in the IUS 2010 in the benchmarking analyses between the EU27 and the US, Japan and the BRIC countries. The switch in denominator from population to GDP has only little effect on the relative performance of countries as shown by the high correlation between PCT patent per billion GDP and EPO patents per million population (0.905 at 1% confidence).

2.3.2 PCT patent applications in societal challenges per billion GDP (in PPP€)

Numerator: Number of PCT patent applications in Climate change mitigation and Health. Patents in Climate change mitigation equal those in Renewable energy, Electric and hybrid vehicles and Energy efficiency in buildings and lighting. Patents in health-related technologies include those in Medical technology (IPC codes (8th edition) A61[B, C, D, F, G, H, J, L, M, N], H05G) and Pharmaceuticals (IPC codes A61K excluding A61K8).

Denominator: Gross Domestic Product in Purchasing Power Parity Euros.

Rationale: This indicator measures PCT applications in health technology and climate change mitigation and is highly relevant as increased numbers of patent applications in health technology and climate change mitigation will be necessary to meet the societal needs of an ageing European society and sustainable growth.

Note: This is a highly skewed indicator and a square root transformation has been used to reduce the volatility and skewed distribution of this indicator.

Data source: OECD / Eurostat

2.3.3 Community trademarks per billion GDP (in PPP€)

Numerator: Number of new community trademarks. A trademark is a distinctive sign, identifying certain goods or services as those produced or provided by a specific person or enterprise. The Community trademark offers the advantage of uniform protection in all countries of the European Union through a single registration procedure with the Office for Harmonization.

Denominator: Gross Domestic Product in Purchasing Power Parity Euros.

Rationale: Trademarks are an important innovation indicator, especially for the service sector. The Community trademark gives its proprietor a uniform right applicable in all Member States of the European Union through a single procedure which simplifies trademark policies at European level. It fulfils the three essential functions of a trademark: it identifies the origin of goods and services, guarantees consistent quality through evidence of the company's commitment vis-à-vis the consumer, and is a form of communication, a basis for publicity and advertising.

Data source: OHIM (Office of Harmonization for the Internal Market) / Eurostat

Comparison with EIS 2009: This indicator replaces the EIS 2009 indicator on community trademarks per million population. The switch in denominator from population to GDP has only little effect on the relative performance of countries as the EIS 2009 and IUS 2010 indicators correlate highly.

2.3.4 Community designs per billion GDP (in PPP€)

Numerator: Number of new community designs. A registered Community design is an exclusive right for the outward appearance of a product or part of it, resulting from the features of, in particular, the lines, contours, colours, shape, texture and/or materials of the product itself and/or its ornamentation.

Denominator: Gross Domestic Product in Purchasing Power Parity Euros.

Rationale: A design is the outward appearance of a product or part of it resulting from the lines, contours, colours, shape, texture, materials and/or its ornamentation. A product can be any industrial or handicraft item including packaging, graphic symbols and typographic typefaces but excluding computer programs. It also includes products that are composed of multiple components, which may be disassembled and reassembled. Community design protection is directly enforceable in each Member State and it provides both the option of an unregistered and a registered Community design right for one area encompassing all Member States.

Data source: OHIM (Office of Harmonization for the Internal Market) / Eurostat

Comparison with EIS 2009: This indicator replaces the EIS 2009 indicator on community designs per million population. The switch in denominator from population to GDP has only little effect on the relative performance of countries as the EIS 2009 and IUS 2010 indicators correlate highly.

3.1.3 SMEs introducing product or process innovations as % of SMEs

Numerator: The number of SMEs who introduced a new product or a new process to one of their markets. Data are taken from CIS 2008 questions 2.1 and 3.1, i.e. those SMEs which have either introduced:

- A product innovation, i.e. have introduced either "New or significantly improved goods" or "New or significantly improved services".
- A process innovation, i.e. have introduced either "New or significantly improved methods of manufacturing or producing goods or services", "New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services" or "New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing".

Denominator: Total number of SMEs.

Rationale: Technological innovation as measured by the introduction of new products (goods or services) and processes is key to innovation in manufacturing activities. Higher shares of technological innovators should reflect a higher level of innovation activities.

Data source: Eurostat (Community Innovation Survey)

3.1.2 SMEs introducing marketing or organisational innovations as % of SMEs

Numerator: Numerator: The number of SMEs who introduced a new marketing innovation and/or organisational innovation to one of their markets Data are taken from CIS 2008 questions 8.1 and 9.1, i.e. those SMEs which have either introduced:

- A marketing innovation, i.e. have introduced either "Significant changes to the aesthetic design or packaging of a good or service (excluding changes that alter the product's functional or user characteristics – these are product innovations)", "New media or techniques for product promotion (i.e. the first time use of a new advertising media, a new brand image, introduction of loyalty cards, etc)", "New methods for product placement or sales channels (i.e. first time use of franchising or distribution licenses, direct selling, exclusive retailing, new concepts for product presentation, etc)" or "New methods of pricing goods or services (i.e. first time use of variable pricing by demand, discount systems, etc)".
- An organisational innovation, i.e. have introduced either "New business practices for organising procedures (i.e. supply chain management, business re-engineering, knowledge management, lean production, quality management, etc)", "New methods of organising work responsibilities and decision making (i.e. first use of a new system of employee responsibilities, team work, decentralisation, integration or de-integration of departments, education/training systems, etc)" or "New methods of organising external relations with other firms or public institutions (i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc").

Denominator: Total number of SMEs.

Rationale: The Community Innovation Survey mainly asks firms about their technical innovation. Many firms, in particular in the services sectors, innovate through other non-technological forms of innovation. Examples of these are marketing and organisational innovations. This indicator tries to capture the extent that SMEs innovate through non-technological innovation.

Data source: Eurostat (Community Innovation Survey)

3.1.1 High-growth innovative firms

Numerator: Number of "high-growth firms".

Denominator: Total number of firms.

Rationale: The report of the High Level Panel on the Measurement of Innovation[3] has provided ample support for the use of an indicator on fast-growing innovative firms. Such an indicator "would be forward looking and compelling (young innovative firms need to grow to create employment), mobilizing (it stresses the role of business in innovation), analytically very relevant, and with strong links to policy. In addition, it would be an integrative indicator: … it would summarize many of the relevant dimensions of an innovation system. … [T]he indicator would also constitute a good complement of the R&D intensity indicator."

Data source: Not yet available

3.2.1 Employment in knowledge-intensive activities as % of total employment

Numerator: Number of employed persons in knowledge-intensive activities in business industries. Knowledge-intensive activities are defined, based on EU Labour Force Survey data, as all NACE Rev.2 industries at 2-digit level where at least 25% of employment has a higher education degree (ISCED5A or ISCED6). These industries include:

- Extraction of crude petroleum and natural gas (06)
- Mining support service activities (09)
- Manufacture of coke and refined petroleum products (19)
- Manufacture of basic pharmaceutical products and pharmaceutical preparations (21)
- Manufacture of computer, electronic and optical products (26)
- Air transport (51)
- Publishing activities (58)
- Motion picture, video and television programme production, sound recording and music publishing activities (59)
- Programming and broadcasting activities (60)
- Telecommunications (61)
- Computer programming, consultancy and related activities (62)
- Information service activities (63)
- Financial service activities, except insurance and pension funding (64)
- Insurance, reinsurance and pension funding, except compulsory social security (65)
- Activities auxiliary to financial services and insurance activities (66)
- Legal and accounting activities (69)
- Activities of head offices; management consultancy activities (70)
- Architectural and engineering activities; technical testing and analysis (71)
- Scientific research and development (72)
- Advertising and market research (73)
- Other professional, scientific and technical activities (74)

[3] European Commission (2010), "Elements for the setting-up of headline indicators for innovation in support of the Europe 2020 strategy", report of the High Level Panel on the Measurement of Innovation established by Ms Máire Geoghegan-Quinn, European Commissioner for Research and Innovation. Brussels: European Commission.

- Veterinary activities (75)
- Travel agency, tour operator and other reservation service and related activities (79)
- Creative, arts and entertainment activities (90)

Denominator: Total employment.

Rationale: Knowledge-intensive activities provide services directly to consumers, such as telecommunications, and provide inputs to the innovative activities of other firms in all sectors of the economy.

Note: This indicator was introduced by the EC services.

Data source: Eurostat

Comparison with EIS 2009: The indicator on knowledge-intensive activities replaces EIS 2009 indicators 3.2.1 on employment in medium-high and high-tech manufacturing and 3.2.2 on employment in knowledge-intensive services. The indicator is highly correlated with the EIS 2009 indicator on knowledge-intensive services but not with the EIS 2009 indicator on medium-high and high-tech manufacturing.

3.2.2 Medium and high technology product exports as % of total product exports

Numerator: Value of medium and high-tech exports, in national currency and current prices. High-tech exports include exports of the following SITC Rev.3 products: 266, 267, 512, 513, 525, 533, 54, 553, 554, 562, 57, 58, 591, 593, 597, 598, 629, 653, 671, 672, 679, 71, 72, 731, 733, 737, 74, 751, 752, 759, 76, 77, 78, 79, 812, 87, 88 and 891.

Denominator: Value of total product exports, in national currency and current prices.

Rationale: The indicator measures the technological competitiveness of the EU i.e. the ability to commercialise the results of research and development (R&D) and innovation in the international markets. It also reflects product specialisation by country. Creating, exploiting and commercialising new technologies are vital for the competitiveness of a country in the modern economy. This is because medium and high technology products are key drivers for economic growth, productivity and welfare, and are generally a source of high value added and well-paid employment.

Data source: UN Comtrade / Eurostat

3.2.3 Knowledge-intensive services exports as % of total services exports

Numerator: Exports of knowledge-intensive services are measured by the sum of credits in EBOPS (Extended Balance of Payments Services Classification) 207, 208, 211, 212, 218, 228, 229, 245, 253, 254, 260, 263, 272, 274, 278, 279, 280 and 284. Total KIS exports will be overestimated as EBOPS 284 also covers activities in ISIC 90 Sewage and refuse disposal, sanitation and similar activities but it is expected that this overestimation is marginal.

Denominator: Total services exports as measured by credits in EBOPS 200.

Rationale: The indicator measures the competitiveness of the knowledge-intensive services sector. The indicator is comparable to indicator 3.2.2 on high-tech manufacturing export performance. Knowledge-intensive services are defined as NACE classes 61-62 and 64-72. These can be related to the above-mentioned EBOPS classes using the correspondence table between NACE, ISIC and EBOPS as provided in the UN Manual on Statistics of International Trade in Services (UN, 2002).

Data source: Eurostat (Balance of Payments statistics) / UN Service Trade

3.2.4 Sales of new-to-market and new-to-firm innovations as % of turnover

Numerator: Sum of total turnover of new or significantly improved products either new to the firm or new to the market for all enterprises. (Community Innovation Survey, CIS 2008 question 2.3, variables TURNMAR and TURNIN)

Denominator: Total turnover for all enterprises (both innovators and non-innovators), in national currency and current prices. (Community Innovation Survey: CIS 2008 question 11.1, variable TURN08)

Rationale: This indicator measures the turnover of new or significantly improved products and includes both products which are only new to the firm and products which are also new to the market. The indicator thus captures both the creation of state-of-the-art technologies (new to market products) and the diffusion of these technologies (new to firm products).

Data source: Eurostat (Community Innovation Survey)

Comparison with EIS 2009: This indicator combines EIS 2009 indicators 3.2.5 on sales of new-to-market products and 3.2.6 on sales of new-to-firm products.

3.2.5 License and patent revenues from abroad as % of GDP

Numerator: Export part of the international transactions in royalties and license fees.

Denominator: Gross Domestic Product.

Rationale: Trade in technology comprises four main categories: Transfer of techniques (through patents and licences, disclosure of know-how); Transfer (sale, licensing, franchising) of designs, trademarks and patterns; Services with a technical content, including technical and engineering studies, as well as technical assistance; and Industrial R&D. TBP receipts capture disembodied technology exports..

Data source: Eurostat

Note: . This is a highly skewed indicator and a square root transformation has been used to reduce the volatility and skewed distribution of this indicator.

Comparison with EIS 2009: The EIS 2009 indicator on TBP flows included the sum of TBP receipts and TBP payments.

3. Methodology for calculating composite scores

The overall innovation performance of each country has been summarized in a composite indicator: the Summary Innovation Index (SII). In this section we explain the methodology used for calculating the SII of the main report, and include some exploratory steps (Box-Cox transformation, geometric aggregation and robustness analysis), which could be employed in future innovation scoreboards. Therefore, the SII scores and rankings obtained in this section can be different from the results given in the main report.

Step 1: Data availability

The Innovation Union Scoreboard uses the most recent statistics from Eurostat and other internationally recognised sources as available at the time of analysis. International sources have been used wherever possible in order to improve comparability between countries. Note that the most recent data for the indicators are available at different years (cf. Table 1). The calculations are made by labelling with *2010* the most recent year available, though the data relate to actual performance in 2007 (4 indicators), 2008 (10 indicators) and 2009 (10 indicators).

The availability of data country by country at each year is given in Table 2 showing that non-EU27 countries have lower availability. The indicator *Venture Capital* has the lowest data availability in the database (69% across all Countries).

Table 2: Country by country data availability (in percentage)

	2010	2009	2008	2007	2006
EU27	100	100	100	100	100
BE	100	100	100	100	100
BG	100	100	100	100	100
CZ	100	100	100	100	100
DK	100	100	100	100	100
DE	96	96	96	96	96
EE	96	96	96	96	96
IE	96	96	96	96	96
GR	100	100	100	100	100
ES	96	96	96	96	96
FR	100	100	100	100	100
IT	100	100	100	100	100
CY	96	96	96	96	96
LV	96	96	96	96	96
LT	96	96	96	96	96
LU	96	96	96	96	96
HU	100	100	100	100	100
MT	96	96	96	96	96

	2010	2009	2008	2007	2006
NL	96	96	96	96	96
AT	100	100	100	100	100
PL	100	100	100	100	100
PT	100	100	100	100	100
RO	100	100	100	100	100
SI	92	92	92	92	92
SK	100	100	100	100	100
FI	100	100	100	100	100
SE	100	100	100	100	100
UK	92	92	92	92	92
HR	92	92	92	92	92
TR	92	92	92	92	92
IS	75	75	75	75	75
NO	96	96	96	96	96
CH	92	92	92	92	92
MK	75	75	75	75	75
RS	75	75	75	75	75

Step 2: Identifying extreme values

Positive outliers are identified as those scores which are higher than the mean plus 2 times the standard deviation[4]. Negative outliers are identified as those scores which are smaller than the mean minus 2 times the standard deviation. These outliers, except Switzerland for non-EU doctoral students, are not modified as they are official values provided by Eurostat. The value of *non-EU doctoral*

[4] This approach follows the well-adopted Chauvenet's Criterion in statistical theory.

students for Switzerland actually represents non-Swiss doctoral students, thus including EU27 students. Being manifestly biased, this value has been cut from 45% to 19.45% (i.e. the aggregate value for EU27 in 2008). Table 3 summarizes which outliers have been identified.

Table 3: Positive and negative outliers are found for various indicators and countries

	2008	2007	2006	2005	2004
POSITIVE OUTLIERS					
1.1.1 New doctorate graduates	SE, CH	PT, SE, CH	CH	FI, CH	FI, SE, CH
1.2.1 International scientific co-publications	SE	DK, SE	DK, SE	DK, SE	DK, SE
1.2.3 Non-EU doctorate students	FR,UK	FR, UK	FR, UK	FR, UK	-
1.3.1 Public R&D expenditure	-	IS	IS	IS	IS
1.3.2 Venture capital	LU	LU	LU, UK	LU, UK	LU
2.1.1 Business R&D expenditure	FI,SE	FI,SE	FI,SE	FI,SE	FI,SE
2.1.2 Non-R&D Innovation expenditure	CY,EE	CY,EE	CY,EE	-	-
2.2.2 Innovative SMEs collaborating with others	UK	CY,FI	CY,FI	-	-
2.2.3 Public-private co-publications	IS, CH	IS, CH	CH	CH	IS, CH
2.3.1 PCT patent applications	SE, FI	SE, FI	SE, FI	FI	SE, FI
2.3.2 PCT patent applications in societal challenges	SE, DK, CH	SE, DK, CH	SE, DK, CH	DK, CH	DK, CH
2.3.3 Community trademarks	LU, MT	LU, IS	LU	LU	LU
2.3.4 Community designs	AT	DK, LU	LU, CH	DK	DK
3.1.1 SMEs introducing product or process innovations	CH	-	-	-	-
3.1.2 SMEs introducing marketing or organisational innovations	DE	DE	DE	-	-
3.2.1 Employment in knowledge-intensive activities	LU	LU	LU	LU	LU
3.2.3 Knowledge-intensive services exports	LU	LU	LU	LU,IE	LU,IE
3.2.4 Sales of new to market and firm innovations	GR, CH	GR,MT	GR,MT	MT	MT
3.2.5 License and patent revenues from abroad	MT, CH	MT, NL, CH	MT,NL, CH	MT, NL, CH	NL, CH
NEGATIVE OUTLIERS					
1.1.3 Youth having attained at least upper secondary education	MT, IS, TR	MT, IS, TR	-	-	PT, IS, TR
3.2.2 Medium and high-tech product exports	IS,NO	IS,NO	NO	NO	NO
3.2.4 Sales of new to market and firm innovations	NO	LV	LV	-	-

<u>Step 3: Transforming data that have highly skewed distributions across Countries</u>

Most of the indicators are fractional indicators with values between 0% and 100%. Some indicators are unbound indicators, where values are not limited to an upper threshold. These indicators may have skewed (non-symmetric) distributions where most countries show low performance levels and a few countries show exceptionally high performance levels (skewness above zero). Values of skewness above 1 were found for 8 indicators out of 24 due to few countries performing extremely well in those indicators (see Table 3 above). The following indicators have high skewness: Non-EU doctorate students (1.23), Venture capital (1.89), Non-R&D innovation expenditure (1.67), Public-private co-publications (1.51), PCT patents aaplications (1.22), PCT patent applications in societal challenges

(1.75), Community trademarks (1.75), Community designs (1.09) and License and patent revenues from abroad (2.31). Therefore, these indicators could be transformed, at all time points, using a Box-Cox transformation[5] with $\lambda = 0.6$. In the main IUS 2010 report the Box-Cox transformation is not employed, hence different SII scores and somehow different country rankings are obtained as compared to the results in this section. With the Box-Cox transformation the skewness becomes smaller than 1 for all indicators except License and patent revenues from abroad. For this latter indicator, a Box-Cox transformation with $\lambda = 0.4$ was necessary to reduce the skewness below 1.

For the indicator Youth having attained at least upper secondary education a negative value of skewness (-1.17) was detected, due to the poor performance of Turkey and Iceland at all years (though Turkey has improved constantly between 2004 and 2008), Portugal from 2004 to 2007, and Malta in 2007 and 2008. This indicator was transformed using Box-Cox with $\lambda = 1.5$, obtaining a more symmetric distribution of scores across countries (the skewness was reduced to -1.00).

In the IUS 2010 report data are transformed using a square root transformation after outliers have been removed (cf. Step 6).

Step 4: Imputation of missing values

If data for the latest year are missing, they are imputed with the data of the latest available year. If data for a year-in-between are missing, they are imputed with the value of the previous year. If data are not available at the beginning of the time series, they are imputed with the oldest available year (see Table 4).

Table 4: Examples of imputation

Example 1 (latest year missing)				
	"2010"	"2009"	"2008"	"2007"
Available relative to EU27 score	Missing	150	120	110
Use most recent year	**150**	150	120	110
Example 2 (year-in-between missing)				
	"2010"	"2009"	"2008"	"2007"
Available relative to EU27 score	150	Missing	120	110
Substitute with previous year	150	**120**	120	110
Example 3 (beginning-of-period missing)				
	"2010"	"2009"	"2008"	"2007"
Available relative to EU27 score	150	130	120	Missing
Substitute with oldest available year	150	130	120	**120**

In case the data for an indicator are not available for a given country at any time point, the composite score is evaluated without that indicator by re-calculating the weights for the other indicators such that their sum is one. This is equivalent to replacing the missing indicator with the weighted average calculated across all the others.

[5] Box-Cox transformations are power transformations which include the logarithmic transformation as a special case: $\Phi_\lambda(x) = \frac{x^\lambda - 1}{\lambda}\ if\ \lambda \neq 0, otherwise\ \Phi_\lambda(x) = \log(\lambda)$.

Step 5: Determining Maximum and Minimum scores

The Maximum score is the highest score for each indicator found for the whole time period within all countries. Similarly, the Minimum score is the lowest score for each indicator found for the whole time period within all countries.

Step 5: Transforming data highly skewed data

Most of the indicators are fractional indicators with values between 0% and 100%. Some indicators are unbound indicators, where values are not limited to an upper threshold. These indicators can be highly volatile and can have skewed data distributions (where most countries show low performance levels and a few countries show exceptionally high performance levels). For each of the indicators the degree of skewness is calculated after adjusting for possible statistical outliers (cf. Step 2). For the following indicators skewness is above 1 and data have been transformed using a square root transformation: Non-EU doctorate students, Venture capital, PCT patents in societal challenges and License and patent revenues from abroad.

