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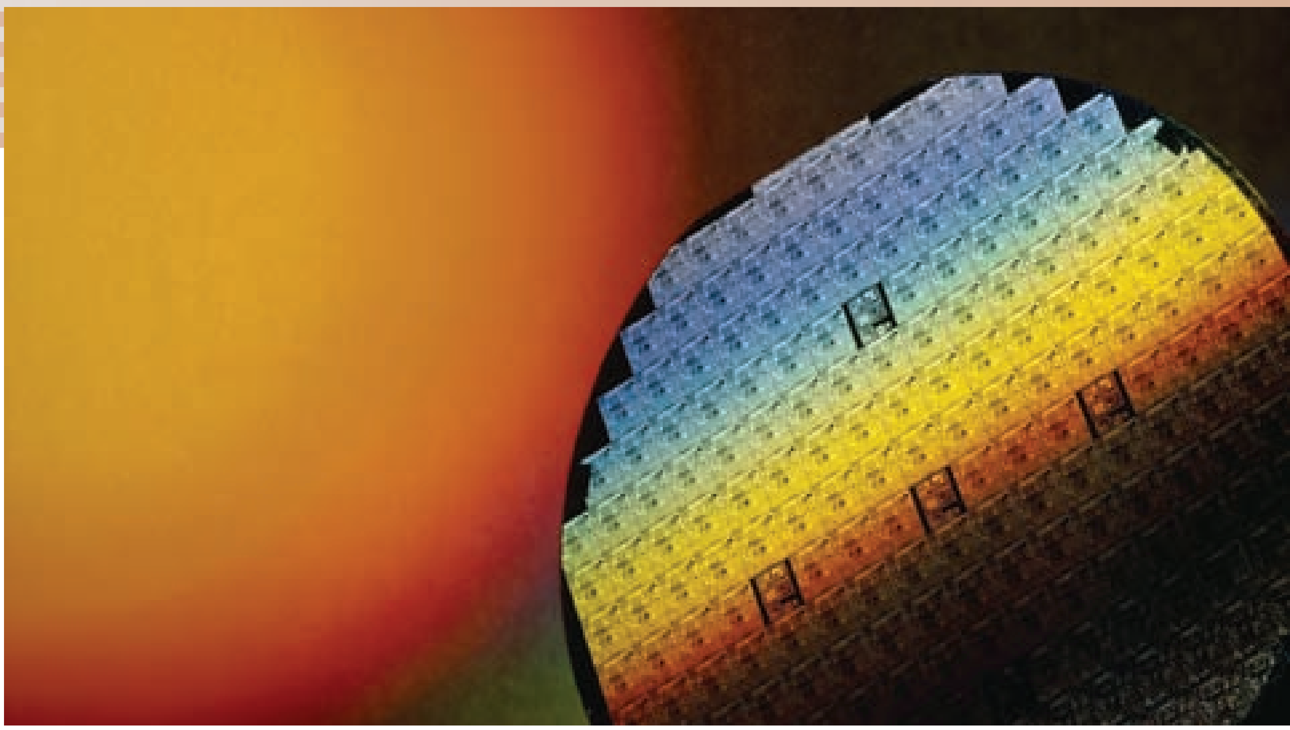
EUROPEAN INNOVATION SCOREBOARD 2007

COMPARATIVE ANALYSIS OF INNOVATION PERFORMANCE



European Commission
DIRECTORATE-GENERAL FOR ENTERPRISE AND INDUSTRY

PRO INNO EUROPE
INNO METRICS

EUROPEAN INNOVATION SCOREBOARD 2007

COMPARATIVE ANALYSIS OF INNOVATION PERFORMANCE

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The innovation policy initiative PRO INNO Europe combines **analysis and benchmarking** of national and regional innovation policy performance with support for cooperation of national and regional innovation programmes and incentives for innovation agencies and other innovation stakeholders to implement joint actions. The initiative aspires to become the main European reference for innovation policy analysis and development throughout Europe and brings together over 200 **innovation policy makers and stakeholders** from 33 countries. Additional information on PRO INNO Europe is available on the Internet (www.proinno-europe.eu).

