3. Measuring innovation: the European Innovation Scoreboard

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Introduction

The Lisbon European Council of 2000 established the strategic goal for the European Union to become the most competitive and dynamic knowledge-based economy in the world by 2010, with sustainable economic growth, more and better jobs, and greater social cohesion. Innovation has been recognised to be at the heart of the Lisbon process and the Lisbon Council asked the European Commission to develop and annually publish a European Innovation Scoreboard (EIS) to 'track and benchmark the relative innovation performance of EU Member States' (EC, 2009). Since the 2000 pilot report, eight full versions of the EIS have been published[1]. Each annual EIS report includes a benchmarking of the Member States' most recent innovation performance, an analysis of the improvement of that performance over time, a detailed comparison of the performance of the EU against that of its main competitors — Japan and the US — and summaries of the results of the EIS thematic reports accompanying the EIS studying specific innovation topics in detail.

In this chapter, first we will briefly discuss the rationale and use of innovation scoreboards in Section 2. Section 3 will then focus on the methodology and results of the EIS and Section 4 concludes.

[1] All EIS reports are available from the EC's PRO INNO Europe website: http://www.proinno-europe.eu/metrics

Innovation Scoreboard: indicators and policy use [2]

Innovation indicators are comparable measures of innovative activities derived from statistics on innovation activities. Since the mid 1990s there has been an increase in the number of available innovation indicators due to new statistics derived from improved methods of analysing existing statistics on R & D and patents and from newly developed innovation surveys as the Community Innovation Survey (CIS)[3].

These innovation indicators are used to construct innovation scoreboards whose main purpose is to assist policy by summarising a range of (diverse) innovation indicators. Following the increase in innovation indicators, the number of innovation scoreboards has increased significantly and well-known examples of such scoreboard are the OECD's Science, Technology and Industry Scoreboard (OECD, 2007), the World Economic Forum's Global Competitiveness Report (World Economic Forum, 2008) and the EC's European Innovation Scoreboard (European Commission, 2009)[4].

It is crucial to meet the following criteria in selecting the indicators to be included in these scoreboards: the indicators should be of comparable importance as measures of the drivers of innovation activity; the indicators should be based on reliable statistics; the indicators should hold their value over time; and the indicators should be of relevance to medium and long-term policy issues. In practice it is difficult, if not impossible, to meet all four criteria as, for example, indicators are derived from both public and private sources and national differences on how firms respond to the questions in the innovation surveys will lead to differences in the quality and comparability of these statistics between countries.

Many scoreboards use *composite indicators* to summarise the statistical information from these indicators in a single number providing an easy-to-grasp summary statistic of a country's innovation performance. The construction of composite indicators is sensitive to the applied normalisation procedure — which ensures that indicators that measured using different units are comparable — and the selection of the weight of each indicator to the composite indicator. The *Handbook on Constructing Composite Indicators* provides detailed guidelines for constructing composite indicators (Nardo et al, 2008). The use of composite indicators has a.lso been criticised for not accurately summarising innovation performance in a single number (e.g. Grupp and Mogee, 2004).

[2] This section is an abridged version of the discussion on innovation scoreboards in Arundel and Hollanders (2008).

[3] The Community Innovation Surveys (CIS) are a series of surveys executed by national statistical offices throughout the European Union since 1992. The harmonised surveys are designed to give information on the innovativeness of firms, sectors, regions and countries. Aggregate statistics at national and sectoral level are published by Eurostat, the Statistical Office of the European Union

[4] Archibugi et al. (2009) provides a recent more detailed overview of different innovation scoreboards.

Innovation scoreboards can have *high policy relevance* for the following reasons. First, these scoreboards can act as an 'early warning' system for potential problems at national level. Of course, this requires very recent and up-to-date statistical indicators. Second, scoreboards can track changes in strengths and weaknesses over time. This requires that these scoreboards are constructed annually using the same methodology ensuring full comparability over time. Third, scoreboards can be used to attract the interest of policy(makers) and as such can help build consensus among governments, public institutions and private firms to introduce policies to improve the innovativeness of firms.

In particular raising interest by European policymakers in innovation has perhaps been the most important contribution of the EC's European Innovation Scoreboard (EIS). The following section will discuss this scoreboard in detail.