Step 7: Normalising scores

After determining minimum and maximum scores across countries for each indicator, the normalized scores for all years are calculated by using the min-max normalization approach. The minimum score is subtracted from each indicator, and the result is divided by the difference between the Maximum and Minimum score. The maximum normalised score is thus equal to 1 and the minimum normalised score is equal to 0.

Step 8: Calculating composite scores at pillar level

The indicators within each pillar are aggregated linearly with equal weights. Three scatter-plots of country performance by pair of pillars are depicted in the following figures for 2010.

High scores for Enablers correspond to high scores for Firm Activities. The countries with the lowest ratio *Firm Activities / Enablers* are Serbia and Lithuania; on the other side, Malta shows the highest ratio *Firm Activities / Enablers*.

The dependency between Enablers and Outputs is less evident, though countries which put more efforts into Enablers have somehow a return in terms of performance. Malta shows the best ratio *Output/Enablers* while Lithuania, Iceland and Norway exhibit the worst ratio.

Similar to the plot in Figure 3.1, the dependence between Firm Activities and Outputs is manifest. The country with the worst ratio *Outputs / Firm Activities* is Iceland, with a score for Outputs lower than expected.

Figure 3.1: Scatter-plot of Enablers vs Firm Activities

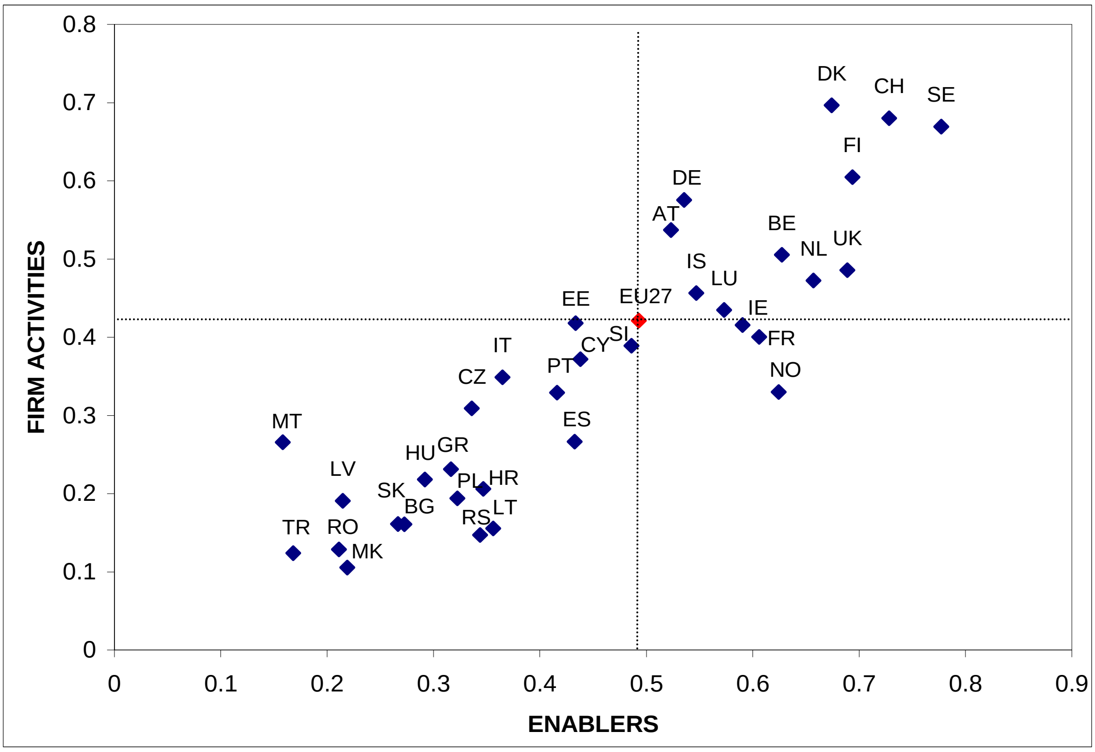


Figure 3.2: Scatter-plot of Enablers vs Outputs

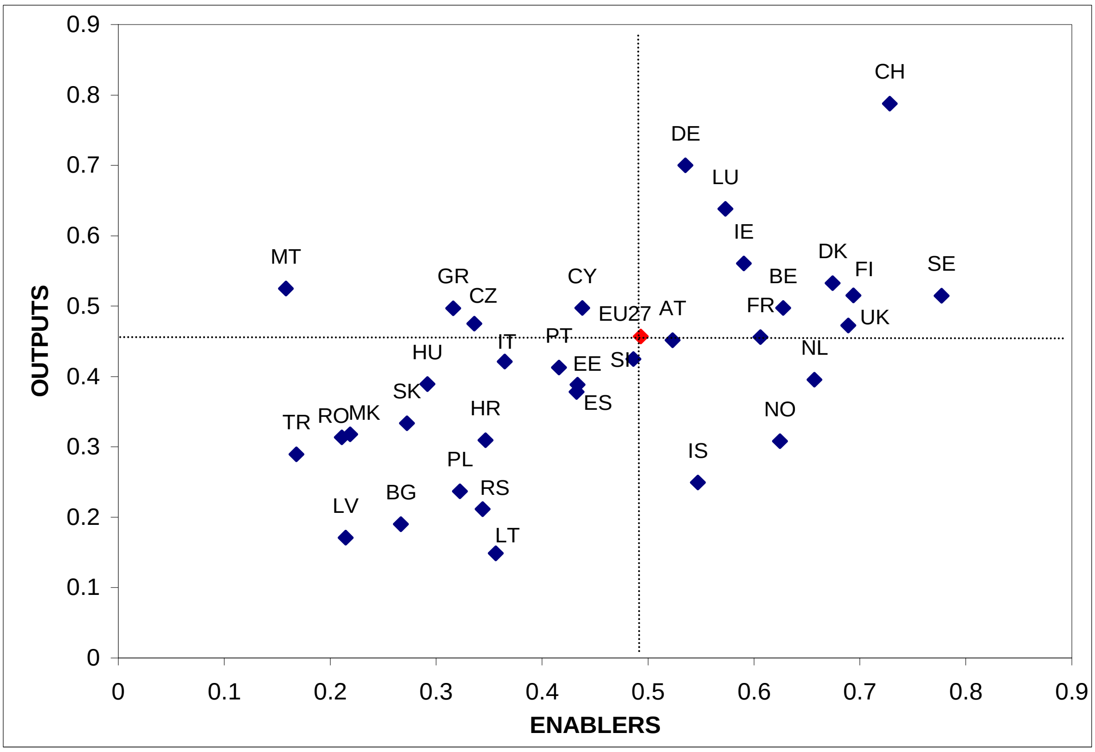
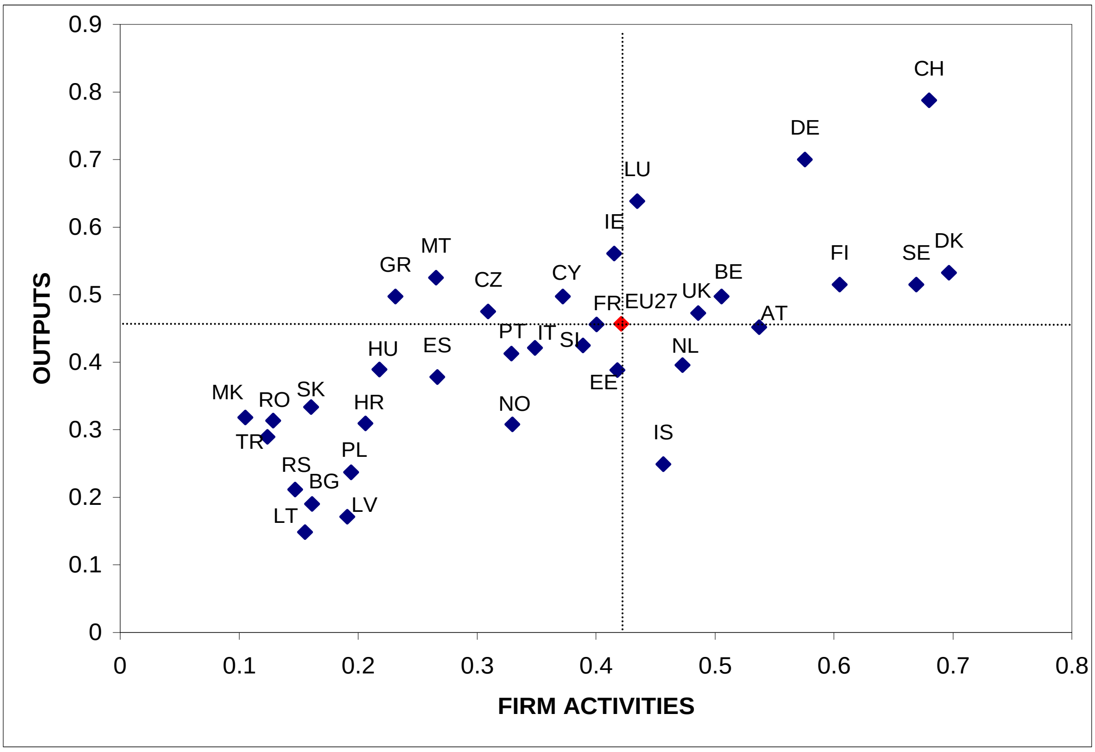


Figure 3.3: Scatter-plot of Firm Activities vs Outputs

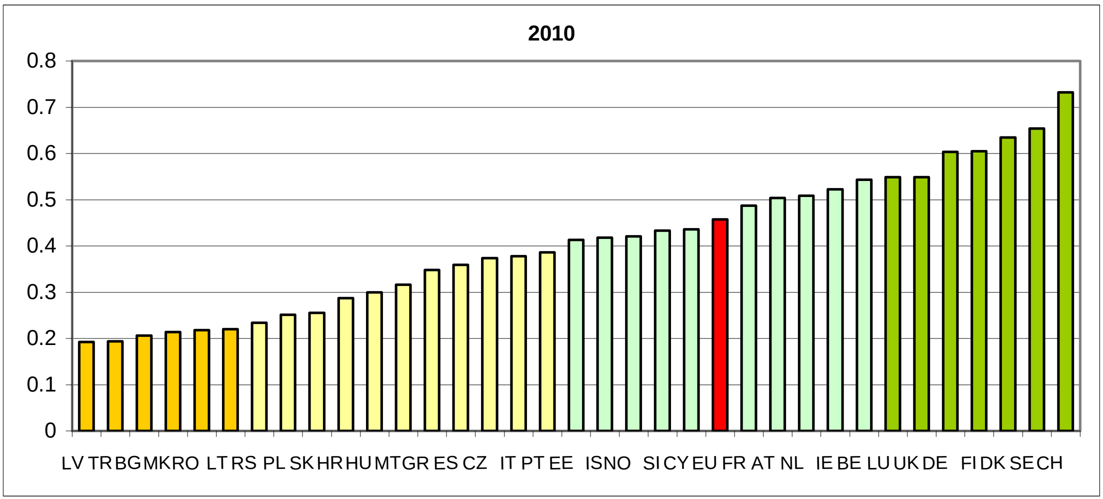


<u>Step 9: Calculating composite innovation scores</u>

For each year a composite innovation score is calculated following two alternative and equally plausible strategies:

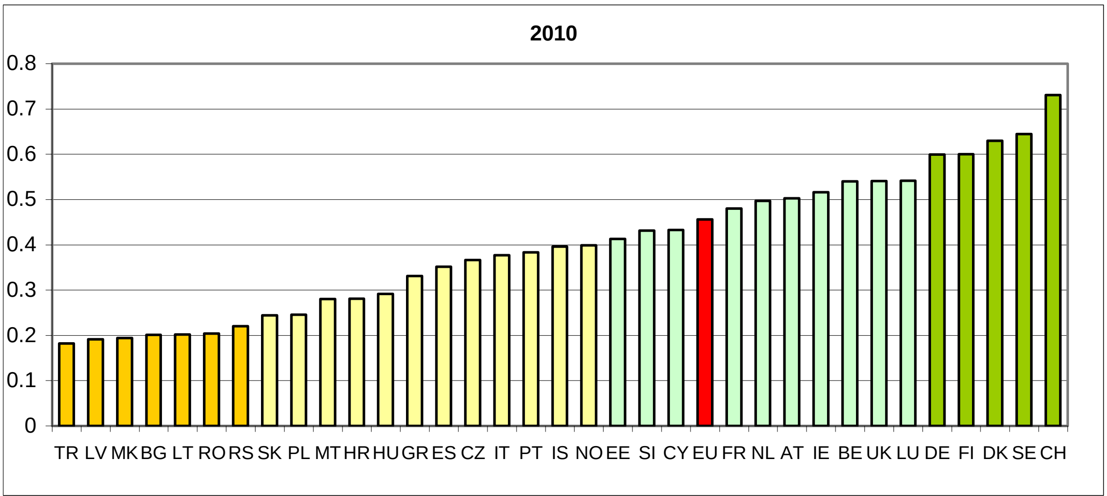
- Strategy 1: the SII is calculated as linear aggregation with equal weights of the scores for the three pillars. This is the simplest technique which implies full compensability of the scores (low performance in some indicators can be traded with high performance in others). Figure 3.4 shows the country scores and rankings. The European Countries fall into four performance groups: Innovation leaders (with score at least 20% above that of EU27), Innovation followers (with score between 90% and 120% of that of EU27), Moderate innovators (with score between 50% and 90% of that of EU27) and Modest innovators (with score below 50% of that of EU27).

Figure 3.4: Composite scores for year 2010 (linear aggregation across pillars)



- Strategy 2: as a geometric aggregation[6] across the pillars (enablers, firm activities and outputs). This methodology combines a full compensability within each dimension with partial compensability across the three dimensions. Indeed the geometric aggregation penalises a country with a low performance in at least one dimension. This type of aggregation is adopted as every dimension is crucial for innovation, i.e. the three different dimensions of innovation are equally legitimate. Figure 3.5 shows the country scores and ranking using this approach.

Figure 3.5: Composite scores for year 2010 (geometric aggregation across pillars)



Country rankings obtained with strategies 1 and 2 are very similar with a few exceptions; see the pairs United Kingdom-Luxembourg, Austria-Netherlands,

[6] The geometric aggregation of n indicators x_i^c with weights w_i is defined according to the following formula: $y^c = \prod_{i=1}^{n} \left(x_i^c\right)^{w_i}$, with $\sum_{i=1}^{n} w_i = 1$.

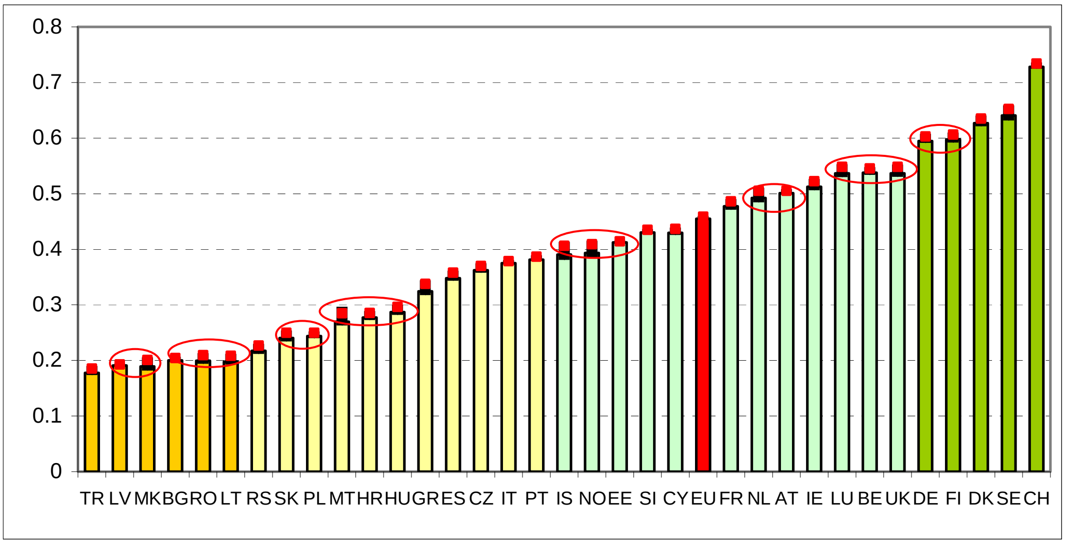
Poland-Slovakia, Lithuania-Romania, Macedonia-Bulgaria and Turkey-Latvia and the triplets Estonia-Iceland-Norway and Malta-Hungary-Croatia. Geometric aggregation between pillars has the effect of moving Malta two positions backward given its particularly low scores in the pillar *Enablers*; geometric aggregation has also the effect of moving Estonia ahead of two positions overcoming both Iceland and Norway.

Under a geometric aggregation, the marginal utility of a country from an increase in a low absolute score is much higher than in a high absolute score. Consequently, a country has greater incentive to address the pillars with low scores, as this gives to it a better chance of improving its position in the ranking (OECD-JRC, 2008). A strong policy implication of geometric aggregation is that governments have to improve upon the worst pillars instead of progressing on the good ones.

Step 10: Robustness analysis of composite innovation scores

Besides the two scenarios analyzed above, composite scores have also been evaluated considering weights varying over a predefined range. While the indicators within each pillar are still aggregated linearly with equal weights, the three pillars are further combined using geometric aggregation and weights varying in the range (0.25 – 0.40), to simulate the presence of uncertainty in their set up. Instead of one single set of weights of value 1/3 each, weights are randomly sampled from the range above and used in the evaluation of the composite scores. This exercise has the objective to examine the extent to which country rankings depend on alternative choices for the weights of the pillars.

Figure 3.6: Robustness of composite scores to variability in the weights for year 2010



Boxplots show variability in the scores. Red circles show countries that are given equal performance as the result of significance tests on medians.

Figure 3.6 shows that, notwithstanding the variability in the weights, the resulting boxplots (ranging from the 5th to the 95th percentile) look reasonably narrow, and consequently country rankings look quite stable. However, some overlaps between countries exist, showing that they have similar performance. Applying the non parametric sign test we have verified that the medians of countries are equivalent for the groups of Countries within the red circles. This is the case of Germany and Finland; United Kingdom, Belgium and Luxembourg; Austria and The Netherlands; Estonia, Norway and Iceland; Hungary, Croatia and Malta; Poland and Slovakia; Lithuania, Romania and Bulgaria; Macedonia and Latvia. This result means that it is not convenient to talk about individual country rankings, but it is better to consider clusters of countries.

Step 11: Analysis of performance growth

Option 1

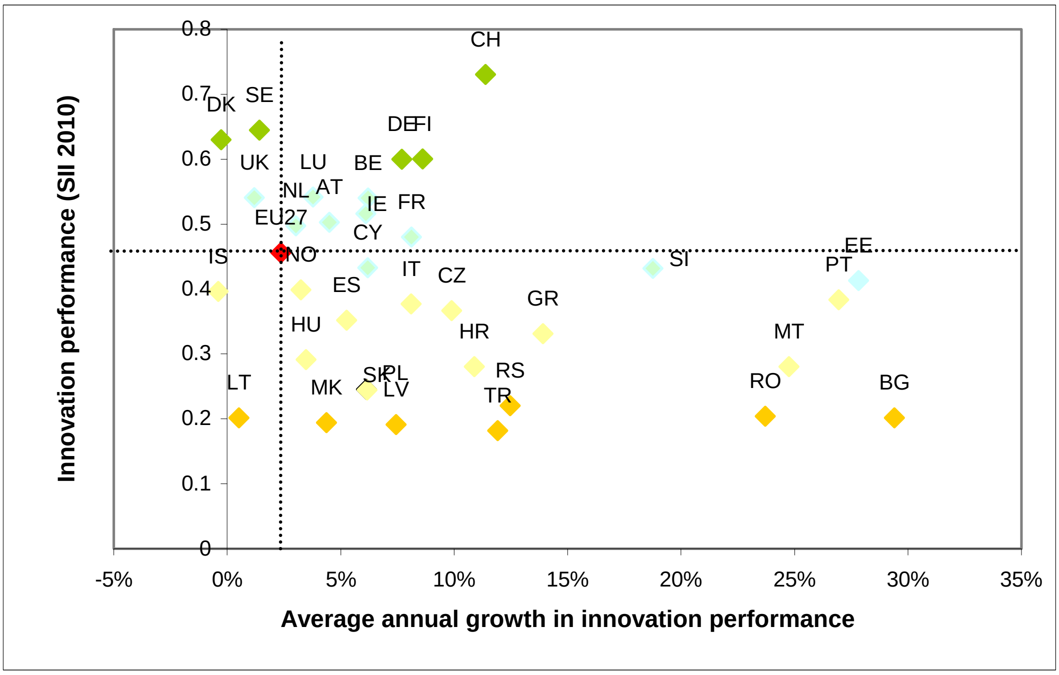
Composite growth rates can be calculated adopting a generalised approach described in (7) (page 13). For each component indicator y_{ic}^{t} (i.e. indicator i for Country c at time t) we compute the growth $y_{ic}^{2010} / y_{ic}^{2006}$ in terms of the ratio between the raw values at year 2006 and year 2010. Those ratios are then aggregated pillar by pillar using equal weights within each pillar and across pillars:

$$1+\tau_{c}^{2006->2010} = \left(\prod_{i \in P_1} \left(\frac{y_{ic}^{2010}}{y_{ic}^{2006}} \right)^{1/8} \cdot \prod_{i \in P_2} \left(\frac{y_{ic}^{2010}}{y_{ic}^{2006}} \right)^{1/9} \cdot \prod_{i \in P_3} \left(\frac{y_{ic}^{2010}}{y_{ic}^{2006}} \right)^{1/7} \right)^{1/3}$$

The $\tau_{c}^{2006->2010}$ represents the overall composite growth rate between 2006 and 2010. The annual average growth rate between year 2006 and year 2010 (i.e. over 4 years) can be obtained as:

$$\left(1+\tau_{c}^{2006->2010}\right)^{1/4} - 1$$

Figure 3.7: Convergence in innovation performance



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7 Cf. Tarantola, S., (2008), "European Innovation Scoreboard: strategies to measure country progress over time", Joint Research Centre, mimeo.