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Contents

1. Executive Summary

This is the seventh edition of the *European Innovation Scoreboard* (EIS). The EIS is the instrument developed at the initiative of the European Commission, under the Lisbon Strategy, to provide a comparative assessment of the innovation performance of EU Member States. The EIS 2007 includes innovation indicators and trend analyses for the EU27 Member States as well as for Croatia, Turkey, Iceland, Norway, Switzerland, Japan, the US, Australia, Canada and Israel. Tables with definitions as well as comprehensive data sheets for every country are included in the Annexes. The EIS report and its Annexes, accompanying thematic papers, interactive tables to view results and the indicators' database are available at http://www.proinno-europe.eu/metrics.

The methodology for the 2007 EIS remains largely the same as that used in 2006, although a more robust analysis of country groupings has been added. For the first time, Australia, Canada and Israel have been included as these countries provide interesting comparisons to EU Member States. The thematic reports that accompany this year's Scoreboard are on innovation in services, wider factors influencing innovation performance and on innovation efficiency. In addition, the 2007 EIS reflects on seven years' experience in comparing countries' innovation performance and on where the main future challenges lie.

Sweden, Finland, Denmark, Germany and UK are the most innovative EU countries and ahead of the US (Section 2)

Based on their innovation performance, the countries included in the EIS 2007 fall into the following country groups:

- The *innovation leaders* include Denmark, Finland, Germany, Israel, Japan, Sweden, Switzerland, the UK and the US. Sweden is the most innovative country, largely due to strong innovation inputs although it is less efficient than some other countries in transforming these into innovation outputs.
- The *innovation followers* include Austria, Belgium, Canada, France, Iceland, Ireland, Luxembourg and the Netherlands.
- The *moderate innovators* include Australia, Cyprus, Czech Republic, Estonia, Italy, Norway, Slovenia and Spain.
- The *catching-up countries* include Bulgaria, Croatia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania and Slovakia. Turkey currently performs below the other countries.

These country groups appear to have been relatively stable over the last five years. Within these groups, countries have changed their relative ranking but it is rare for a country to have moved between groups. Only Luxembourg seems to be on the verge of entering the group of innovation leaders.

Czech Republic, Estonia and Lithuania are on track to reach the EU average within a decade (Section 3)

Although there is relative stability in the country groupings, over a longer time period there is a general process of convergence, with the countries showing below average EU innovation performance moving towards the EU average and closing the gap with the innovation followers and leaders. Based on trends over recent years, it would take most moderate innovators and catching-up countries 20 or more years to close the gap with the EU. However Cyprus, Czech Republic, Estonia, Lithuania and Slovenia seem to be in a position to close this gap in a shorter period of time, and for the Czech Republic and Estonia and Lithuania this could occur within 10 years.

A persistent but decreasing innovation gap with the US and Japan (Section 4)

The innovation gap between the EU and its two main competitors, the US and Japan, has been decreasing but remains significant. The US keeps its lead in 11 out of 15 indicators for which comparable data are available, and Japan keeps its lead in 12 out of 14 such indicators. A comparison over time shows that the EU is experiencing an increasing lead over the US in S&E graduates, employment in medium-high and high-tech manufacturing and Community trademarks, and a stable lead in Community designs. The EU is experiencing a declining gap with the US in broadband penetration, early-stage venture capital, ICT expenditures and triad patents. But the gap with the US is increasing in public R&D expenditures and high-tech exports.

Innovation policies might need to better take account of the needs of services innovators (Section 5.1)

Services are becoming more and more important as the major contributor to GDP and employment in the European economies. A comparison between manufacturing and services firms of the importance for innovation of different policy actions shows a bias towards manufacturing firms in two areas: demand from public procurement and support from innovation programmes. Here better policy interventions could help to improve the innovative capabilities of services firms. Elsewhere there do not seem to be systematic differences in innovation performance between service and manufacturing firms, although this may be due to current limitations in measuring innovation in services.