European Innovation Scoreboard (EIS)

History, indicators and composite innovation index

The EIS was developed by MERIT and SPRU as part of the European Commission's Trend Chart project. The first version in 2000 covered 17 European countries and used 16 indicators; it was one of the first scoreboards to use results from innovation surveys with four indicators from the CIS. Full versions of the EIS have been published annually from 2001 and, following a number of small and sometimes larger revisions, the number of countries has steadily increased to 37 in 2007 and the number of indicators to 29 in 2008 (cf. Annex 1 for an overview of the change in the indicators used in the EIS over time).

The EIS methodology was revised again in 2008 with the intention of using the new methodology in the consecutive 2008, 2009 and 2010 reports so as to ensure full comparability over time. The 2008 revision of the EIS was a direct result of the challenges discussed in the EIS 2007 report: to measure new forms of innovation; to (better) assess overall innovation performance; to improve comparability at national, regional and international level; and to measure progress and changes over time (EC, 2009). The EIS 2008 Methodology Report provided full details of the new methodology (Hollanders and van Cruysen, 2008).

Innovation performance in the EIS is measured using data from 29 innovation indicators. These indicators are grouped in three main blocks covering enablers, firm activities and outputs covering seven different innovation dimensions.

Enablers capture the main drivers of innovation that are external to the firm covering the availability of high-skilled and educated people as captured in the human resources dimensions and the availability of finance for innovation projects and the support of governments for innovation activities as captures in the Finance and support dimension.

Firm activities capture innovation efforts that firms undertake recognising the fundamental importance of firms' activities in the innovation process as captured by three innovation dimensions. Firm investments cover a range of different investments firms make in order to generate innovations; linkages & entrepreneurship captures entrepreneurial efforts and collaboration efforts among innovating firms and also with the public sector; and throughputs captures the Intellectual Property Rights (IPR) generated as a throughput in the innovation process and Technology Balance of Payments flows.

Outputs capture the outputs of firm activities as measured by the number of firms that have introduced innovations onto the market or within their organisations, covering technological and non-technological innovations (the Innovators dimension) and by the economic success of innovation in employment, exports and sales due to innovation activities (the Economic effects dimension).

These dimensions form the core of national innovation performance. In addition, there are wider socioeconomic factors that influence innovation, such as the role of governments, markets, social factors and the demand and acceptance of innovation. These factors and their relationship with innovation performance are as such not included in the EIS benchmarking but have been explored in various EIS thematic papers [5].

The EIS 2008 uses the most recent statistics from Eurostat and other internationally recognised sources as available at the time of analysis. The 29 indicators which are included in each of the dimensions are shown in Table 1. It is important to note that, due to data availability, the data relates to actual performance in 2006 and 2007 [6]. As a consequence the 2008 EIS does not capture the most recent changes in innovation performance, or the impact of policies introduced in recent years which may take some time to impact on innovation performance.

[5] cf. the full list of EIS thematic papers available for download at http://www.proinno-europe.eu/metrics

[6] Of the 29 indicators, 12 indicators capture in performance in 2007, 15 indicators capture performance in 2006 and two indicators capture performance in 2005.

Table 1: European Innovation Scoreboard indicators

Block	Dimension/indicator	Data source
ENABLERS		
	Human resources	
1.1.1	S&E and SSH graduates per 1 000 population aged 20–29 (first stage of tertiary education — ISCED 5)	Eurostat
1.1.2	S&E and SSH doctorate graduates per 1 000 population aged 25–34 (second stage of tertiary education — ISCED 6)	Eurostat
1.1.3	Population with tertiary education per 100 population aged 25–64	Eurostat
1.1.4	Participation in lifelong learning per 100 population aged 25–64	Eurostat
1.1.5	Youth education attainment level (share of young people aged 20–24 having attained at least upper secondary education)	Eurostat
	Finance and support	
1.2.1	Public R & D expenditures (% of GDP)	Eurostat
1.2.2	Venture capital (% of GDP)	EVCA/Eurostat
1.2.3	Private credit (relative to GDP)	IMF
1.2.4	Broadband access by firms (% of firms)	Eurostat
FIRM ACTIVITIES		
	Firm investments	
2.1.1	Business R & D expenditures (% of GDP)	Eurostat
2.1.2	IT expenditures (% of GDP)	EITO/Eurostat
2.1.3	Non-R & D innovation expenditures (% of turnover)	Eurostat — CIS
	Linkages & entrepreneurship	
2.2.1	SMEs innovating in-house (% of SMEs)	Eurostat — CIS
2.2.2	Innovative SMEs collaborating with others (% of SMEs)	Eurostat — CIS
2.2.3	Firm renewal (SME entries plus exits) (% of SMEs)	Eurostat
2.2.4	Public-private co-publications per million population	Thomson Reuters/ CWTS
	Throughputs	
2.3.1	EPO patents per million population	Eurostat
2.3.2	Community trademarks per million population	OHIM/Eurostat
2.3.3	Community designs per million population	OHIM/Eurostat
2.3.4	Technology Balance of Payments flows (% of GDP)	World Bank
OUTPUTS		
	Innovators	
3.1.1	SMEs introducing product or process innovations (% of SMEs)	Eurostat — CIS
3.1.2	SMEs introducing marketing or organisational innovations (% of SMEs)	Eurostat — CIS
3.1.3	Resource efficiency innovators (% of firms), unweighted average of the share of innovators where innovation has significantly reduced labour costs and the share of innovators where innovation has significantly reduced the use of materials and energy	Eurostat — CIS
	Economic effects	
3.2.1	Employment in medium-high & high-tech manufacturing (% of workforce)	Eurostat
3.2.2	Employment in knowledge-intensive services (% of workforce)	Eurostat
3.2.3	Medium and high-tech manufacturing exports (% of total exports)	Eurostat
3.2.4	Knowledge-intensive services exports (% of total services exports)	Eurostat
3.2.5	New-to-market sales (% of turnover)	Eurostat — CIS
3.2.6	New-to-firm sales (% of turnover)	Eurostat — CIS