Growth results following this methodology are shown in the horizontal axis in Figure 3.7. Within the innovation leaders (i.e. the countries with composite score larger than 120% of EU27) Germany, Finland and Switzerland are also the growth leader. Within the innovation leaders, Denmark shows slight reduction in performance. Among the Innovation followers (with composite score between 90% and 120% of EU27) Slovenia and Estonia have the highest annual average growth. Of the Moderate innovators (with composite score between 50% and 90% of EU27) all countries but Iceland have grown faster than the EU27. The growth leaders here are Portugal and Malta. All the Modest innovators, but Lithuania, have grown at a faster pace than the EU27. Bulgaria and Romania are the growth leaders of the Modest innovators.

Option 2 (as used in the IUS 2010 report)

For the calculation of the average annual growth rate in innovation performance in the IUS 2010 a generalized approach has been adopted[8]:

Step I: First define growth for each country *c* per indicator *i* as $y_{ic}^{t} / y_{ic}^{t-1}$, i.e. as the ratio between the non-normalised values for year t and year t-1. In order to minimize the effect of growth outliers on the overall growth rate, these ratios are restricted to a maximum of 2 (such that growth in an individual indicator is restricted to 100%) and 0.5 (such that a decrease in an individual indicator is limited to -50%).

Step II: Aggregate these indicator growth rates between year t and year t-1 using a geometric average[9] to calculate the average yearly growth rate τ_{c}^{t}:

$$1+\tau_{c}^{t} = \prod_{i \in I} \left(\frac{y_{ic}^{t}}{y_{ic}^{t-1}} \right)^{w_i}$$

where *I* is the set of innovation indicators used for calculating growth rates and where all indicators receive the same weight w_i (i.e. 1/24 if data for all 24 indicators are available), contrary to option 1 above.

The average yearly growth rate τ_{c}^{t} is invariant to any ratio-scale transformation and indicates how much the overall set of indicators has progressed with respect to the reference year t-1.

Step III: Calculate for each country *c* the average annual growth rate in innovation performance as the geometric average of all yearly growth rates:

$$1+InnovationGrowthRate_{c} = \prod_{t} \left(1+\tau_{c}^{t}\right)^{w_t}$$

where $t \in [2006, 2010]$ and each average yearly growth rate receives the same weight w_t.

[8] Cf. Tarantola, S., (2008), "European Innovation Scoreboard: strategies to measure country progress over time", Joint Research Centre, mimeo.

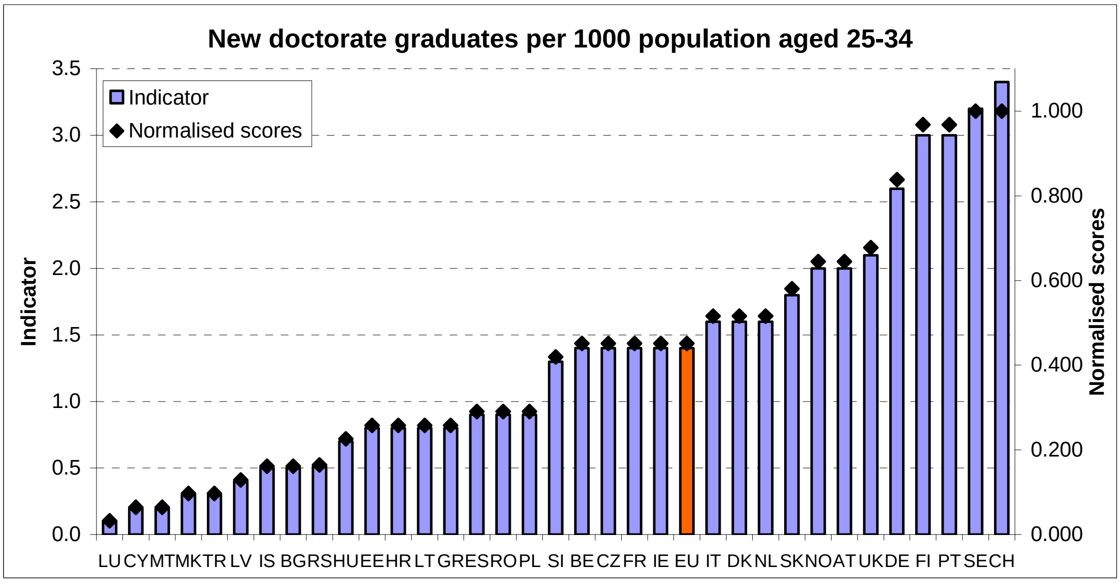
[9] A geometric mean is an average of a set of data that is different from the arithmetic average. The geometric mean is of two data points X and Y is the square root of (X*Y), the geometric mean of X, Y and Z is the cube root of (X*Y*Z), and so forth.

The results for the growth rates calculated using the methodologies in options 1 and 2 are not identical. For the main IUS report option 2 has been used and the results shown in Figure 3.7 thus do not reflect those published in the IUS 2010 report.

4. Performance per indicator

This section will discuss static and dynamic performance for each of the indicators. In the following plots normalised scores are also displayed. Normalised scores are obtained by transforming raw data such that the minimum value equals zero and the maximum value equals one.

1.1.1 New doctorate graduates (ISCED6) per 1000 population aged 25-34



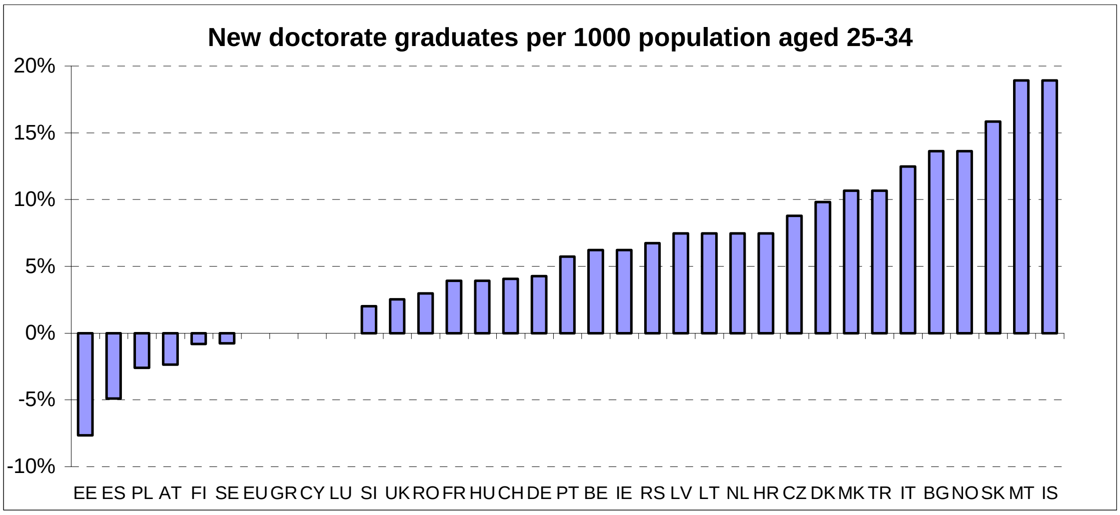
Statistical outliers: Sweden, Switzerland

The indicator is a measure of the supply of new second-stage tertiary graduates in all fields of training. For most countries ISCED 6 captures PhD graduates only, with the exception of Finland, Portugal and Sweden where also non-PhD degrees leading to an award of an advanced research qualification are included.

In 2008 more than 3 new PhD graduates per 1000 people aged 25 to 34 were awarded in Finland, Portugal, Sweden and Switzerland. The average rate for the EU27 was 1.4 and in 8 countries this rate was below 0.5.

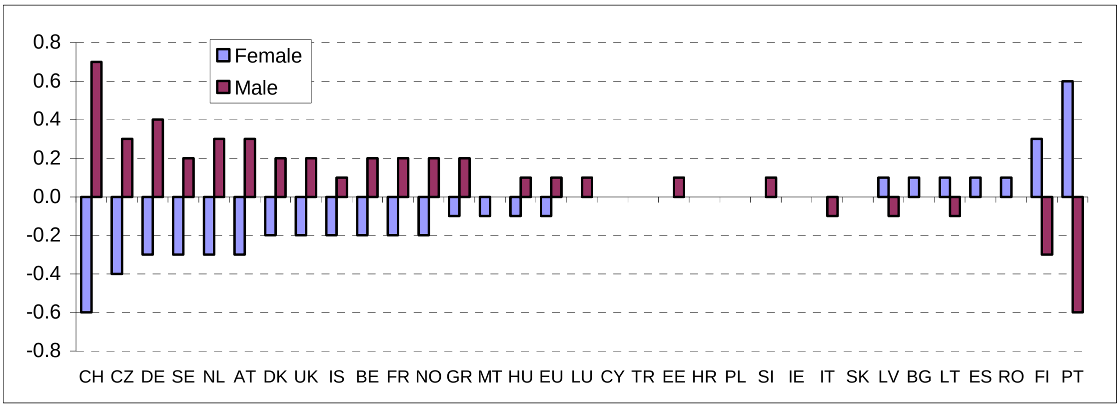
Growth performance

Malta and Iceland have been rapidly increasing their graduation rates over the last 5 years. Graduation rates have declined in Austria, Estonia, Finland, Poland, Spain and Sweden.

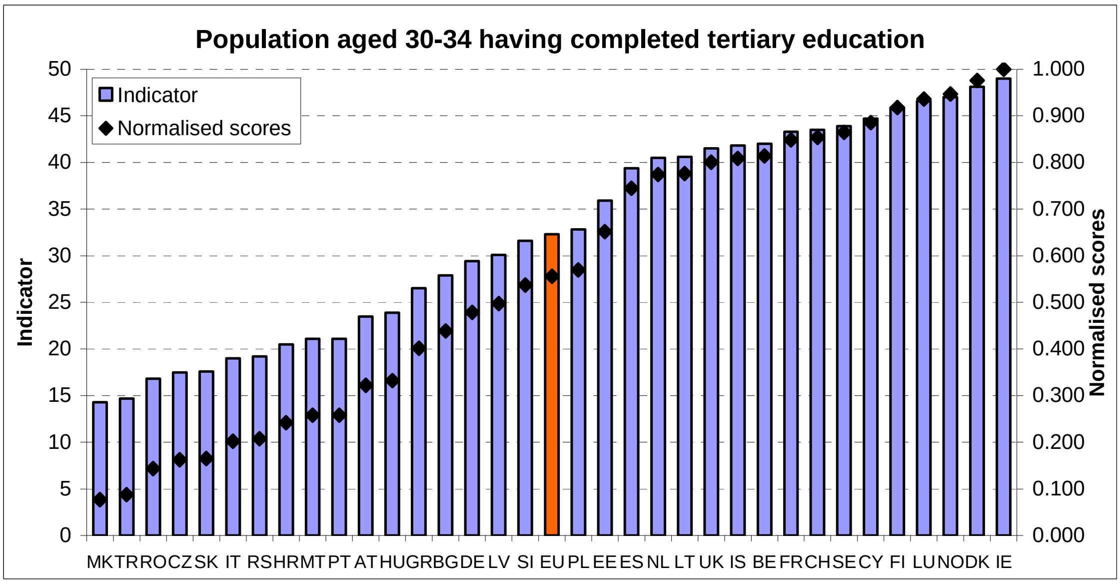


Gender balance

The graph below shows the gender balance for this indicator. In Finland and Portugal graduation rates are considerably higher among women. In 16 other countries, and particularly in Czech Republic, Germany and Switzerland, graduation rates are higher among men.



1.1.2 Percentage population aged 30-34 having completed tertiary education

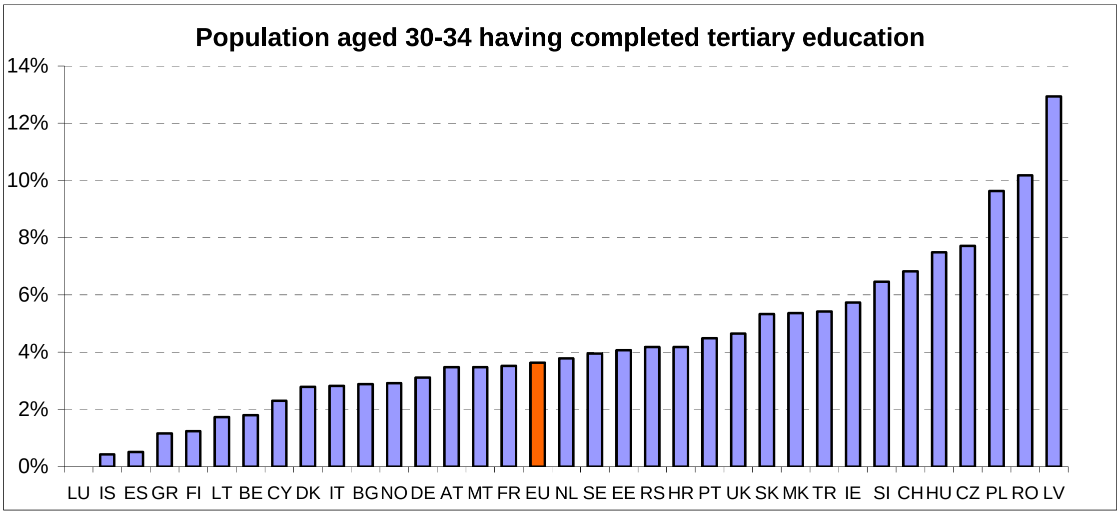


This is a general indicator of the supply of advanced skills. It is not limited to science and technical fields because the adoption of innovations in many areas, in particular in the service sectors, depends on a wide range of skills. International comparisons of educational levels however are difficult due to large discrepancies in educational systems, access, and the level of attainment that is required to receive a tertiary degree. The indicator focuses on a narrow share of the population aged 30 to 34 and it will more easily and quickly reflect changes in educational policies leading to more tertiary graduates.

On average 32% of the EU27 population between age 30 and 34 have completed tertiary education. But there is room for improvement as shown by the large differences between Member States with more than 45% having completed tertiary education in Denmark, Finland, Ireland and Luxembourg and less than 20% in Czech Republic, Italy, Romania and Slovakia.

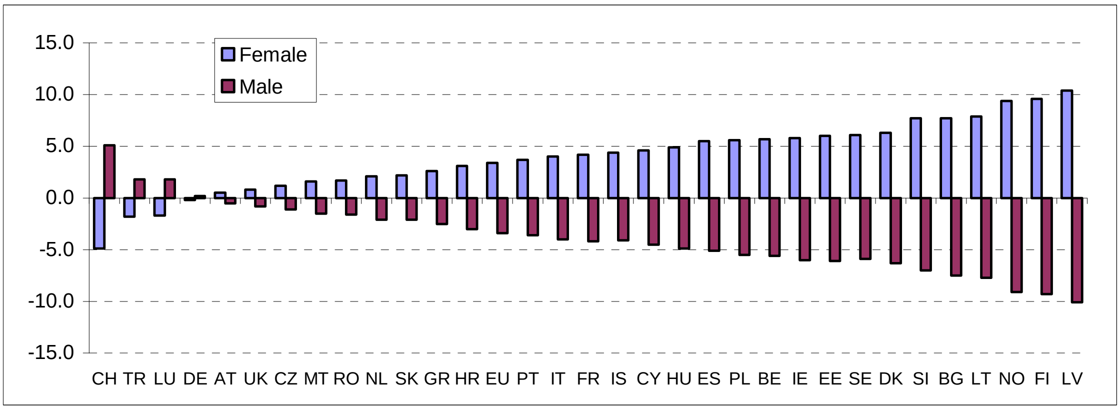
Growth performance

An increasing share of the European population aged 30 to 34 has completed tertiary education. On average this rate has been increasing at 3.6% but in some countries the increase is spectacular. In Poland and Romania it is close to 10% and in Latvia it is almost 13%. Of concern is the situation of Italy, Malta, Austria, Greece and Bulgaria for which both growth and level performances are below European average.

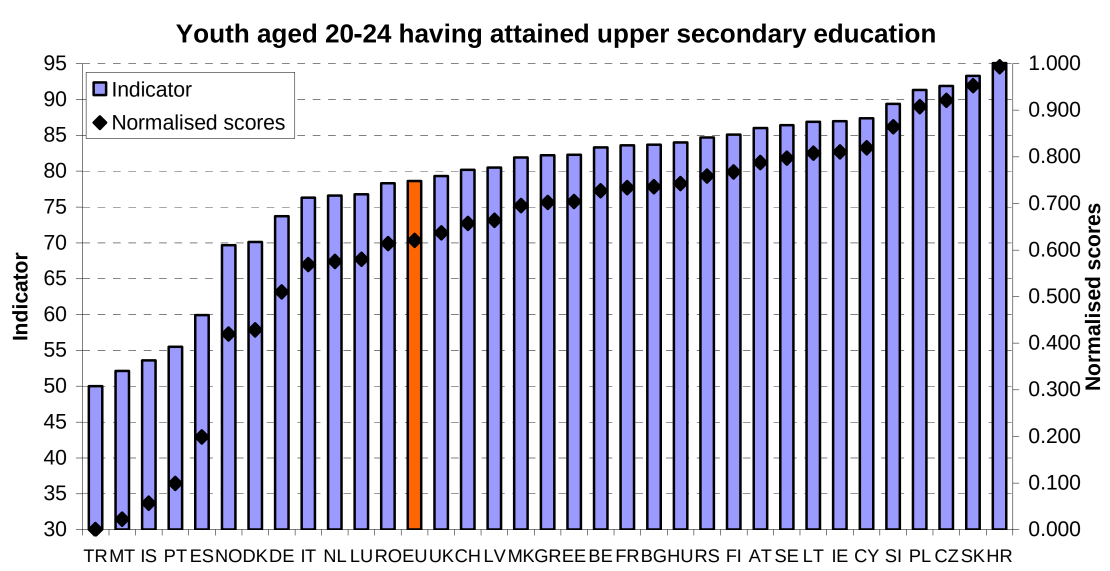


Gender balance

The graph below shows the gender balance for this indicator. Only in Luxembourg, Switzerland and Turkey relatively more men have completed tertiary education. In all other countries, and particularly in Finland, Latvia and Norway, relatively more women have completed tertiary education.



1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education



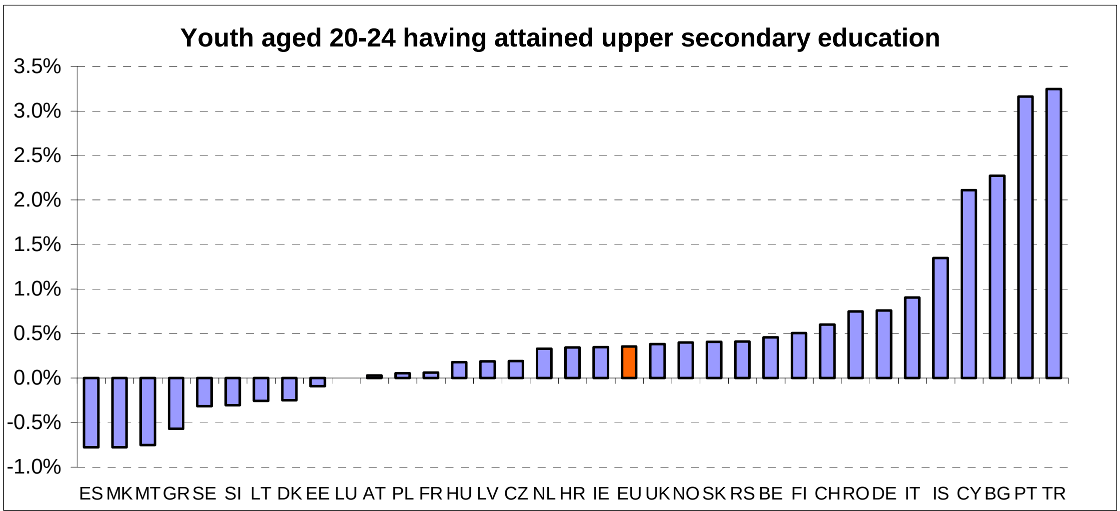
Statistical outlier: Turkey

The indicator measures the qualification level of the population aged 20-24 years in terms of formal educational degrees. It provides a measure for the "supply" of human capital of that age group and for the output of education systems in terms of graduates. Completed upper secondary education is generally considered to be the minimum level required for successful participation in a knowledge-based society and is positively linked with economic growth.