Social capital and knowledge flows are potential key factors in innovation performance (Section 5.2)

Although there is a general process of convergence in innovation performance, there still remain large differences in performance between European countries. An analysis, which builds upon previous EIS reports, examines the effect of 26 indicators measuring various aspects of a country's wider socio-economic environment on each of the 5 EIS innovation dimensions. This shows that beyond GDP, differences in social capital and technology flows have the greatest power to explain differing levels of innovation performance.

Most Member States could improve their efficiency in transforming innovation inputs into outputs (Section 5.3)

Innovation performance in the EIS is measured as the average performance on both innovation inputs and innovation outputs. Efficiency analyses between the different input and output dimensions show that for most countries there are efficiency gains to be reached. This applies to countries of all levels of performance: many of the innovation leaders have relatively low innovation efficiency while several of the moderate innovators and catching-up countries have relatively high efficiencies.

Non-R&D based innovation is as widespread as R&D driven innovation (Section 5.4)

R&D is important as a driver of productivity increases and has often been the focus, both by policy makers and academics, of measuring innovation. However, an analysis of European innovative firms shows that almost half of these innovate without doing any R&D, for example through organisational or marketing innovations. In particular the least innovative countries have the highest shares on non-R&D innovators. It is therefore important to understand if there are different behaviours and needs between non-R&D and R&D innovators in order to improve the effectiveness of public policies to stimulate innovation.

2. European Innovation Scoreboard: Base Findings

2.1. Summary Innovation Index

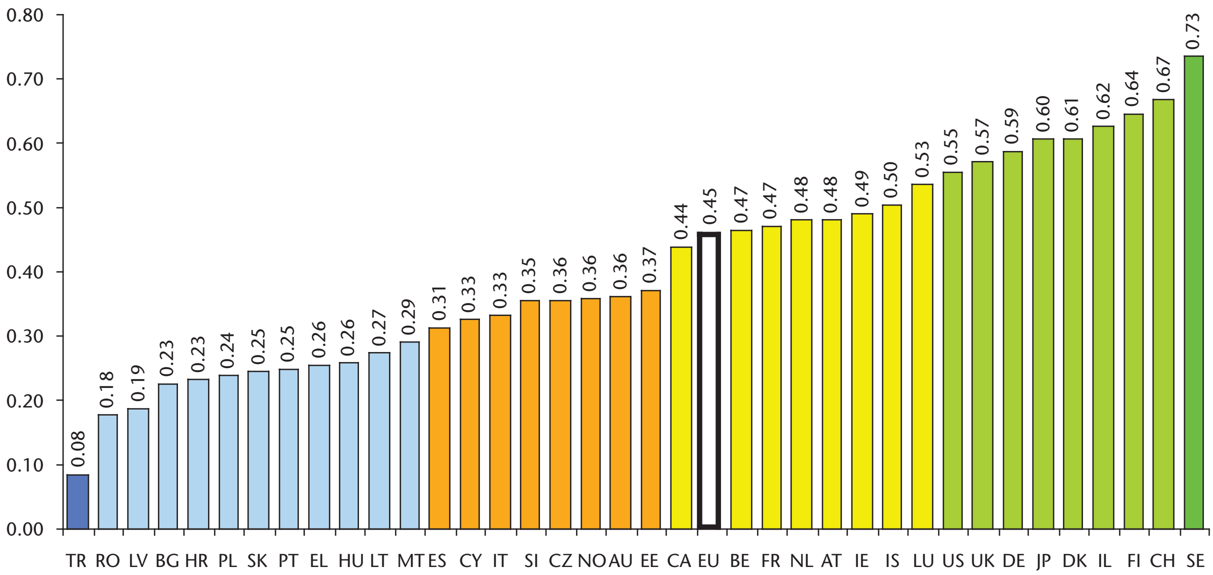
The Summary Innovation Index (SII) gives an 'at a glance' overview of aggregate national innovation performance. Figure 1 shows the results for the 2007 SII. For Australia, Canada, Croatia, Israel, Japan, Turkey and the US the SII is an estimate based on a more limited set of indicators. The relative position of these countries in Figure 1 should thus be interpreted with care[1].