Innovation performance in the EIS is summarised using composite indicators for each year over a five-year period. The methodology involved the following steps: (i) for highly volatile and asymmetric distributed indicators the data are transformed; (ii) data outliers are identified; (iii) reference years are chosen for each of the indicators reflecting most recent data availability for most of the countries; (iv) missing time series data are imputed using the available data; (v) data are extrapolated for 2009 and 2010 ensuring that; (vi) the worst and best performers over all years can be identified such that these worst and best performing scores can also be used in the future EIS 2009 and EIS 2010; and (vii) all data are normalised within the same range such that the best performing score is equal to 1 and the worst performing score is equal to 0. For each of the innovation dimensions and main blocks composite indicators are then calculated as the average of the normalised data of the indicators included in each dimension or block. Overall innovation performance — the Summary Innovation Index — is calculated as the average of the normalised data of all 29 indicators (cf. EC (2009) and Hollanders and Cruysen (2008) for more details).

EIS benchmarking results

The EIS 2008 includes innovation indicators and trend analyses for the EU-27 Member States as well as for Croatia, Iceland, Norway, Turkey, and Switzerland. Based on their innovation performance across 29 indicators as measured by the Summary Innovation Index (SII), EU Member States fall into the following four country groups (cf. Figure 1):

- Denmark, Germany, Finland, Sweden, and the UK are the Innovation leaders, with innovation performance well above that of the EU average and all other countries. Of these countries, Germany is improving its performance fastest while Denmark is stagnating.
- Belgium, Ireland, France, Luxembourg, the Netherlands and Austria are the Innovation followers, with innovation performance below those of the innovation leaders but above that the EU average. Ireland's performance has been increasing fastest within this group, followed by Austria.
- Czech Republic, Estonia, Greece, Spain, Italy, Cyprus, Portugal and Slovenia are the Moderate innovators, with innovation performance below the EU average. The trend in Cyprus' innovation performance is well above the average for this group, followed by Portugal, while Spain and Italy are not improving their relative position.

- Bulgaria, Latvia, Lithuania, Hungary, Malta, Poland, Romania and Slovakia are the catching-up countries with innovation performance well below the EU average. All of these countries have been catching up, with the exception of Lithuania. Bulgaria and Romania have been improving their performance the fastest.