Almost 80% of EU27 youth has attained at least upper secondary education. But in some countries these shares are still too low, in particular in Iceland, Malta, Portugal, Spain and Turkey where only between 50% and 60% have attained such education.

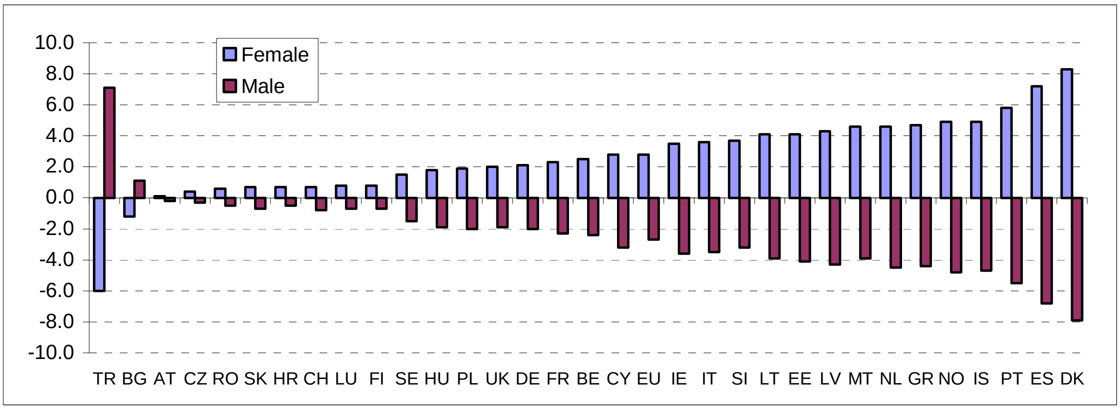
Growth performance

The youth share having attained at least upper secondary education has been growing at a high rate of more than 2% per year in Bulgaria, Cyprus, Portugal and Turkey. Worrying is the fact that this share has been declining in 8 countries, in particular in Greece, Malta and Spain.

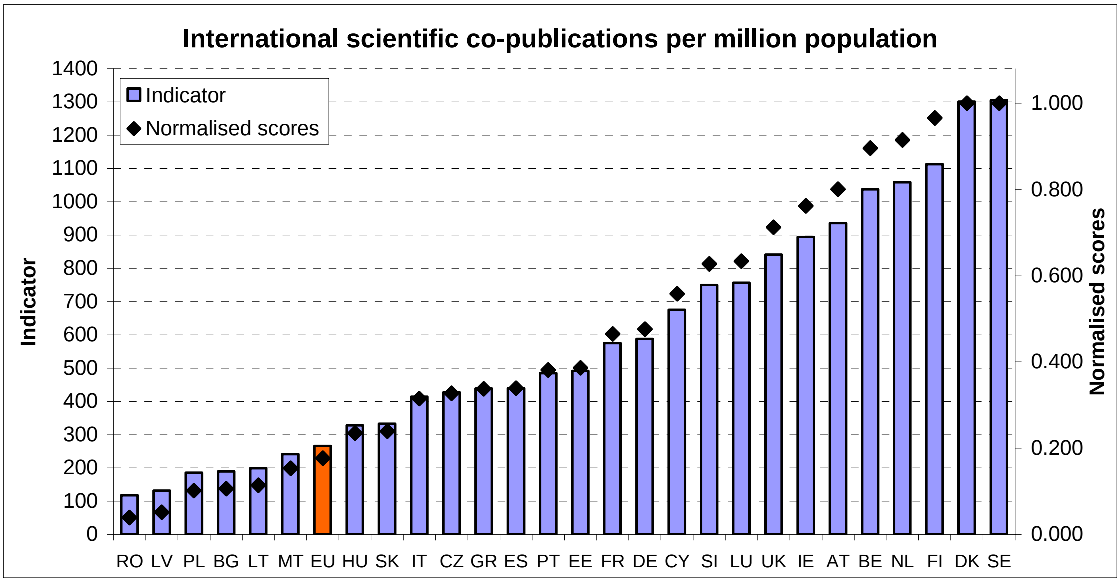


Gender balance

The graph below shows the gender balance for this indicator. In most countries, and in particular in Denmark, Portugal and Spain, relatively more women have attained at least upper secondary education. In Bulgaria, and in particular Turkey, more men have attained at least upper secondary education.



1.2.1 International scientific co-publications per million population



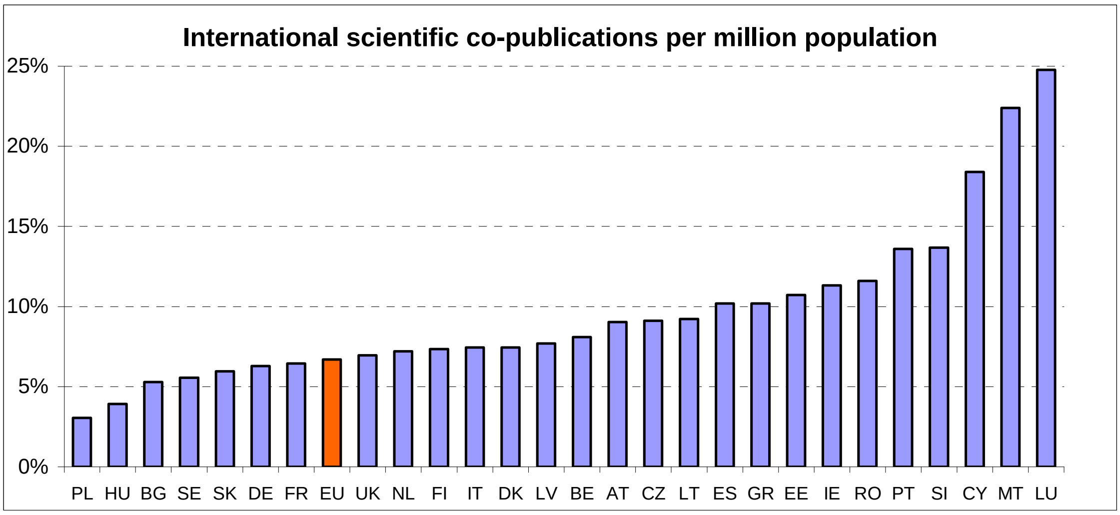
Statistical outliers: Denmark, Sweden

International scientific co-publications are a proxy for the quality of scientific research as collaboration increases scientific productivity. Data availability for this indicator is limited to the EU27 Member States.

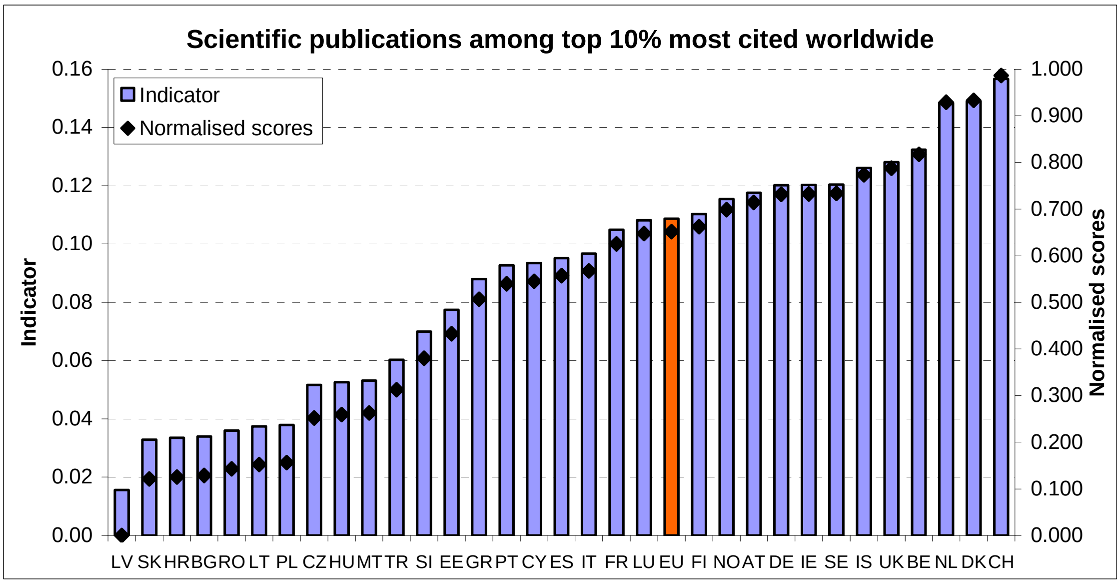
Belgium, Denmark, Finland, Netherlands and Sweden have more than 1000 co-publications per million population. These are all relatively small countries where researchers prefer to publish in international journals. International research co-operation is less well developed in Latvia and Romania. The EU average is relatively low as here only co-publications with non-EU countries are included.

Growth performance

The number of international scientific co-publications has been increasing at high rates. For almost all countries the annual rate of increase has been higher than 5% and in 3 smaller countries these rates have been exceptionally high (18% in Cyprus, 22% in Malta and 25% in Luxembourg).



1.2.2 Scientific publications among the top-10% most cited publications worldwide as % of total scientific publications of the country

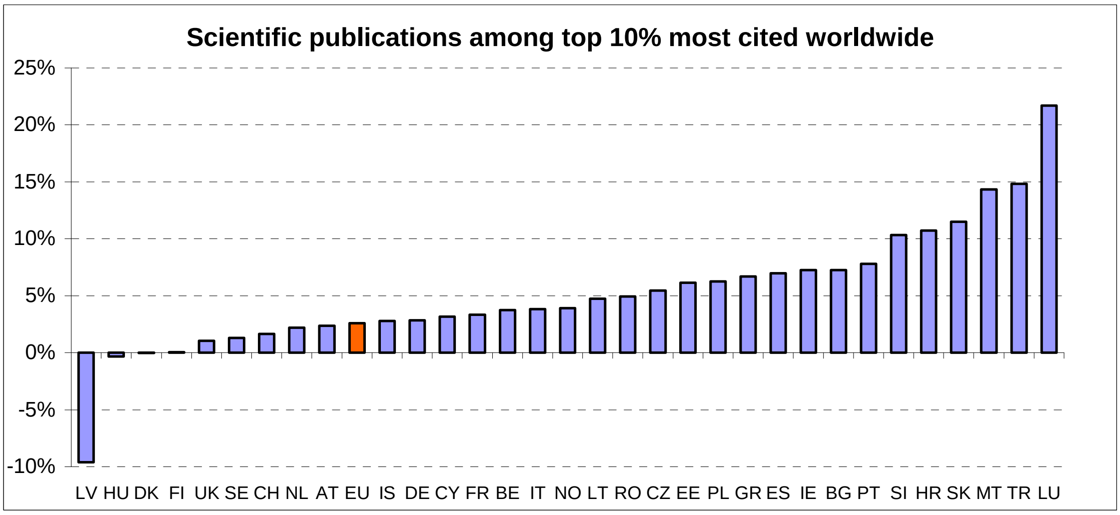


The indicator is a proxy for the efficiency of the research system as highly cited publications are assumed to be of higher quality. There could be a bias towards small or English speaking countries given the coverage of Scopus' publication data. Countries like France and Germany, where researchers publish relatively more in their own language, are more likely to underperform on this indicator as compared to their real academic excellence.

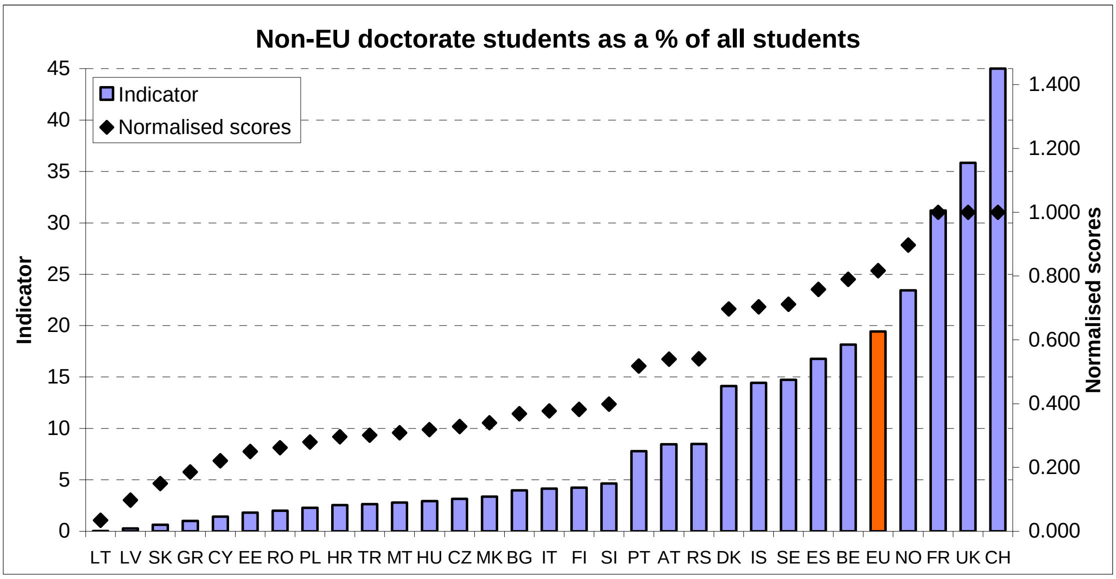
The best performance is observed for Denmark, Netherlands and Switzerland. Performance in Latvia is poor and, to a lesser extent, also in Bulgaria, Croatia, Lithuania, Poland, Romania and Slovakia.

Growth performance

The poor performance in Latvia is partly due to a strong decline over the past 5 years of almost 10% per year. Except for Denmark and Hungary, the indicator has been increasing in all countries, in particular in Luxembourg, Malta and Turkey.



1.2.3 Non-EU doctorate students as % of total doctorate students of the country



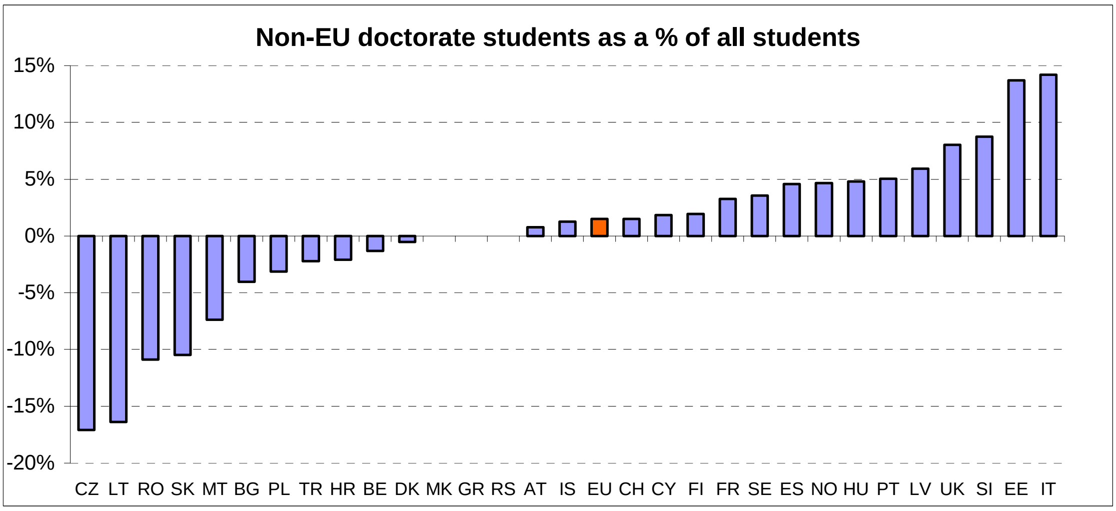
Statistical outliers: France, Switzerland, UK. Indicator skewed and a square-root transformation has been used for deriving the normalised scores.

The share of non-EU doctorate students reflects the mobility of students as an effective way of diffusing knowledge. Attracting high-skilled foreign doctorate students will add to creating a net brain gain and will secure a continuous supply of researchers.

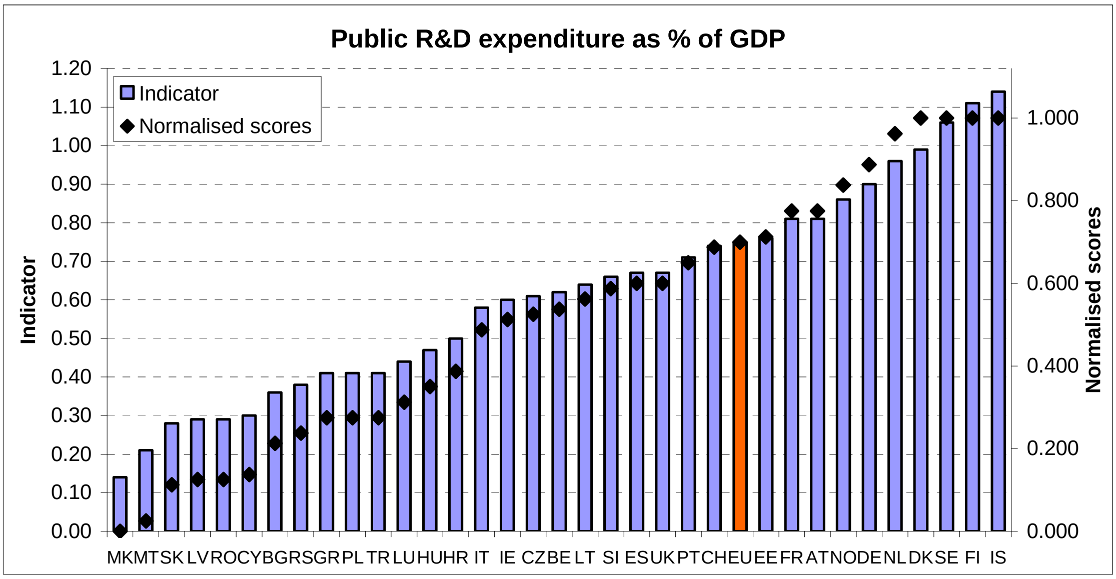
The average share of non-EU doctorate students is almost 20%; in France and UK this share is close to 30% and 35%, respectively. In Switzerland almost 1 out of 2 doctorate students is a non-Swiss student. In the New Member States the shares of non-EU doctorate students are still small at rates below 5%.

Growth performance

Growth performance is diverse with increases over time in 16 countries and decreases in 11 countries. Growth has been very strong in Estonia and Italy with annual increases close to 14%. The share of non-EU doctorate students has been declining rapidly in the Czech Republic and Lithuania.



1.3.1 Public R&D expenditures as % of GDP



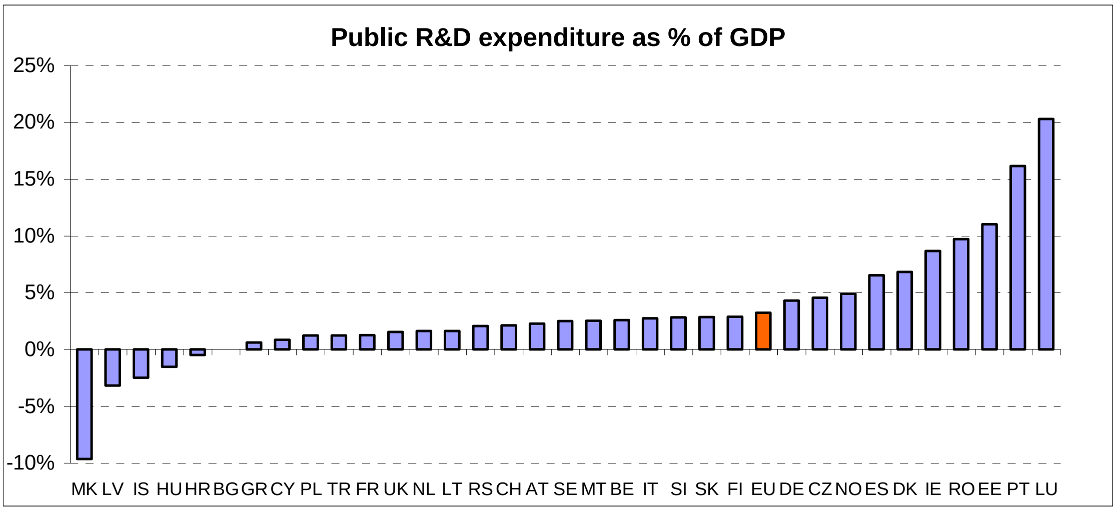
Statistical outlier: Iceland

R&D expenditure represents one of the major drivers of economic growth in a knowledge-based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.