The SII is calculated using the most recent statistics from Eurostat and other internationally recognised sources as available at the time of analysis, as shown in Annex A[2]. International sources have been used wherever possible in order to improve comparability between countries[3]. It is important to note that the data relates to actual performance in years previous to 2007 as indicated in Annex B[4]. As a consequence the 2007 SII does not capture the most recent changes in innovation performances, or the impacts of policies introduced in recent years which may take some time to impact on innovation performance.

Based on their SII scores the countries can be divided into the following groups[5]. This grouping also takes account of performance over a 5 year time period in order to increase robustness.

- Sweden, Switzerland, Finland, Israel, Denmark, Japan, Germany, the UK and the US are the *innovation leaders*, with SII scores well above that of the EU27 and most other countries. Sweden has the highest SII of all countries, but its leading position is mostly based on strong inputs.
- Luxembourg, Iceland, Ireland, Austria, the Netherlands, France, Belgium and Canada are the *innovation followers*, with SII scores below those of the innovation leaders but equal to or above that of the EU27.

Figure 1: The 2007 Summary Innovation Index (SII)



[1] The Technical Annex (section 7.2) provides more details.

[2] Data as available on 18 October 2007. More recent data which might have become available after 18 October 2007 could not be included due to the time constraint in the publication scheme of the EIS.

[3] The EU Member States, Iceland and Norway are fully covered by Eurostat. For these countries only data from international sources are used. For the other countries data from other, sometimes national, sources are also used in order to improve data availability for these countries.

[4] In the large majority of cases (almost 90%) data is from 2004, 2005 or 2006.

[5] These country groups were determined using hierarchical clustering techniques (with between-groups linkage using squared Euclidean distances as the clustering method) and SII scores for 5 years between 2003 and 2007.

- Estonia, Australia, Norway, Czech Republic, Slovenia, Italy, Cyprus and Spain are the *moderate innovators* with SII scores below that of the EU27.
- Malta, Lithuania, Hungary, Greece, Portugal, Slovakia, Poland, Croatia, Bulgaria, Latvia and Romania are the *catching-up countries*. Although their SII scores are significantly below the EU average, these scores are increasing towards the EU average over time with the exception of Croatia and Greece. Turkey is currently performing below the other countries included in the EIS.

2.2. Key dimensions of innovation performance

As in previous EIS reports, the 25 innovation indicators in the 2007 EIS have been classified into five dimensions to better capture the various aspects of the innovation process[6]. *Innovation drivers* measure the structural conditions required for innovation potential, *Knowledge creation* measures the investments in R&D activities, *Innovation & entrepreneurship* measures the efforts towards innovation at the firm level, *Applications* measures the performance expressed in terms of labour and business activities and their value added in innovative sectors, and *Intellectual property* measures the achieved results in terms of successful know-how.

Figure 2 shows the ranking of countries and for each of the 5 dimensions, from worst to best performer. Countries and groups generally perform at a comparable level in each of these dimensions but with some noteworthy exceptions.

The *innovation leaders* are among the best performers in all 5 dimensions. However, Germany is performing relatively worse in Innovation drivers, Denmark in Knowledge creation and in Applications and the UK in Intellectual property. Sweden's overall innovation leadership is based on its exceptional performance in the three dimensions capturing innovation inputs, but Sweden's performance in the two dimensions capturing innovation outputs is not as good. Of the newly added countries, we observe that Israel is a strong performer in Innovation drivers, Knowledge creation and Applications, but that Intellectual property is a relatively weakness.

The *innovation followers* are above average performers in almost all cases. However, Luxembourg is performing relatively worse in Innovation drivers, the Netherlands in Innovation & entrepreneurship and in Applications and Austria in Applications. Iceland is performing relatively well in Knowledge creation and Luxembourg in Intellectual property.