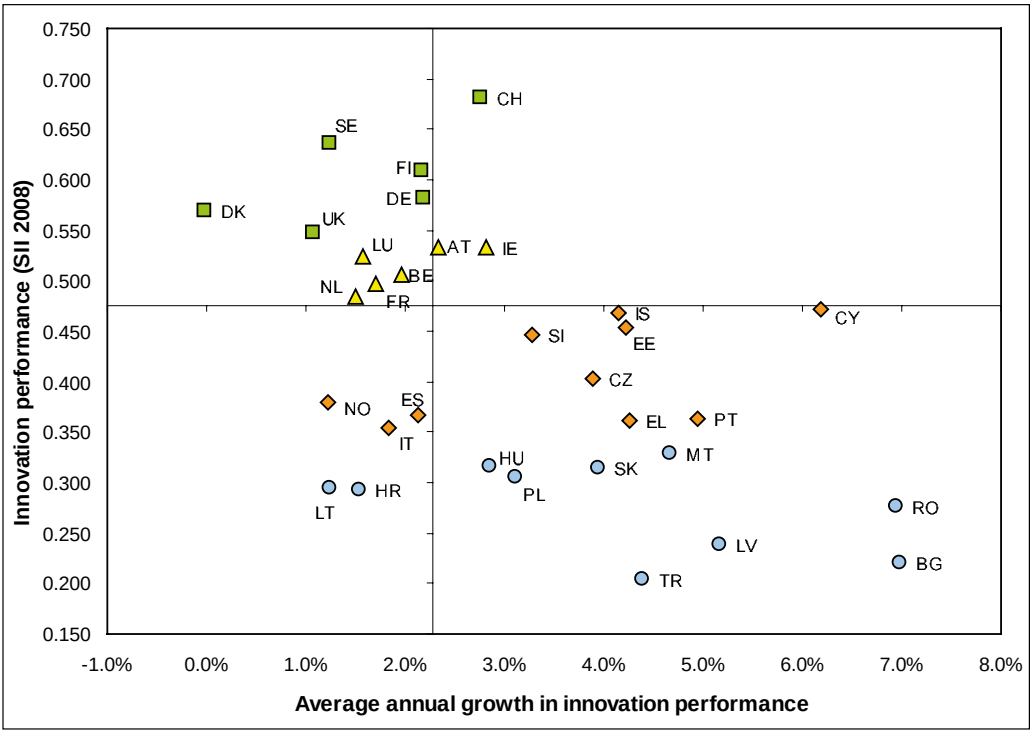

Figure 1: Innovation performance: current and trend performance
Colour coding as follows: green are the innovation leaders; yellow are the innovation followers; orange are the moderate innovators; blue are the catching-up countries. Average annual growth rates are calculated over a five-year period. The dotted lines show EU performance and growth.
Source: European Innovation Scoreboard 2008 (EC, 2009).

The development in innovation performance has been calculated for each country and for the EU-27 using data over a five-year period. All countries, with the exception of Denmark show an absolute improvement in their innovation performance. Bulgaria and Romania have experienced the fastest growth in performance, albeit from a low starting point.

Within the four identified country groups growth performance is very different. Within the innovation leaders, Switzerland is the growth leader and all other countries in this group show a rate of improvement that is below that of the EU-27. For the in-

novation followers we observe that only Austria and Ireland have managed to grow faster than the EU-27. These countries are the growth leaders within the innovation followers. Of the moderate innovators seven countries have grown faster than the EU-27, but three countries have shown a slower progress: Italy, Norway and Spain. The growth leaders here are Cyprus and Portugal. Of the catching-up countries two countries have actually grown at a slower pace than the EU-27: Croatia and Lithuania. Bulgaria and Romania are the growth leaders also showing the overall fastest rate of improvement in innovation performance.

The average growth rates for the four country groups[7] show that there is between group convergence with the Moderate innovators and the catching-up countries growing at a faster rate than the Innovation leaders and Innovation followers. This overall process of catching up, where countries with below average performance have faster growth rates than those with above average performance, can also be observed at the level of most individual countries. Notable exceptions include Cyprus which combines a close to average level of performance with a high growth rate; Croatia, Italy, Lithuania, Norway and Spain which combine below average levels of performance with below average growth rates; and Switzerland which is combining a high level of innovation performance and an above average rate of improvement.

Japan and the US are not included in the main EIS analysis as for both countries data are missing for too many indicators. Using a smaller selection of 17 indicators, average innovation performance of Japan and the US is well above that of the EU-27 (Figure 2). The EU-US gap has dropped significantly, in particular between 2005 and 2006 although the relative progress of the EU appears to have slowed down since then. The EU-Japan gap at first increased but has been declining at a steady rate in the last four years. There remains a significant gap between the EU and these two other regions and this gap is concentrated in four areas: international patenting (as measured under the patent cooperation treaty), public private linkages and numbers of researchers (despite the improvements in both these areas), and business R & D expenditures (where both EU and US values have stagnated, while Japan's have increased).

[7] Average growth for the innovation leaders is 1.6 %, for the innovation followers 2.0 %, for the moderate innovators 3.6 % and for the catching-up countries 4.1 %.