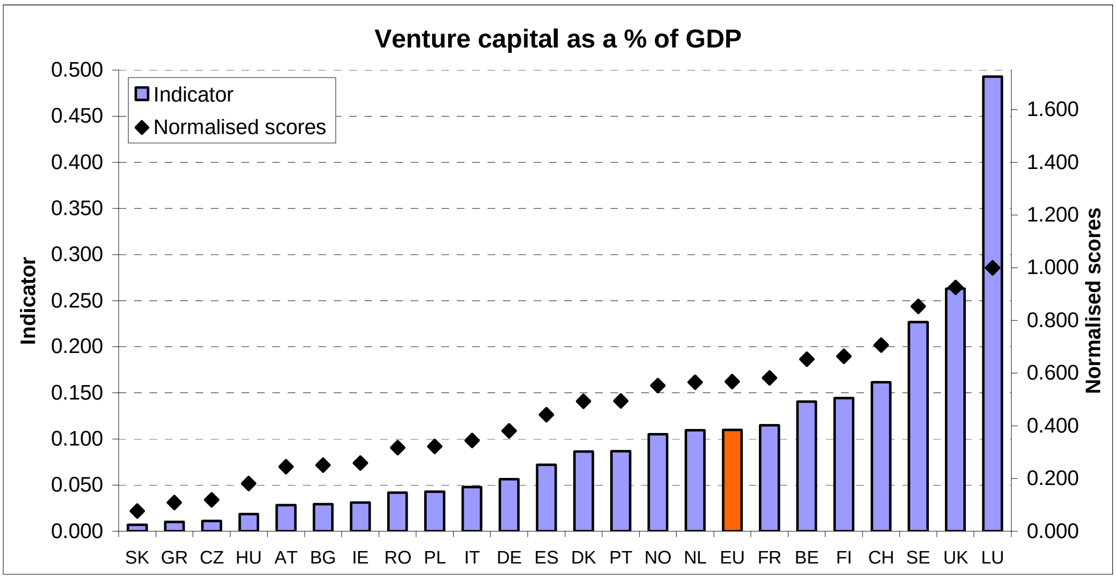
Public R&D expenditure is close to or above 1% of GDP in Finland, Iceland and Sweden. The average intensity is 0.67% for the EU27. In Bulgaria, Cyprus, Luxembourg, Malta and Slovakia R&D intensities are below half that of the EU27.

Growth performance

Public R&D expenditures have been increasing most rapidly in Estonia, Latvia, Luxembourg, Portugal and Romania. The Innovation Union has renewed the 3% R&D target towards 2020 but more progress needs to be made as the average increase for the EU27 is too weak partly due to decreases in major R&D spending countries as Finland, France and the Netherlands.



1.3.2 Venture capital (% of GDP)



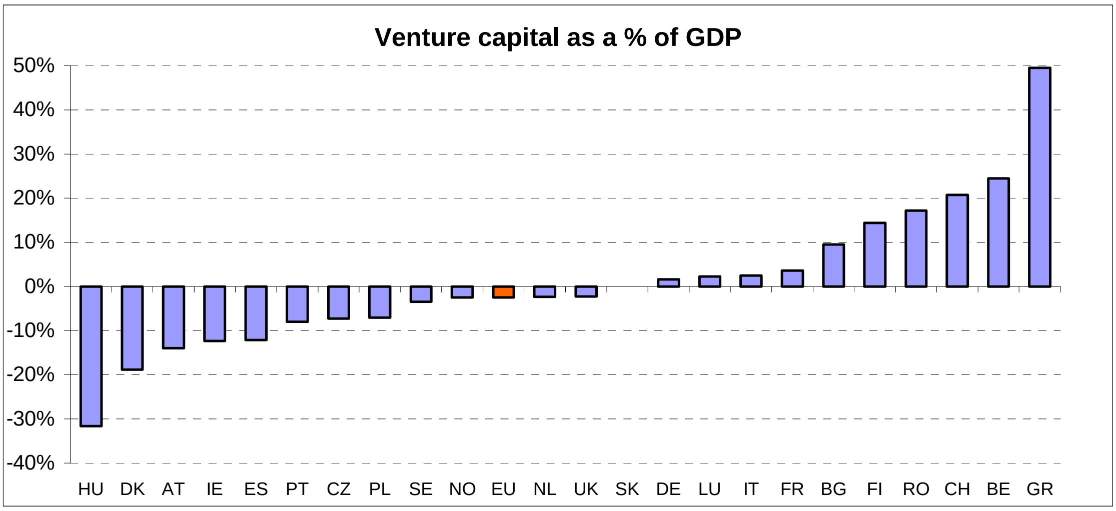
Statistical outlier: Luxembourg. Two-year averages have been used to reduce volatility rates. Indicator skewed and a square-root transformation has been used for deriving the normalised scores.

The amount of venture capital is a proxy for the relative dynamism of new business creation. In particular for enterprises using or developing new (risky) technologies venture capital is often the only available means of financing their (expanding) business. A broader definition including early-stage, expansion and replacement would provide a better picture on the availability of a domestic venture capital industry and would also decrease volatility.

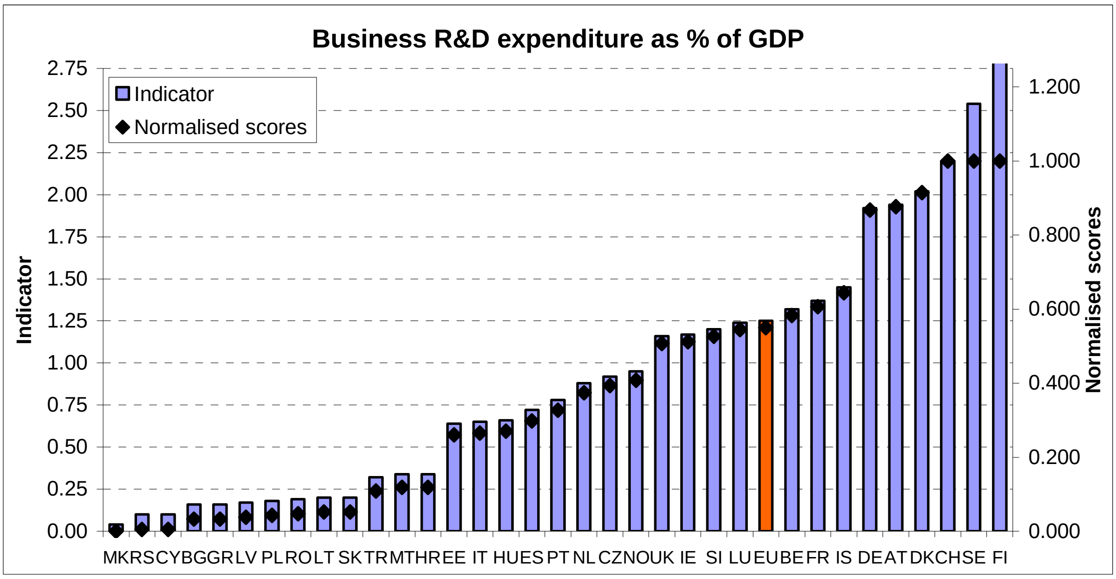
For several countries data are not available as the domestic Venture Capital markets are too small to collect such data. The availability of venture capital differs widely in Europe. Only in Luxembourg, Sweden and the UK venture capital represents more than 0.2% of GDP.

Growth performance

Growth performance is diverse with increases over time in 10 countries and decreases in 12 countries plus the EU27. Growth has been very strong in Belgium with an annual increase above 20% and in particular in Greece with an annual growth close to 50%. The availability of venture capital has been declining rapidly in Austria, Denmark, Hungary, Ireland and Spain.



2.1.1 Business R&D expenditures (% of GDP)



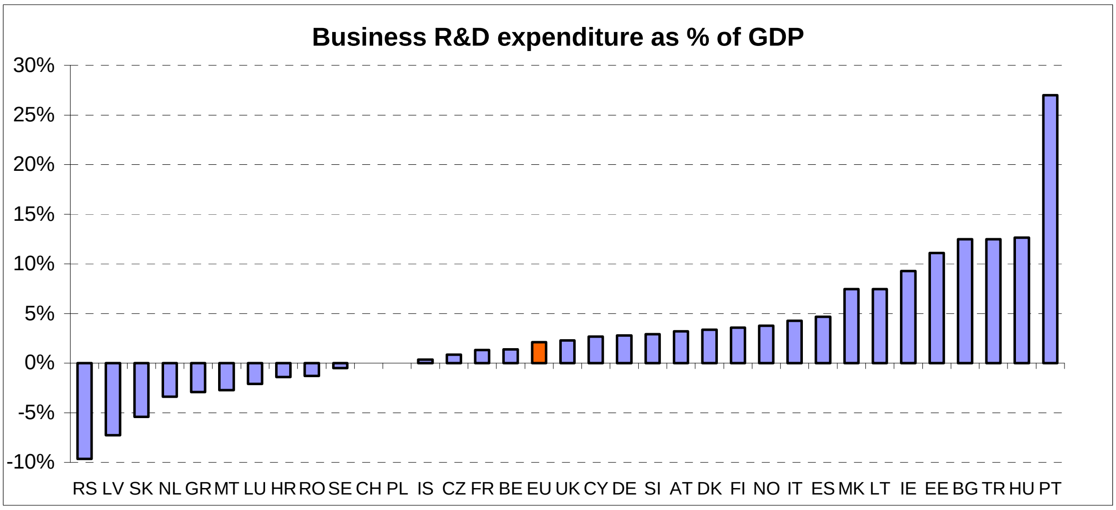
Statistical outliers: Finland, Sweden

The indicator captures the formal creation of new knowledge within firms. It is particularly important in the science-based sector (pharmaceuticals, chemicals and some areas of electronics) where most new knowledge is created in or near R&D laboratories.

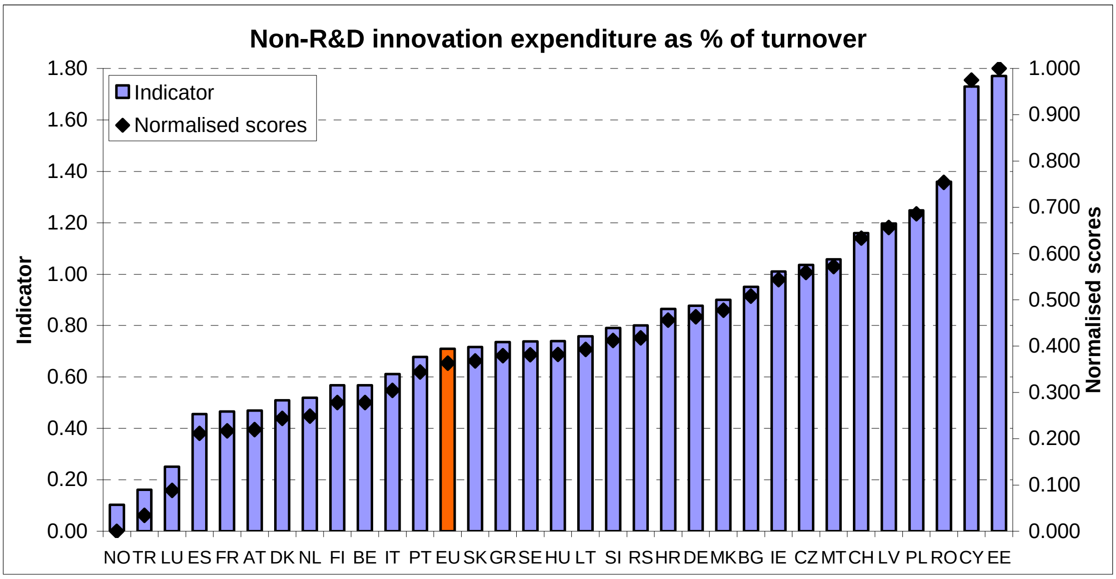
The R&D intensity is above 2% of GDP in only 3 countries: Finland, Sweden and Switzerland. The average R&D intensity for the EU27 is 1.21% and for 12 countries the intensity is below 0.50%.

Growth performance

The Innovation Union has renewed the 3% R&D target towards 2020 but more progress needs to be made as the average increase for the EU27 is too weak partly due to decreases in major R&D spending countries as France and the Netherlands. Only Estonia, Hungary, Portugal and Turkey have managed to significantly increase their business R&D expenditures.



2.1.2 Non-R&D innovation expenditures as % of total turnover

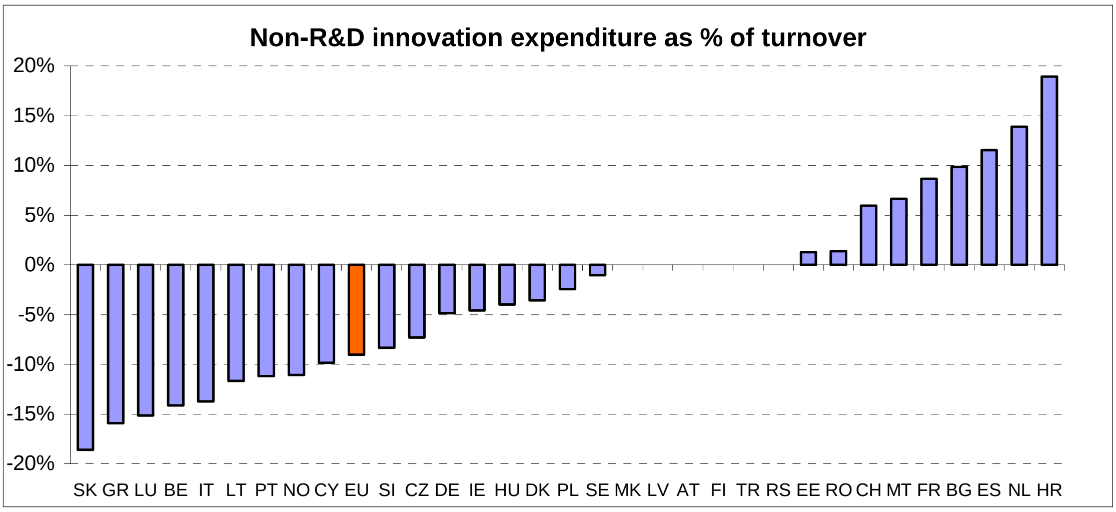


This indicator measures non-R&D innovation expenditure as percentage of total turnover. Several of the components of innovation expenditure, such as investment in equipment and machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas. The indicator does not include intramural and extramural R&D expenditures and does not overlap with the indicator on business R&D expenditures.

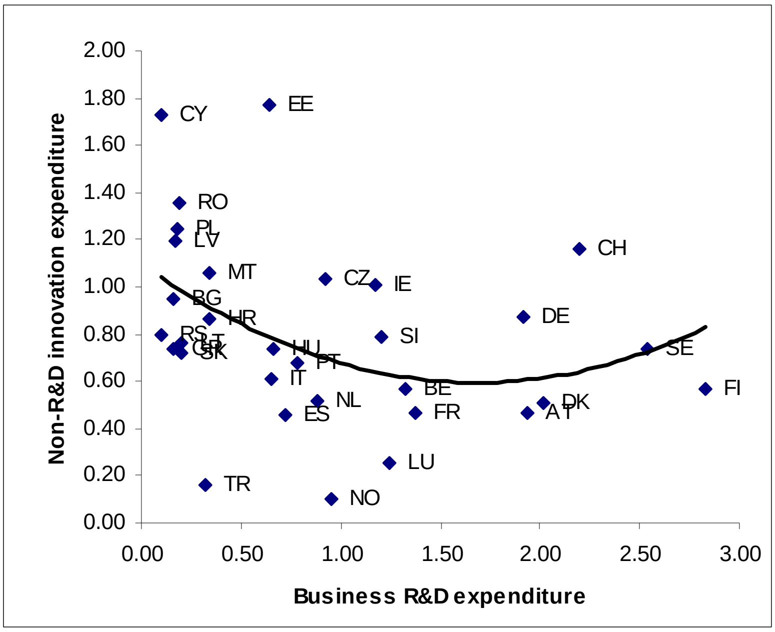
On average 0.7% of total turnover is spent non-R&D innovation in Europe. In Cyprus and Estonia this share is almost 1.8%, while in Luxembourg, Norway and Turkey it is close to or below 0.2%.

Growth performance

The share of non–R&D innovation expenditures has increased most in Croatia, Netherlands and Spain and has declined most in Greece, Luxembourg and Slovakia. For the EU27 this share has declined with almost 10%.

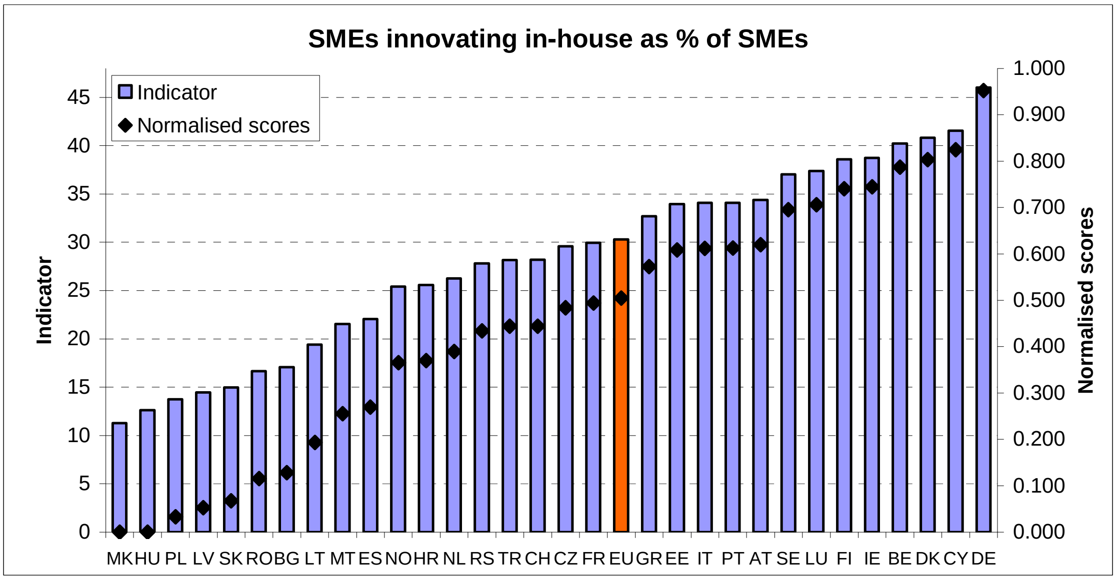


Correlation with the indicator on business R&D expenditure



Indicators 2.1.1 and 2.1.2 both measure investment in innovation activities: the first in R&D activities and the second in non-R&D activities as the purchase of advanced machinery and equipment. The indicator on non-R&D innovation expenditure is not correlated with the indicator on business R&D expenditure. One explanation is that for both indicators different denominators have been used. Business R&D expenditure is expressed as a percentage of total GDP whereas non-R&D innovation expenditure is expressed as a percentage of turnover of business firms only. The latter only represents part of GDP as it excludes e.g. mining, construction and the public sector.

2.2.1 SMEs innovating in-house as % of all SMEs

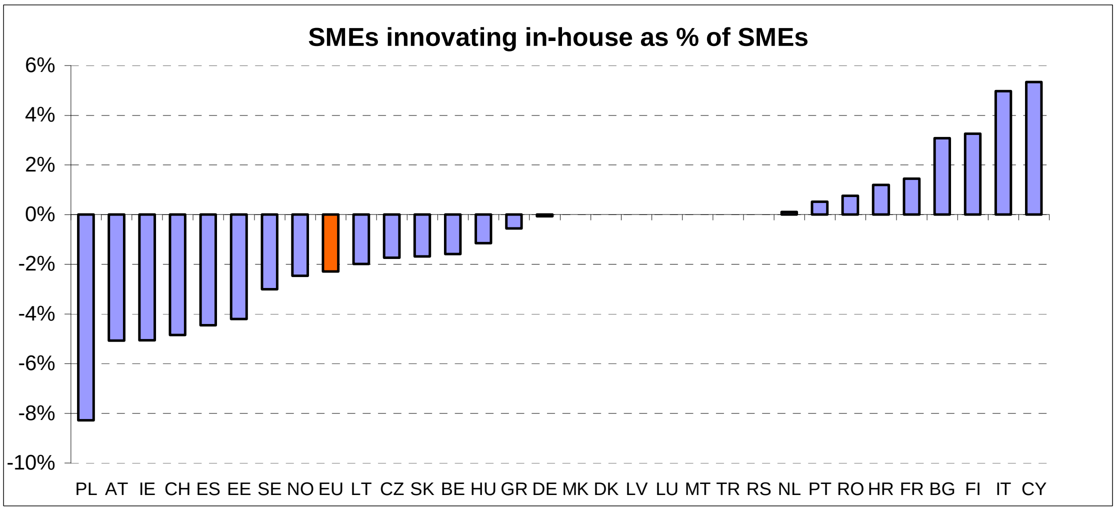


This indicator measures the degree to which SMEs that have introduced any new or significantly improved products or production processes have innovated in-house. The indicator is limited to SMEs because almost all large firms innovate and because countries with an industrial structure weighted towards larger firms tend to do better.