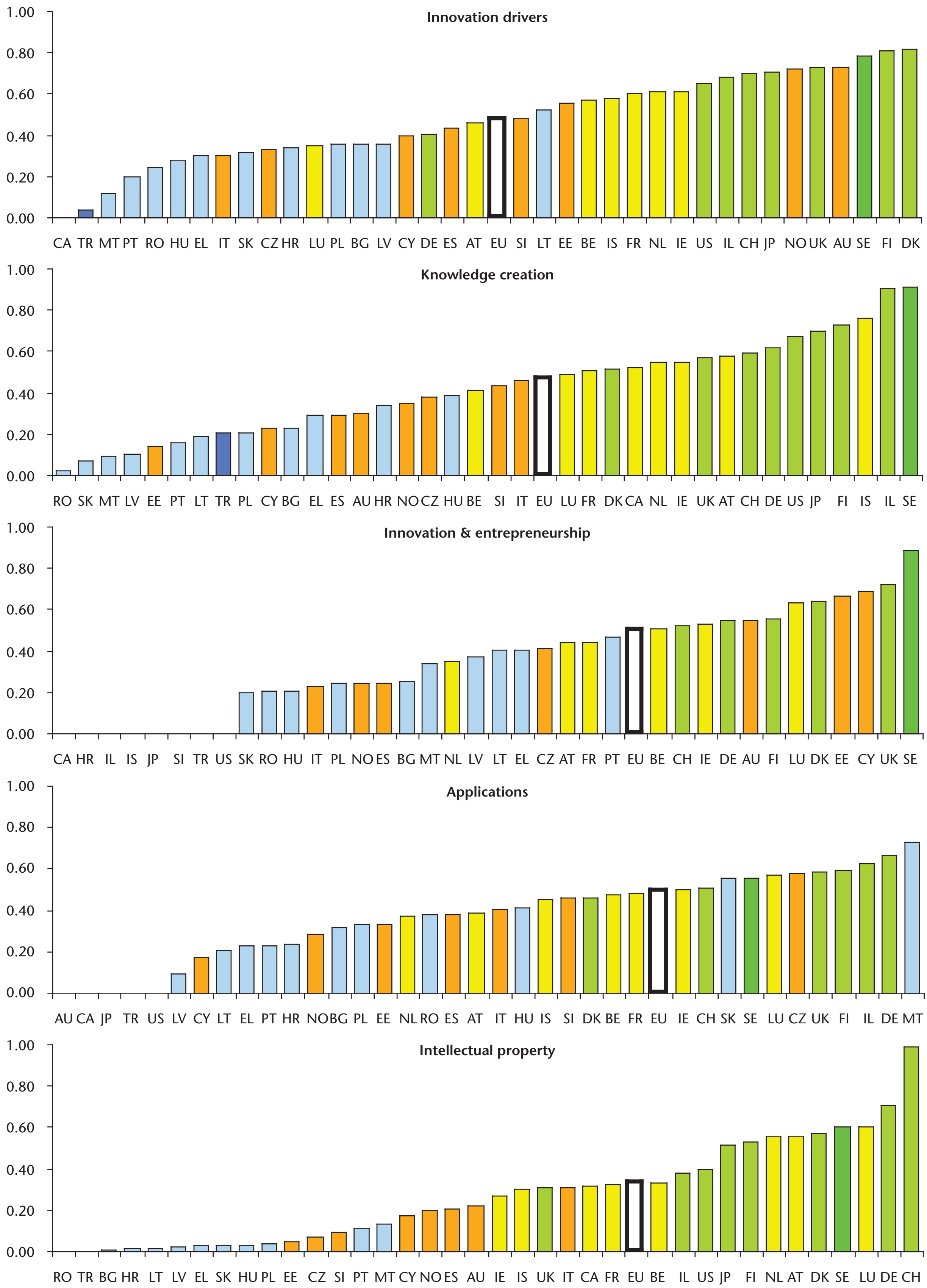
The *moderate innovators* are close to or below average across the dimensions. However, Norway is performing relatively well in Innovation drivers, Cyprus and Estonia in Innovation & entrepreneurship and Czech Republic in Applications. Performance is relatively worse for Italy in Innovation drivers and Innovation & entrepreneurship, Estonia in Knowledge creation and Cyprus in Applications. The relative gap between the moderate innovators and innovation leaders tends to be greatest in Intellectual Property. Of the newly added countries, Australia shows relatively strong performance in Innovation drivers and Innovation & entrepreneurship, but performance in Knowledge creation and Intellectual property is relatively weak. For Canada only information for two of the dimensions is available, showing about the same relative moderate performance.