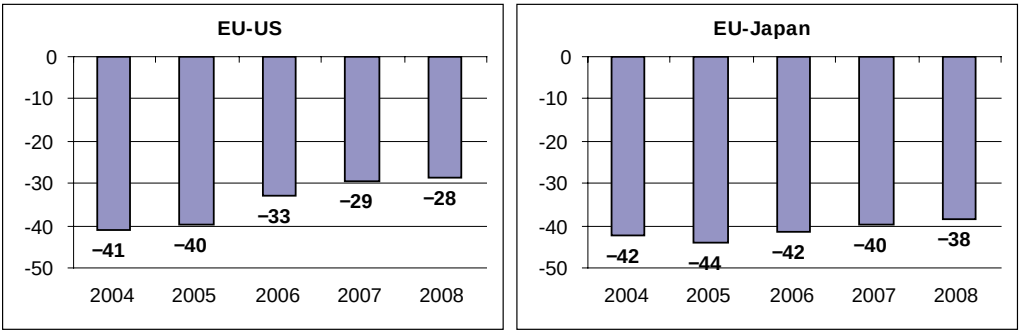

Figure 2: EU Innovation gap towards US and Japan

Performance for each reference year is measured using, on average, data with a two-year lag (e.g. performance for 2008 is measured using data for 2006). The EU innovation gap is measured as the distance between the average performance of the EU and those of the US and Japan on 16 indicators. An EU innovation gap of e.g. – 40 means that the US or Japan is performing at a level of 140, or 40 % above that of the EU.

Source: European Innovation Scoreboard 2008 (EC, 2009).

Conclusions

Innovation performance can be measured using innovation scoreboards which provide good overview of trends in innovation over a period of time. They also highlight individual countries' strengths and weaknesses. Innovation performance in the EU is measured by the European Innovation Scoreboard. After its introduction in 2000 the EIS has undergone several revisions of which the last one was in 2008. The EIS now captures 29 innovation indicators classified in seven different innovation dimensions. Average performance is measured using composite indicators and the summary Innovation Index captures average performance at the country level. The 2008 EIS shows that the European countries can be divided in four different groups, of which the Innovation leaders show the best innovation performance and the catching-up countries show the fastest rate of improvement. A comparison with its main competitors the US and Japan shows that the innovation gap for the EU has been declining but that the rate of decline is slowing down and the remaining gap is still significant.

Table 2: Changes in the European Innovation Scoreboard

	EIS 2000 (Pilot)	EIS 2001	EIS 2002	EIS 2003	EIS 2004
Number of indicators	16	18	18	22	22
Number of groups/dimensions	4	4	4	4	4
Indicators based on CIS	4	4	4	5	6
Summary Innovation Index	No	Yes	No	Yes	Yes
Countries	17: EU-15, US, JP	17	33: + 10 NMS BG, IS, NO, RO, CH, TR	33	33
Indicators					
S&E (Science and engineering) graduates	Share of post-secondary graduates	Share of population aged 20–29	←	←	←
S&E and SSH graduates (ISDED 6)	x	x	x	x	x
Share of working-age population with tertiary education	←	←	←	←	←
Participation in lifelong learning	x	←	←	←	←
Youth education attainment level	x	x	x	x	x
Public R & D expenditures (% of GDP)	GOVERD only	GOV-ERD + HERD	GERD — BERD	←	←
Venture capital (% of GDP)	Early stage and expansion stage			Early stage only	←
High-tech venture capital	x	Share of GDP	←	←	Share of venture capital
Private credit (% of GDP)	x	x	x	x	x
Capitalisation of new markets (% of GDP)	←	←	←	x	x
Broadband penetration rate (population)	x	x	x	x	x
Internet use	Users per 100 population	Share of households	←	Composite indicator for households and firms	←
Share of enterprises that receive public funding for innovation (CIS)	x	x	x	x	x
Business R & D expenditures (% of GDP)	←	←	←	←	←
Share of medium-high/high-tech R & D in manufacturing	x	x	x	x	x
ICT expenditures (% of GDP)	←	←	←	←	←
Innovation expenditures (% of turnover) (CIS)	Manufacturing sector	←	←	+ Services sector	Total business sector
Share of SMEs innovating in-house (CIS)	Manufacturing sector	←	←	+ Services sector	Total business sector
Share of SMEs cooperating in innovation (CIS)	Manufacturing sector	←	←	+ Services sector	Total business sector

← : same definition as previous year; x: no longer included

Table 2: Changes in the European Innovation Scoreboard (continued)