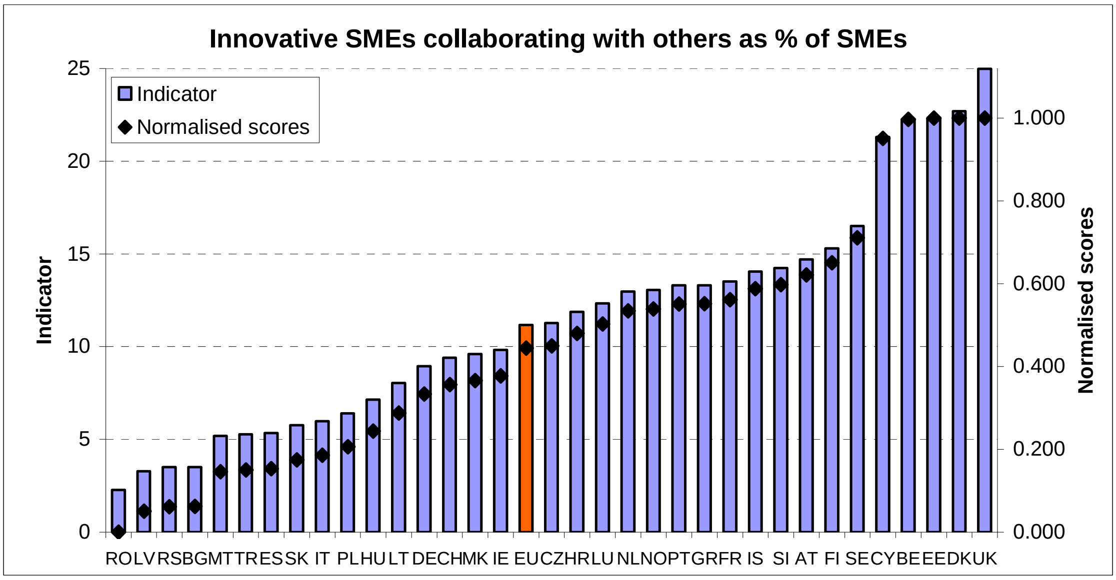
On average 30% of SMEs innovate in-house. Much higher shares are observed for Germany where more than 45% of SMEs innovate in-house. In the Former Yugoslav Republic of Macedonia, Hungary, Latvia, Poland and Slovakia less than 15% of SMEs innovate in-house.

Growth performance

Growth performance is diverse with increases over time in 8 countries and decreases in 15 countries plus the EU27. Growth has been very strong in Cyprus and Italy. The share of SMEs innovating in-house has been declining most rapidly in Austria, Ireland and in particular Poland.



2.2.2 Innovative SMEs co-operating with others (% of all SMEs)



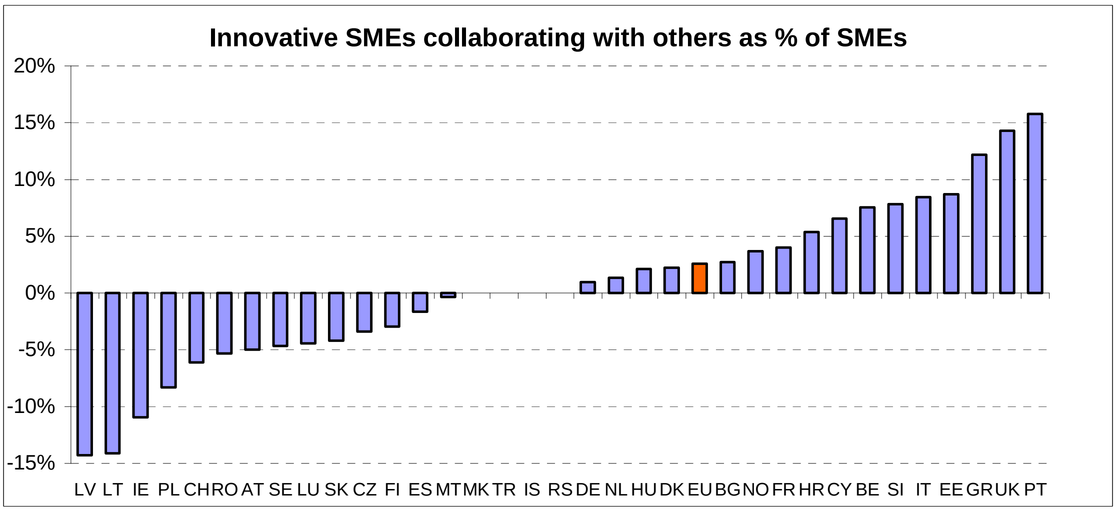
Statistical outliers: Denmark, UK

This indicator measures the degree to which SMEs are involved in innovation co-operation. Complex innovations, in particular in ICT, often depend on the ability to draw on diverse sources of information and knowledge, or to collaborate on the development of an innovation. This indicator measures the flow of knowledge between public research institutions and private firms and between firms and other firms. The indicator is limited to SMEs because almost all large firms are involved in innovation co-operation.

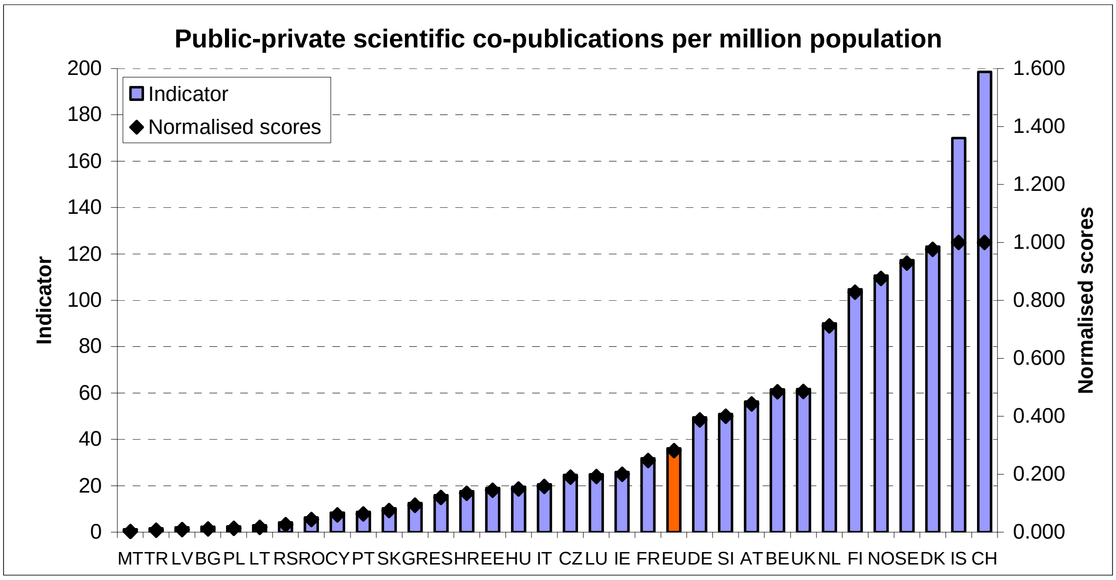
About 11% of EU27 SMEs collaborate with others. In Belgium, Cyprus, Denmark, Estonia and the UK more than 1 out 5 SMEs collaborate, whilst in Bulgaria, Latvia, Serbia and Romania this is less than 1 out of 20.

Growth performance

Growth performance is diverse with increases over time in 16 countries and decreases in 14 countries. Growth has been very strong in Greece, Portugal and the UK with an annual increase above 10%. In Ireland, Latvia and Lithuania the share of SMEs collaborating with others has decreased with more than 10% annually.



2.2.3 Public-private scientific co-publications per million population



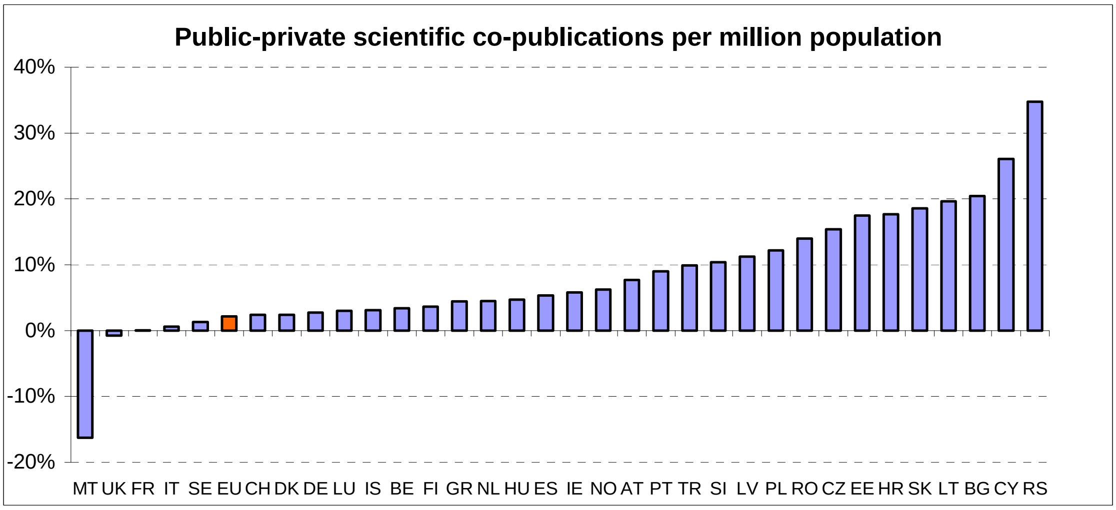
Statistical outliers: Iceland, Switzerland. Two-year averages have been used to reduce volatility rates.

This indicator captures public-private research linkages and active collaboration activities between business sector researchers and public sector researchers resulting in academic publications.

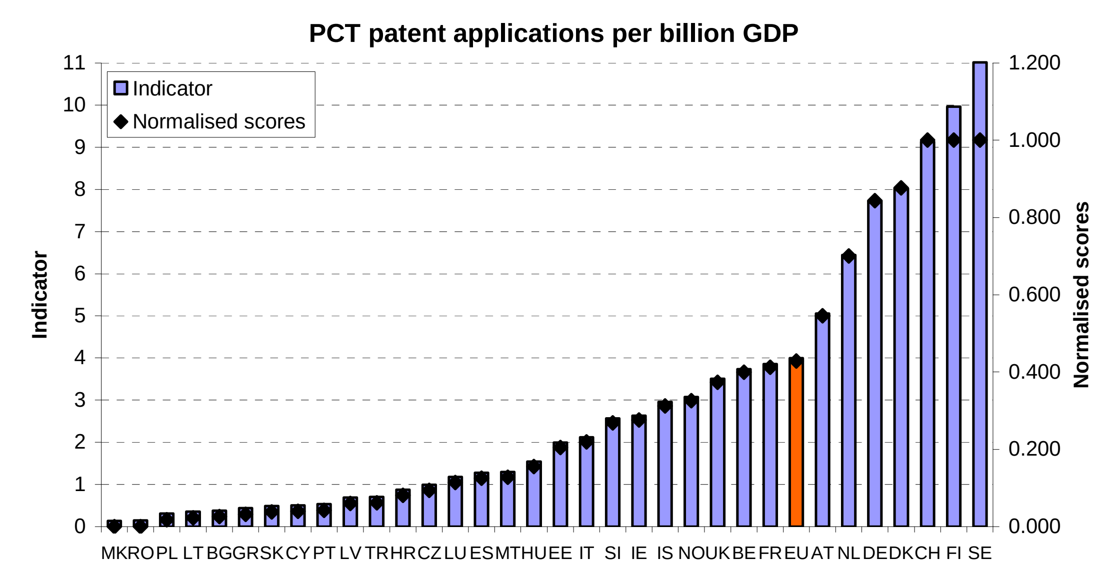
On average 36 co-publications are observed for the EU27. But there are large differences, with more than 160 co-publications in Iceland and Switzerland and less than 5 co-publications in Bulgaria, Latvia, Lithuania, Malta, Poland, Serbia and Turkey.

Growth performance

Public-private scientific co-publications have been increasing in almost all countries, in particular in Cyprus and Serbia. In the UK and in particular in Malta we observe a decline for this indicator.



2.3.1 PCT patent applications per billion GDP (in PPP€)



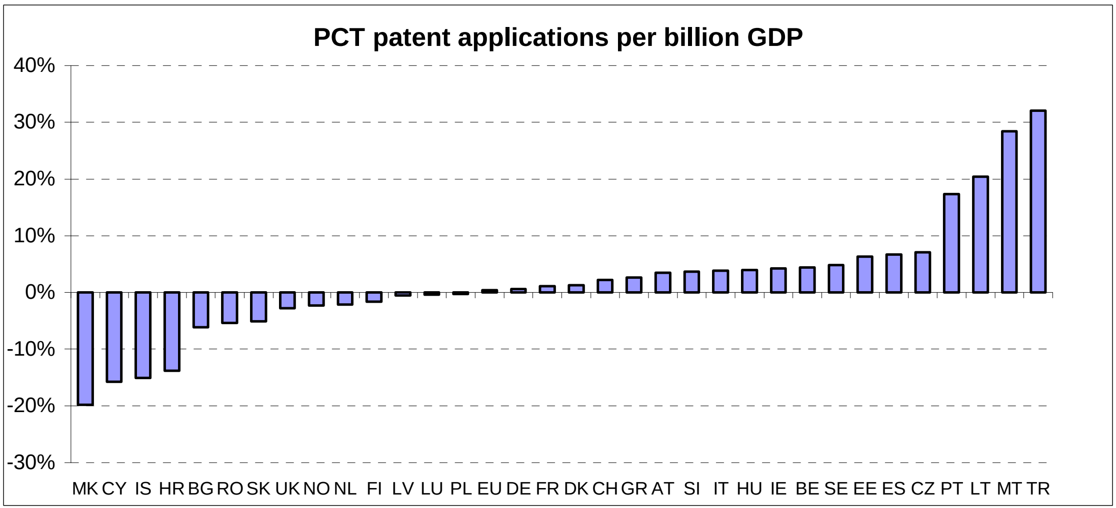
Statistical outliers: Finland, Sweden

The capacity of firms to develop new products will determine their competitive advantage. One indicator of the rate of new product innovation is the number of patents. This indicator measures the number of PCT patent applications.

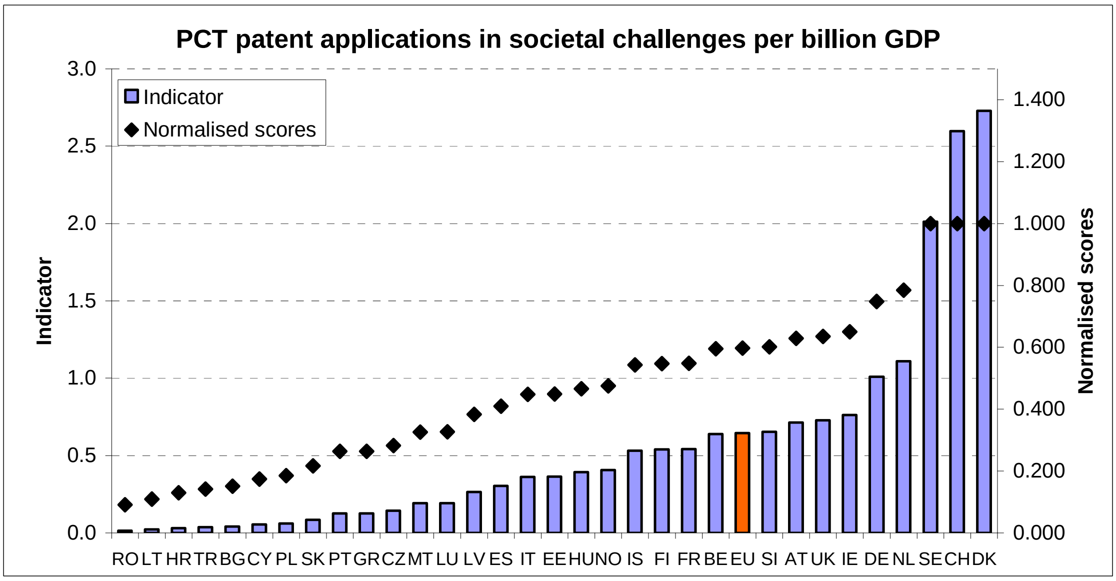
For the EU27 on average 4 PCT patents per billion GDP have been applied for. There are large differences with 10 or more patent applications in Finland and Sweden and less than 1 application in Bulgaria, Cyprus, Czech Republic, Greece, Latvia, Lithuania, the Former Yugoslav Republic of Macedonia, Poland, Portugal, Romania, Slovakia and Turkey.

Growth performance

In Lithuania, Malta, Portugal and Turkey PCT patent applications have been growing rapidly; in Malta and Turkey at rates close to 30% per year. In several countries the indicator has been falling, in particular in Croatia, Cyprus and Iceland.



2.3.2 PCT patent applications in societal challenges per billion GDP (in PPP€)



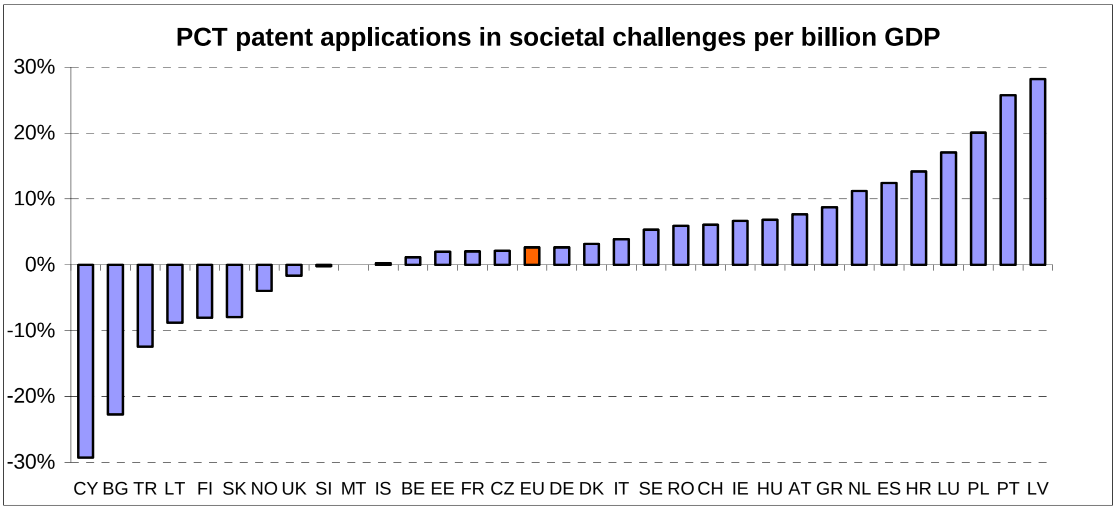
Statistical outliers: Denmark, Sweden, Switzerland. Indicator skewed and a square-root transformation has been used for deriving the normalised scores.

This indicator measures PCT applications in health technology and climate change mitigation. From a policy point of view the indicator on patent applications in societal challenges is highly relevant as increased number of patent applications in health technology and climate change mitigation will be necessary to meet the societal needs of an ageing European society and sustainable growth.

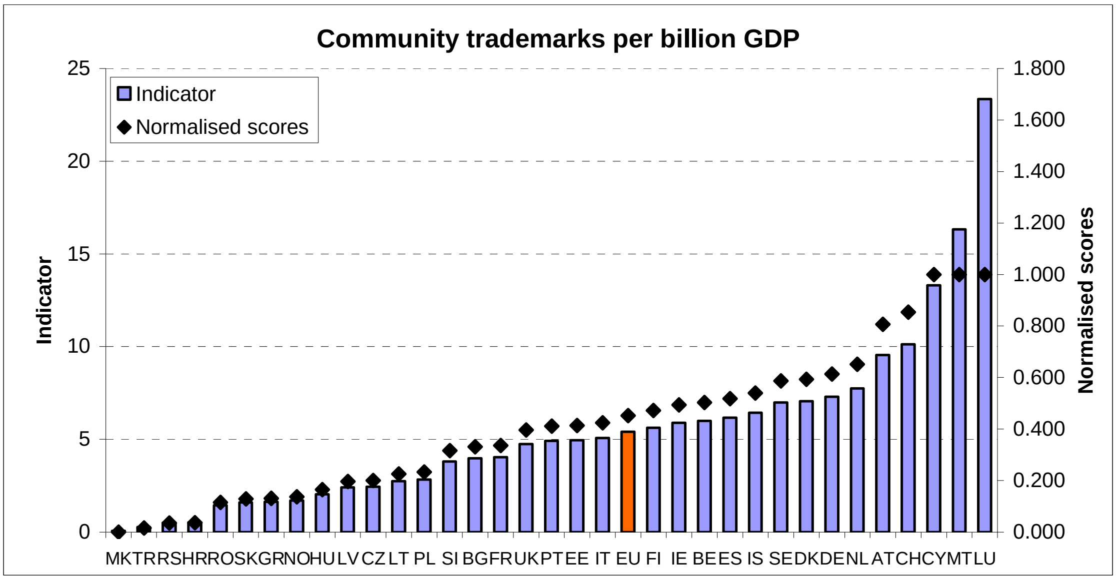
Denmark, Sweden and Switzerland are the countries with the highest numbers of patent applications in societal challenges. In a large number of countries such applications are very low but this can be partly explained by their overall low number of patent applications (cf. indicator 2.3.1).

Growth performance

Patent applications in societal challenges are growing in 23 countries but are also declining in 8 countries. Decline has been strong in Bulgaria and Cyprus whereas in Latvia and Portugal growth has been strongest.