The *catching-up countries* are below EU average in all of the dimensions with the noticeable exception on Applications where Malta has the highest ranking and Slovakia ranks above some innovation leaders. In both cases these countries score highly on sales of new to market products, which may be a reflection of the relatively small markets that companies in these countries operate within. In both cases the high ranking on Applications is also partly due to the structure of their economies as Malta has high exports of high technology products and Slovakia a high share of employment in medium-high and high tech manufacturing. Although Turkey's overall performance is below that of EU Member States, it has a stronger performance than some Member States on Knowledge creation[7].

[6] These dimensions were introduced in the EIS 2005. Details can be found in the 2005 Methodology Report: http://www.proinno-europe.eu/extranet/admin/uploaded_documents/EIS_2005_Methodology_Report.pdf

[7] Turkey's performance may not be accurately reflected in the Intellectual property dimension as it does not have the same 'home advantage' for EPO patents and Community designs and trademarks as the EU Member States have.

Figure 2: Innovation performance per innovation dimension[8]



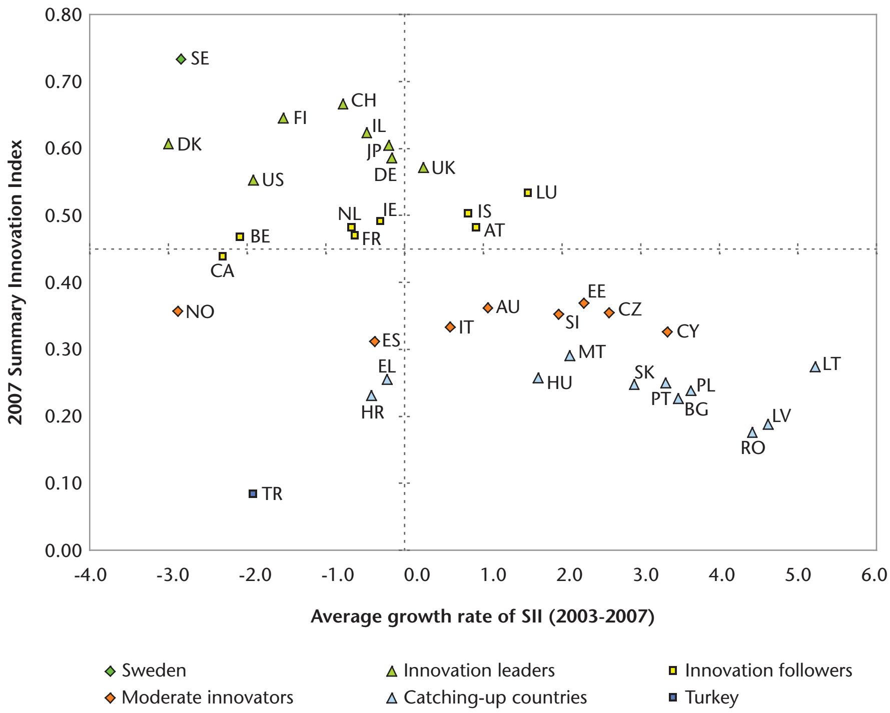
Colour coding is conform the groups of countries as identified in Section 2.1: bright green is Sweden, green are the innovation leaders, yellow are the innovation followers, orange are the moderate innovators, blue are the catching-up countries, dark blue is Turkey.

[8] For Innovation drivers CA is not ranked due to missing information. For Innovation & entrepreneurship CA, HR, IL, IS, JP, SI, TR and US are not ranked due to missing information. For Applications AU, CA, JP, TR and US are not ranked due to missing information. See Annex A. For Intellectual property scores for RO and TR are too small to be shown in the figure.