	EIS 2000 (Pilot)	EIS 2001	EIS 2002	EIS 2003	EIS 2004
Volatility rates of SMEs	x	x	x	←	x
Public-private co-publication per million population	x	x	x	x	x
Share of university R & D funded by private sector	x	x	x	x	x
EPO patents per million population	x	x	x	←	←
USPTO patents per million population	x	x	x	←	←
Triad patents per million population	x	x	x	x	x
Community trademarks per million population	x	x	x	x	x
Community designs per million population	x	x	x	x	X
High-tech EPO patents per million population	←	←	←	←	←
High-tech USPTO patents per million population	x	←	←	←	←
Technology Balance of Payments flows (% of GDP)	x	x	x	x	x
Share of SMEs introducing product or process innovation	x	x	x	x	x
Share of SMEs using organisational innovations (CIS)	x	x	x	x	Using non-technological change
Share of resource efficiency innovators	x	x	x	x	x
Share of medium-high/high-tech manufacturing employment	←	←	←	←	←
Share of high-tech manufacturing value-added	Percent change	Share of value-added	←	←	←
Share of high-tech services employment	←	←	←	←	←
Share of high-tech exports	x	X	x	x	x
Share of knowledge-intensive services exports	x	X	x	x	x
New-to-market products (% of turnover) (CIS)	Manufacturing sector	←	←	+ Services sector	Total business sector
New-to-firm products (% of turnover) (CIS)	x	X	x	Manufacturing + Services sector	Total business sector

← : same definition as previous year; x: no longer included

Table 2: Changes in the European Innovation Scoreboard (continued)

	EIS 2005	EIS 2006	EIS 2007	EIS 2008
Number of indicators	26	25	25	29
Number of groups/dimensions	5	5	5	7
Indicators based on CIS	7	7	7	8
Summary Innovation Index	Yes	Yes	Yes	Yes
Countries	33	34: + HR	37: + AU, CA, IL	32: EU-27, HR, IS,NO,CH,TR
Indicators				
S&E (Science and Engineering) graduates	←	←	←	S&E and SSH graduates, ISCED 5
S&E and SSH graduates (ISDED 6)	x	x	x	←
Share of working-age population with tertiary education	←	←	←	←
Participation in lifelong learning	←	←	←	←
Youth education attainment level	←	←	←	←
Public R & D expenditures (% of GDP)	←	GOVERD + HERD	←	←
Venture capital (% of GDP)	←	←	←	←
High-tech venture capital	x	x	x	X
Private credit (% of GDP)	x	x	x	←
Capitalisation of new markets (% of GDP)	x	x	x	X
Broadband penetration rate (population)	x	←	←	Broadband access by firms
Internet use	x	x	x	x
Share of enterprises that receive public funding for innovation (CIS)	←	←	←	x
Business R & D expenditures (% of GDP)	←	←	←	←
Share of medium-high/high-tech R & D in manufacturing	←	←	←	x
ICT expenditures (% of GDP)	←	←	←	IT expenditures
Innovation expenditures (% of turnover) (CIS)	←	←	←	Non-R & D innovation expenditures
Share of SMEs innovating in-house (CIS)	←	←	←	←
Share of SMEs cooperating in innovation (CIS)	←	←	←	←
Volatility rates of SMEs	x	x	x	Size class and sector limitation
Public-private co-publication per million population	x	x	x	←

← : same definition as previous year; x: no longer included

Table 2: Changes in the European Innovation Scoreboard (continued)

	EIS 2005	EIS 2006	EIS 2007	EIS 2008
Share of university R & D funded by private sector	←	x	x	x
EPO patents per million population	←	←	←	←
USPTO patents per million population	←	←	←	x
Triad patents per million population	←	←	←	x
Community trademarks per million population	←	←	←	←
Community designs per million population	←	←	←	←
High-tech EPO patents per million population	x	x	x	x
High-tech USPTO patents per million population	x	x	x	x
Technology Balance of Payments flows (% of GDP)	x	x	x	←
Share of SMEs introducing product or process innovation	x	x	x	←
Share of SMEs using organisational innovations (CIS)	←	Using organisational innovations	←	Marketing or organisational innovation
Share of resource efficiency innovators	x	x	x	←
Share of medium-high/high-tech manufacturing employment	←	←	←	←
Share of high-tech manufacturing value-added	x	x	x	x
Share of high-tech services employment	←	←	←	Knowledge-intensive services
Share of high-tech exports	←	←	←	Medium and high-tech manufacturing exports
Share of knowledge-intensive services exports	x	x	x	←
New-to-market products (% of turnover) (CIS)	←	←	←	←
New-to-firm products (% of turnover) (CIS)	←	←	←	←

← : same definition as previous year; x: no longer included

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