2.3.3 Community trademarks per billion GDP (in PPP€)



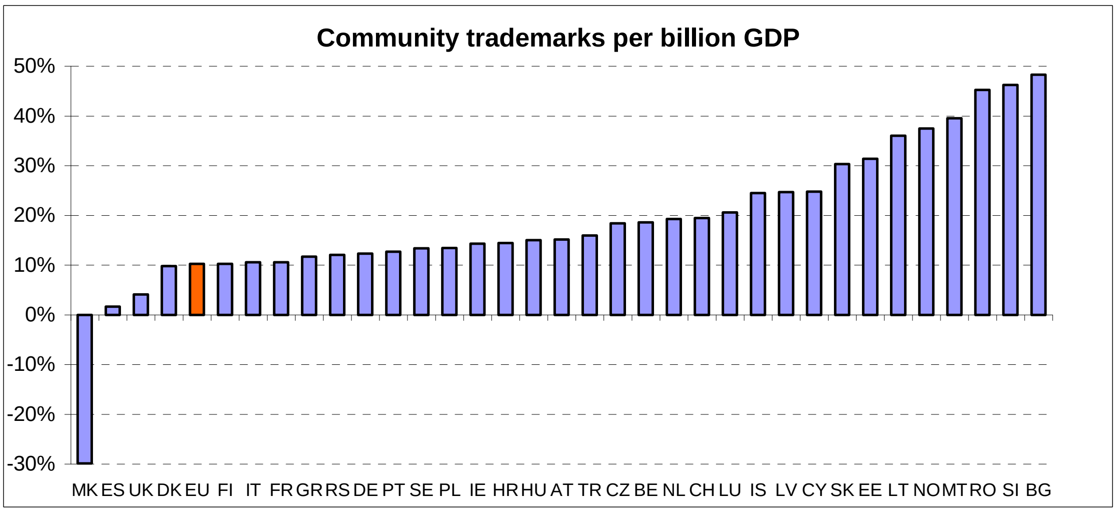
Statistical outliers: Cyprus, Luxembourg, Malta

Trademarks are an important innovation indicator, especially for the service sector. The Community trademark gives its proprietor a uniform right applicable in all Member States of the European Union through a single procedure which simplifies trademark policies at European level. It fulfils the three essential functions of a trademark: it identifies the origin of goods and services, guarantees consistent quality through evidence of the company's commitment vis-à-vis the consumer, and is a form of communication, a basis for publicity and advertising.

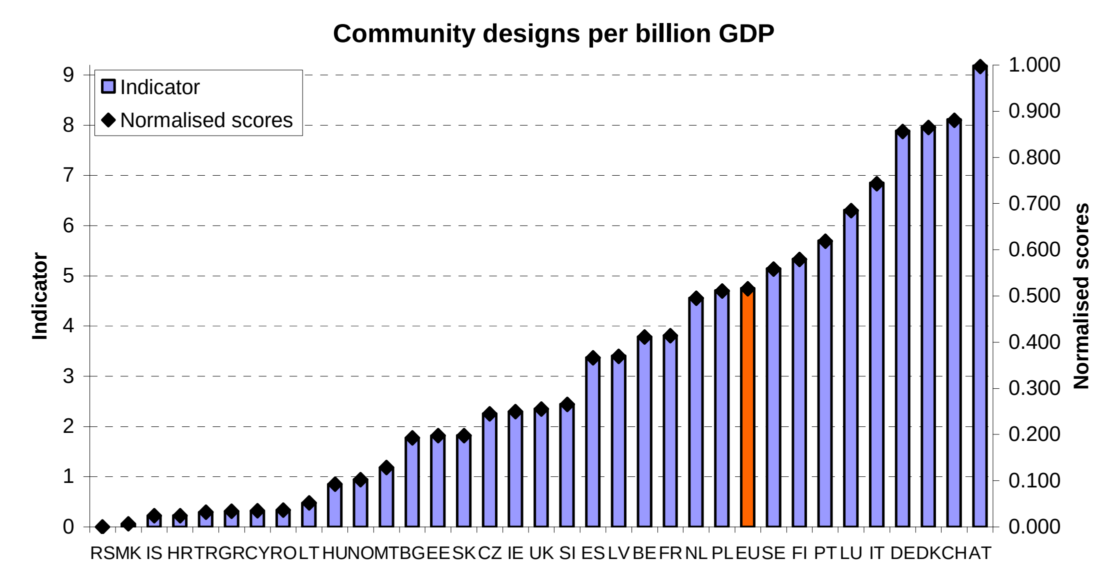
Most trademarks are applied for in Cyprus, Luxembourg and Malta. Trademark applications are low in Croatia, the Former Yugoslav Republic of Macedonia, Serbia and Turkey.

Growth performance

Trademark applications have been growing in all countries (except the Former Yugoslav Republic of Macedonia), in particular in Bulgaria, Romania and Slovenia.



2.3.4 Community designs per billion GDP (in PPP€)

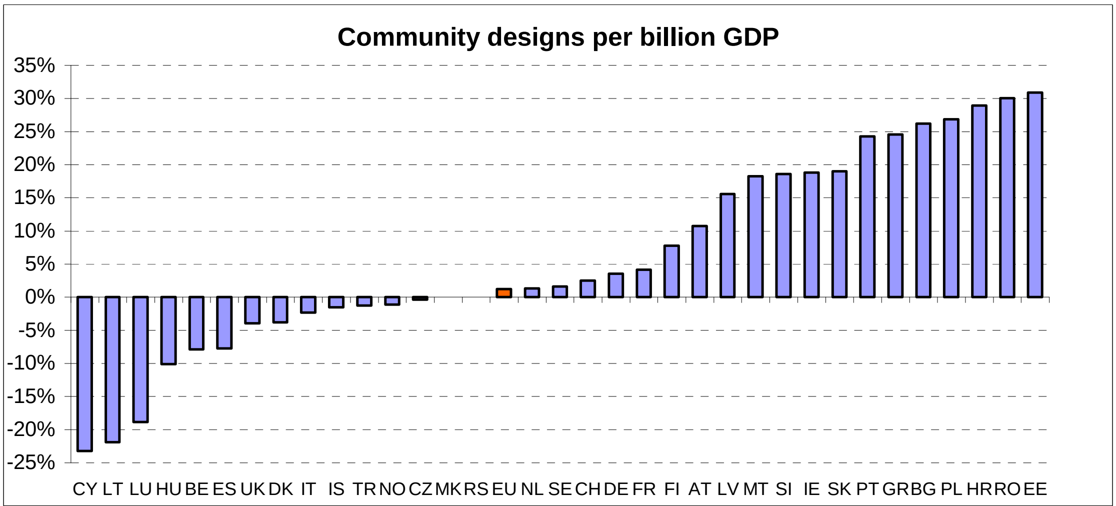


A design is the outward appearance of a product or part of it resulting from the lines, contours, colours, shape, texture, materials and/or its ornamentation. A product can be any industrial or handicraft item including packaging, graphic symbols and typographic typefaces but excluding computer programs. It also includes products that are composed of multiple components, which may be disassembled and reassembled. Community design protection is directly enforceable in each Member State and it provides both the option of an unregistered and a registered Community design right for one area encompassing all Member States.

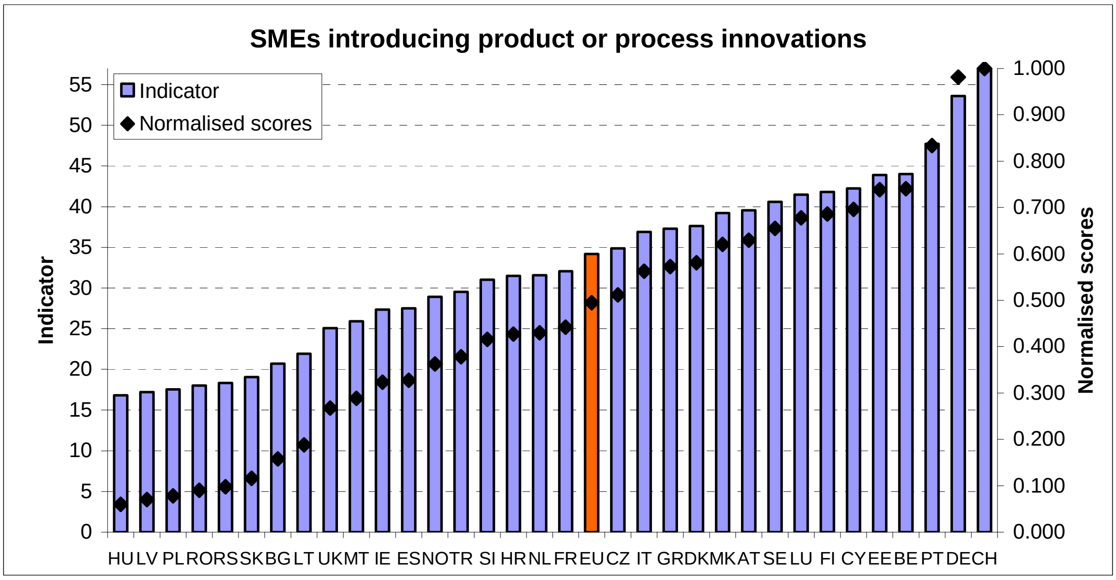
Most designs are applied for Austria, Denmark, Germany and Switzerland. Design applications are low in Croatia, Cyprus, Greece, Hungary, Iceland, Lithuania, the Former Yugoslav Republic of Macedonia, Norway, Romania, Serbia and Turkey.

Growth performance

Growth performance for designs shows that these have been growing in 19 countries but declining in 13 countries. On average there is only a modest increase in the number of designs per billion GDP.



3.1.1 SMEs introducing product or process innovations as % of SMEs



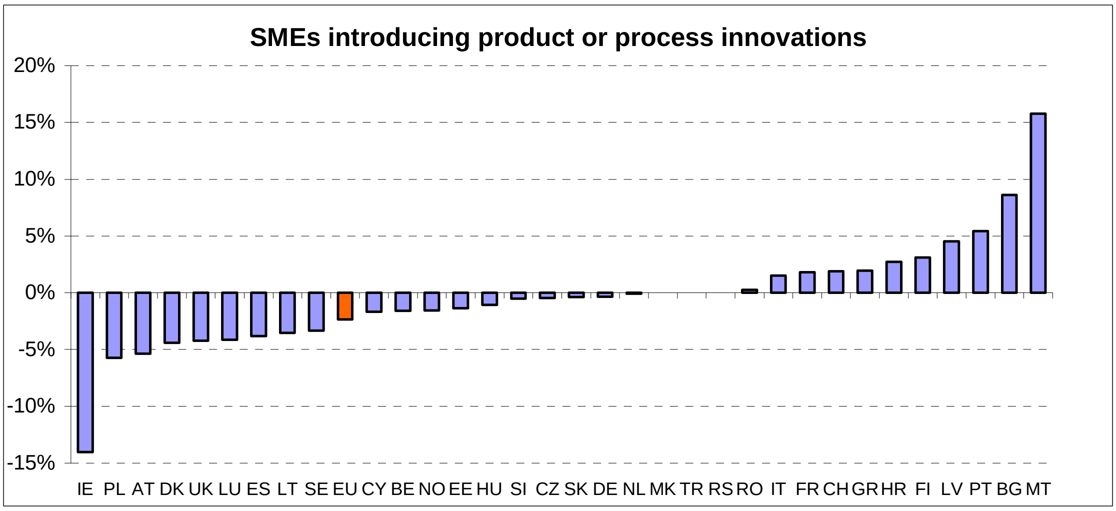
Statistical outlier: Switzerland

Technological innovation, as measured by the introduction of new products (goods or services) and processes, is a key ingredient to innovation in manufacturing activities. Higher shares of technological innovators should reflect a higher level of innovation activities.

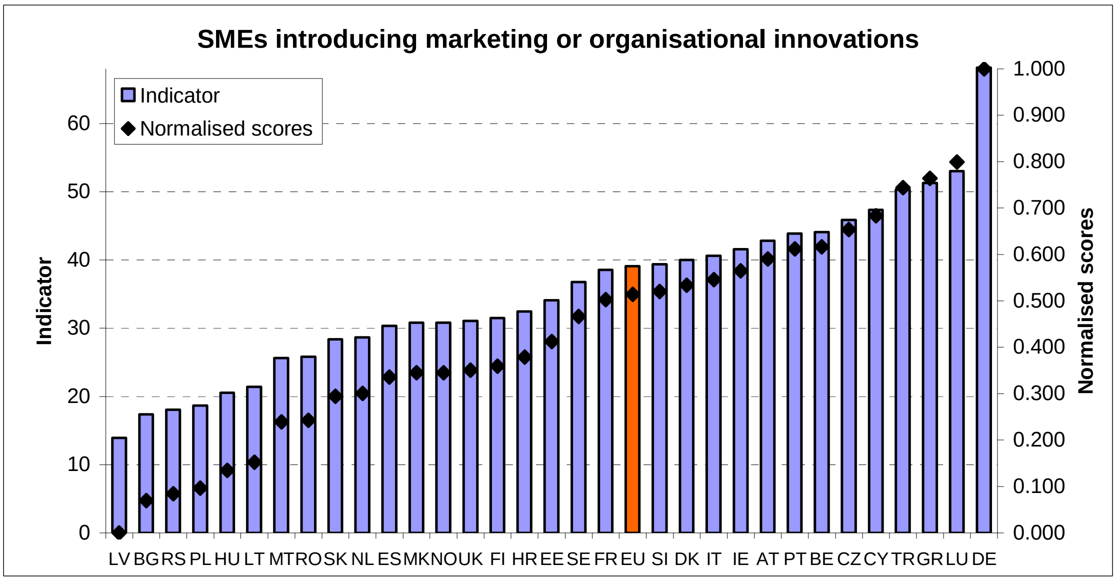
Almost 35% of EU27 SMEs have innovated by introducing a new product or a new process. In Germany and Switzerland more than 50% of SMEs have introduced a new product or process, in Hungary, Latvia, Poland, Romania, Serbia and Slovakia this share is below 20%.

Growth performance

Over the last 5 years on average a smaller share of SMEs has introduced new products or new processes. In most countries shares have been declining; only in 10 countries do we observe a significant increase.



3.1.2 SMEs introducing marketing or organisational innovations as % of SMEs

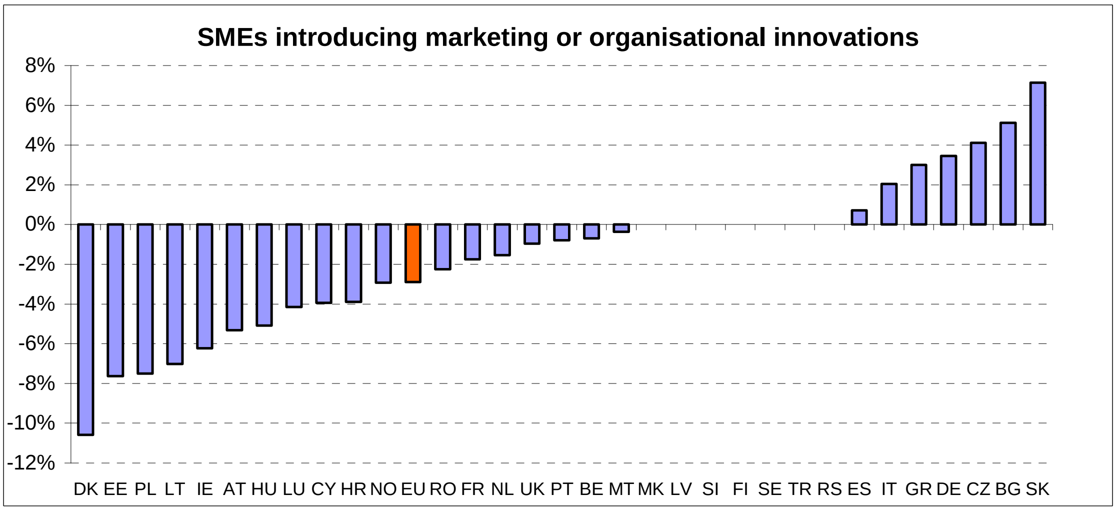


The Community Innovation Survey mainly asks firms about their technological innovation. Many firms, in particular in the services sectors, innovate through other non-technological forms of innovation. Examples of these are marketing and organisational innovations. This indicator tries to capture the extent that SMEs innovate through non-technological innovation.

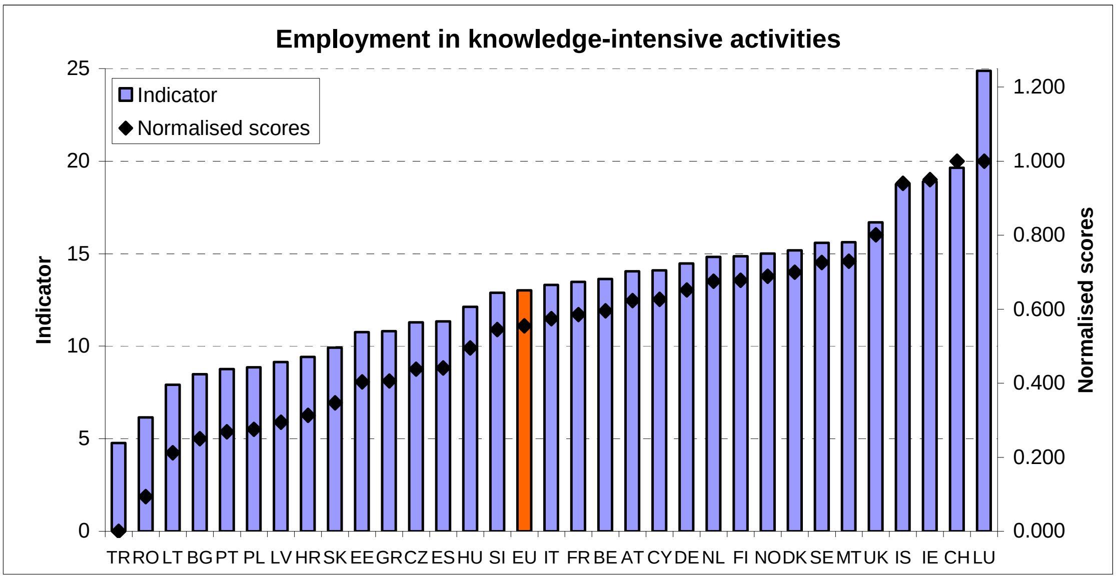
Almost 40% of EU27 SMEs have innovated by introducing a new marketing or new organisational innovation. In Germany more than 60% of SMEs have introduced a new marketing or new organisational innovation, in Bulgaria, Latvia, Poland and Serbia this share is below 20%.

Growth performance

The share of SMEs that have introduced marketing or organisational innovations has been declining for the EU27 and for most countries over the last 5 years. Only in 7 countries we observe an increase.



3.2.1 Employment in knowledge-intensive activities as % of total employment



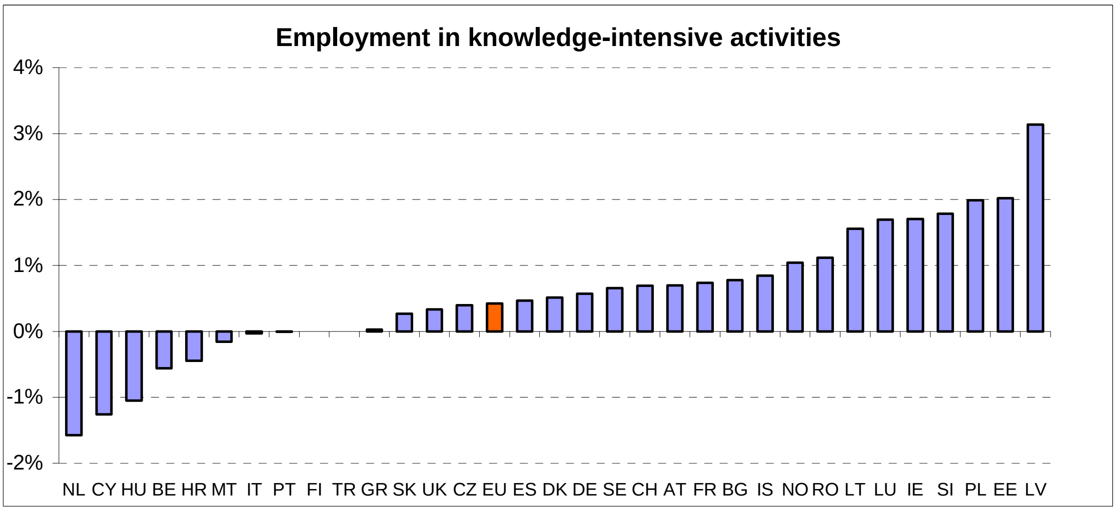
Statistical outlier: Luxembourg

The indicator on knowledge-intensive activities replaces the European Innovation Scoreboard indicators on employment in medium-high and high-tech manufacturing and employment in knowledge-intensive services. Knowledge-intensive activities are defined as those industries where at least 33% of employment has a university degree (ISCED5 or ISCED6).