An important result from this analysis is that the innovation leaders and the innovation followers have a relatively even and strong performance across all five dimensions of innovation[9]. This tends to indicate mature innovation systems, although in all cases there are areas of relative weakness that require attention. In contrast, the moderate innovators and catching up countries tend to have a less even performance across the five dimensions, indicating that these countries may need to correct the imbalances in their innovation systems if they are to progress to higher levels of performance (Figure 3).

Figure 3: Convergence in innovation performance

Current performance as measured by the SII is shown on the vertical axis. Relative to EU growth performance of the SII is shown on the horizontal axis. This creates four quadrants: countries above both the average EU trend and the average EU SII are forging ahead from the EU, countries below the average SII but with an above average trend performance are catching up, countries with a below average SII and a below average trend are falling behind, and countries with an above average SII and a below average trend maintain their lead but are growing at a slower rate.



Dotted lines show EU performance.

[9] As demonstrated in the EIS 2005 Thematic report on Strengths and Weaknesses, a well-rounded and equivalent performance on all dimensions increases overall innovation performance.

3. Convergence in Innovation Performance between EU Member States

3.1. Overall process of convergence

Figure 3 shows current innovation performance as measured by the SII on the vertical axis against short-run trend performance of the SII on the horizontal axis[10]. There is a *process of convergence* in innovation performance in Europe with most Member States with below average performance having positive trends. Most of the moderate innovators and catching-up countries are closing the gap with the EU and the innovation leaders and followers. The innovation leaders and followers are experiencing a relative decline in their innovation lead. Notable exceptions include Luxembourg which combines a moderate level of performance which a high SII growth rate; Spain, Greece and Croatia which all have relatively low SII growth rates; and Norway and Turkey which are experiencing very low SII growth rates. The following section will analyse in more detail if this overall process of convergence is taking place between and/or within the four identified country groupings.

3.2. Stable membership of country groups

As set out in Section 2.1, countries have been classified into different innovation groups based on their SII scores over a 5-year period. Changes in group membership within the 5-year period of time are shown in Figure 4. Group memberships are largely stable but we do see some changes:

- Luxembourg is in the process of moving from the innovation followers to the innovation leaders;
- Cyprus and Malta have moved from the catching-up countries to the moderate innovators;
- Latvia and Romania are first part of a cluster with Turkey and then moved to the catching-up countries.

Cluster membership (Figure 4) is more stable than the ranks of countries; ranks within a cluster are far from stable, as shown by for example Belgium in the cluster of innovation followers and the US in the cluster of innovation leaders. These results show that one should not focus too much on changes in rank from one year to the next within the same cluster. It is better to focus on cluster membership and the countries within the same cluster and to identify for each country peer countries. This is consistent with the Strengths and Weaknesses report of 2005 where peer countries were identified based on comparable relative performance levels.

3.3. Convergence between country groups

The previous section showed that despite the general process of convergence, cluster membership is stable over time. This suggests that the observed convergence is a general trend rather than the result of exceptional single countries' developments. This can be shown by plotting the evolution of the innovation performance of the different clusters (upper half of Figure 5. We observe increasing relative performance for the catching-up countries and the moderate innovators, stable relative performance for the innovation followers and declining relative performance for the innovation leaders. Convergence between the country groups is shown in the lower half of Figure 5 where the differences in the cluster SII scores have been plotted over time. The results show a strong process of convergence

[10] The Technical Annex (section 7.3) provides more details.

taking place between the innovation leaders, innovation followers and moderate innovators. There is also some convergence between catching-up countries and moderate innovators. We can estimate the theoretical time of convergence for each of these processes using a simple linear approach which will be discussed in Section 3.4. On this simplified basis, it would take almost 30 years for the catching-up countries to close the gap with the moderate performers, and almost 40 years for the latter to close the gap with the innovation followers and about 25 years for the latter to close the gap with the innovation leaders. In conclusion one can see that convergence between clusters is taking place, but it is likely to take many years before this convergence process is completed.