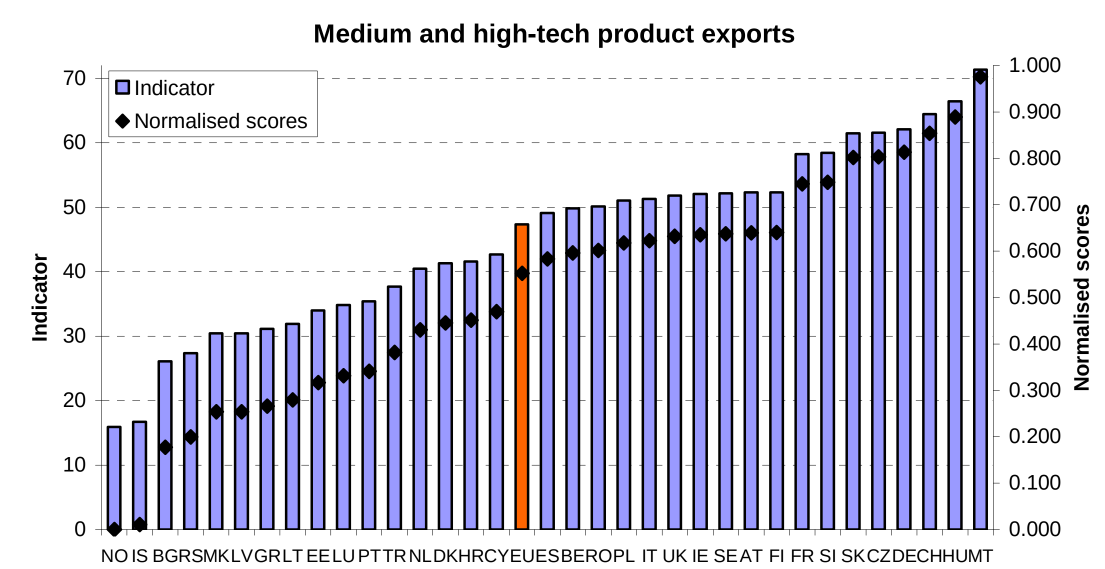
The average value for the indicator is 13%. Countries with high shares of knowledge-intensive activities include Iceland, Ireland, Luxembourg and Switzerland. In Romania and Turkey the share of knowledge-intensive activities is below or close to 5%.

Growth performance

Employment in knowledge-intensive activities has been growing for the EU27 and for most countries. The employment share has decreased with more than 1% annually in Cyprus, Hungary and the Netherlands.



3.2.2 Medium and high-technology product exports as % of total product exports



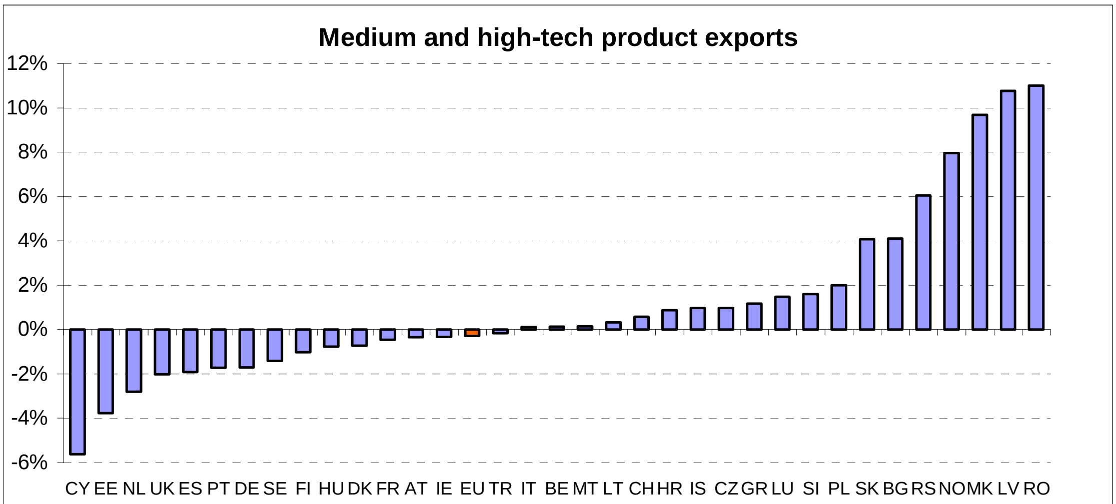
Statistical outlier: Norway. Medium and High-tech exports include exports of the following SITC Rev.3 products: 266, 267, 512, 513, 525, 533, 54, 553, 554, 562, 57, 58, 591, 593, 597, 598, 629, 653, 671, 672, 679, 71, 72, 731, 733, 737, 74, 751, 752, 759, 76, 77, 78, 79, 812, 87, 88 and 891.

The indicator measures the technological competitiveness of the EU i.e. the ability to commercialize the results of research and development (R&D) and innovation in the international markets. It also reflects product specialization by country. Creating, exploiting and commercializing new technologies are vital for the competitiveness of a country in the modern economy. This is because medium and high technology products are key drivers for economic growth, productivity and welfare, and are generally a source of high value added and well-paid employment.

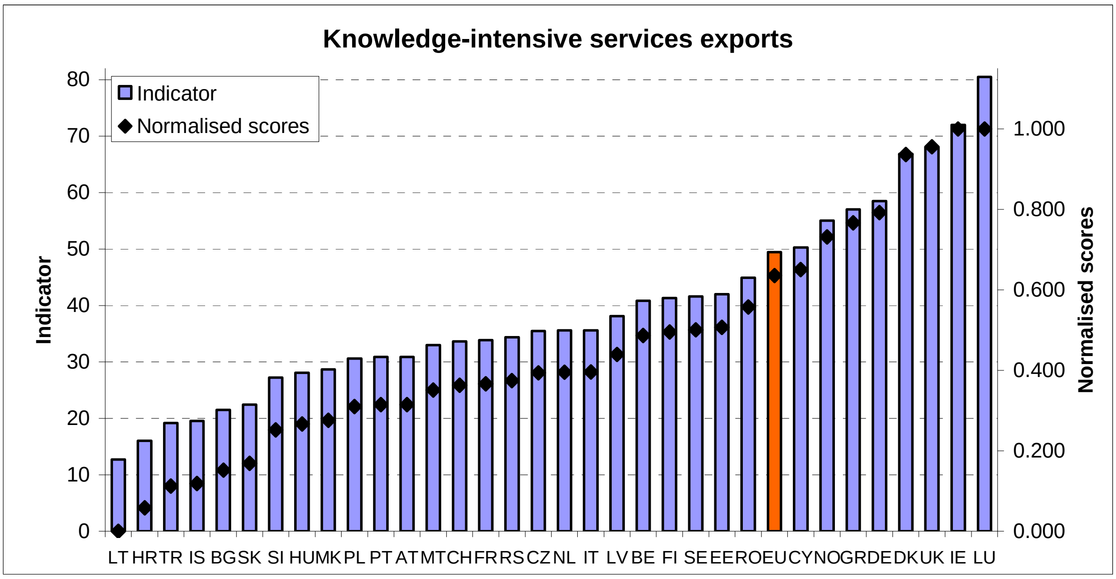
Export shares are very high in Hungary, Malta and Switzerland and very low in Iceland and Norway.

Growth performance

The share of medium and high-tech product exports has been growing rapidly in Latvia, Norway and Romania. On average there is a small decline and in Cyprus, Estonia and the Netherlands this decline has been strongest.



3.2.3 Knowledge-intensive services exports as % of total services exports



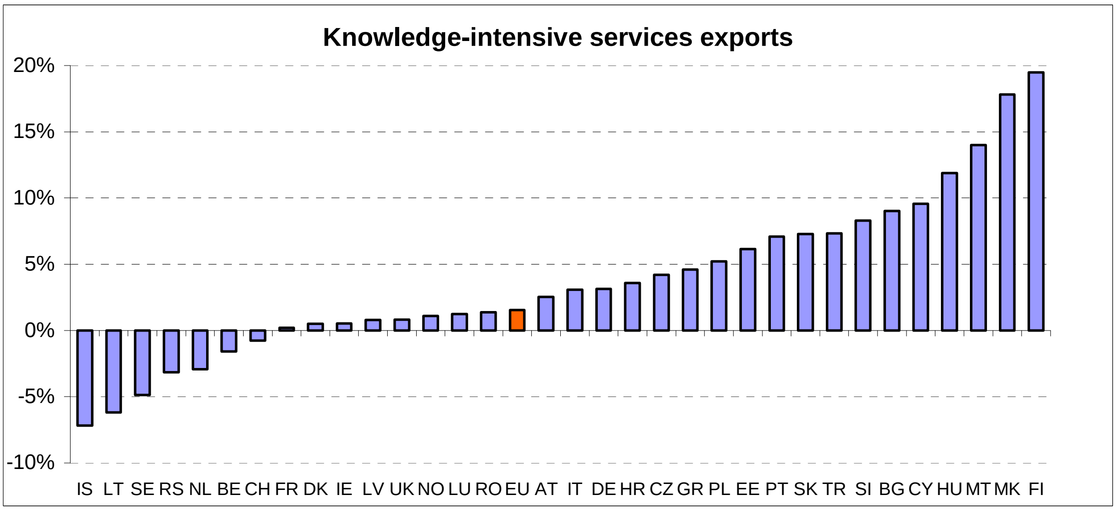
Statistical outliers: Ireland, Luxembourg. Exports of knowledge-intensive services are measured by the sum of credits in EBOPS (Extended Balance of Payments Services Classification) 207, 208, 211, 212, 218, 228, 229, 245, 253, 254, 260, 263, 272, 274, 278, 279, 280 and 284.

The indicator measures the competitiveness of the knowledge-intensive services sector. The indicator is comparable to the indicator manufacturing export performance. Knowledge-intensive services are defined as NACE classes 61-62 and 64-72. These can be related to the above-mentioned EBOPS classes using the correspondence table between NACE, ISIC and EBOPS as provided in the UN Manual on Statistics of International Trade in Services (UN, 2002).

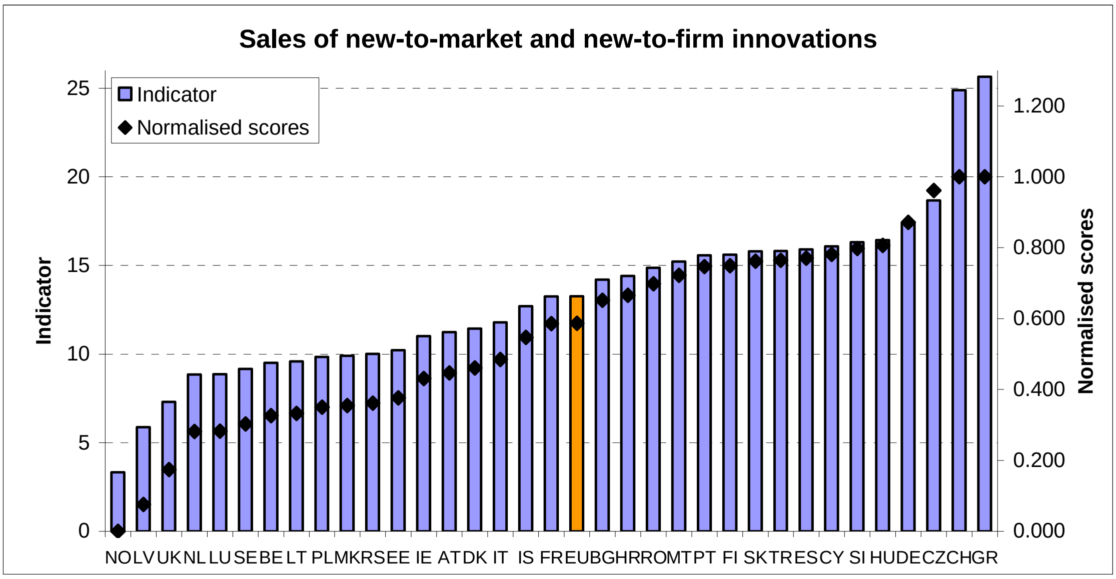
At EU level about half of the total services exports are knowledge-intensive. Export shares are around 70% in Denmark, Ireland and UK, and about 80% in Luxembourg; whilst they are very low, below 20%, in Croatia, Iceland, Lithuania and Turkey.

Growth performance

The export share of knowledge-intensive services has been growing at an average rate of 1.5% for the EU27. High growth rates above 10% are observed for Finland, Hungary and Malta. Export shares have declined in Iceland, Lithuania and Sweden at a rate above 5%.



3.2.4 Sales of new-to-market and new-to-firm innovations as % of turnover



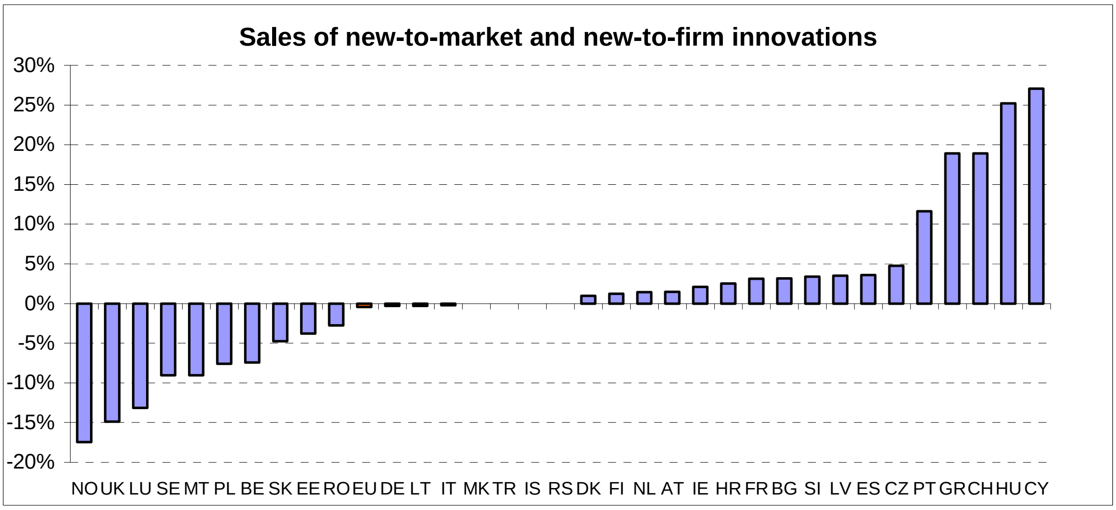
Statistical outliers: Greece, Norway, Switzerland

This indicator measures the turnover of new or significantly improved products and includes both products which are only new to the firm and products which are also new to the market. The indicator thus captures both the creation of state-of-the-art technologies (new to market products) and the diffusion of these technologies (new to firm products).

The average score for the EU27 is 13% but in Greece and Switzerland these shares are close to or above 25%. In Norway the sales share of new or significantly improved products is below 5%.

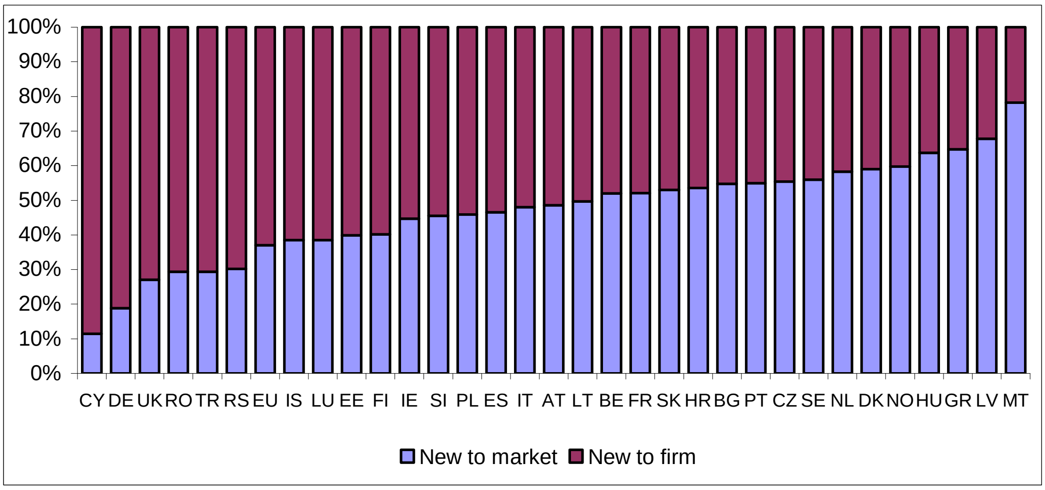
Growth performance

Sales of new-to-market and new-to-firm innovations have shown a strong increase in Cyprus, Greece Hungary and Switzerland. In Luxembourg, Norway and the UK these sales have been falling most.

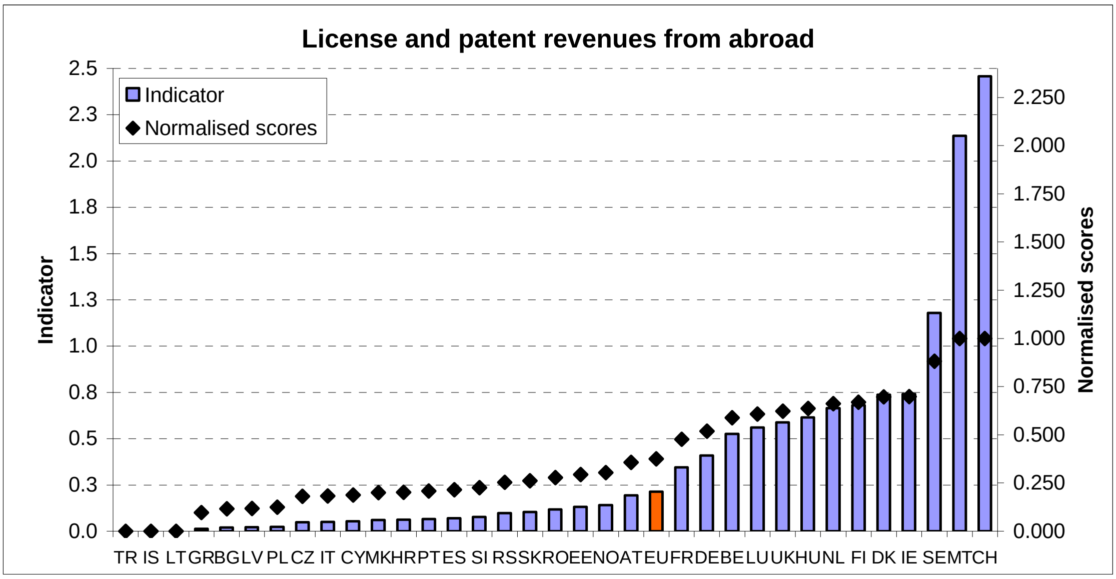


New-to-market versus new-to-firm sales

Sales of new-to-market products capture the creation of state-of-the-art technologies. Sales of new-to-firm products capture the diffusion of these technologies. In some countries sales of new-to-market products represents a much higher share than sales of new-to-firm products. The share of new-to-market products is above 60% in Greece, Hungary, Latvia, Malta and Norway. The share due to new-to-firm products is above 70% in Cyprus, Germany, Romania, Serbia, Turkey and the UK.



3.2.5 License and patent revenues from abroad as % of GDP



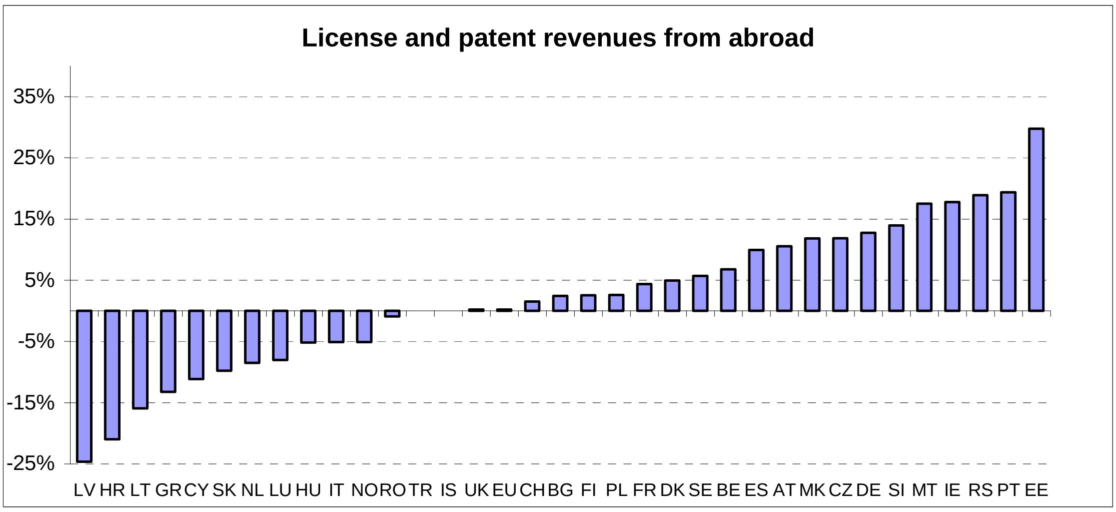
Statistical outliers: Malta, Netherlands, Switzerland. Indicator skewed and a square-root transformation has been used for deriving the normalised scores.

License and patent revenues from abroad capture disembodied technology acquisition. Technology exports reflect the successful commercialization of close-to-the-frontier technological activities.

These revenues are very high in Malta, Netherlands and Switzerland between 2% and 2.5% of GDP. In most countries these revenues represent less than 0.5% of GDP and in Iceland, Lithuania and Turkey they are close to zero.

Growth performance

License and patent revenues from abroad have increased in 20 countries, in particular in Estonia, Malta and Poland. In 10 countries these revenues have decreased relative to GDP.



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