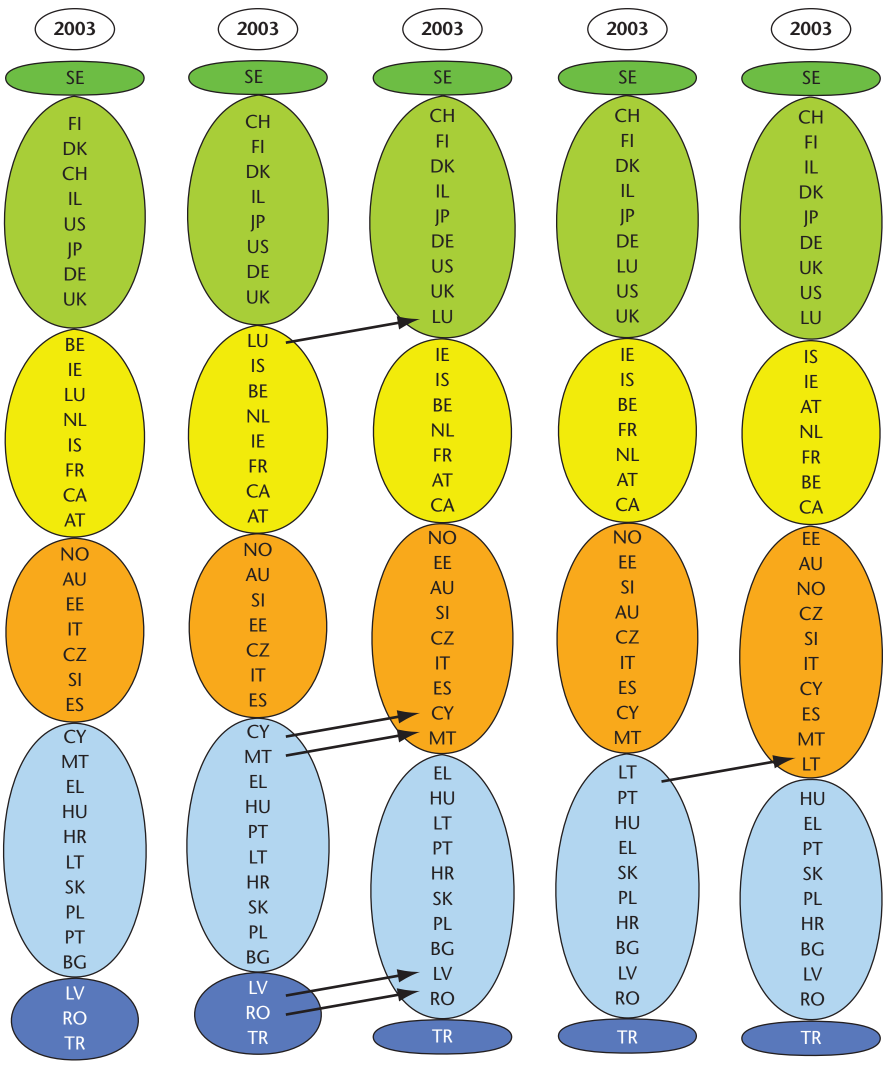
3.4. Expected time to convergence

Using a simple linear extrapolation of current performance levels and growth rates[11], an estimate can be made for how many years it would take countries to either catch up or decline to the EU average level of performance based on current trends. Figure 6 shows the estimated number of years to catch up to or decline to the EU average for European countries only. For 4 of the moderate innovators and catching-up countries a short-term convergence to the EU average performance level could be expected in about 10 year's time. These countries are Estonia, Czech

Figure 4: Cluster membership over time

Colour coding is conform the groups of countries as identified in Section 2.1: bright green is Sweden, green are the innovation leaders, yellow are the innovation followers, orange are the moderate innovators, blue are the catching-up countries, dark blue is Turkey. The ordering of the countries follows the rankings of their SII score for that year (see Annex D).

These country groups were determined using hierarchical clustering techniques (with between-groups linkage using squared Euclidean distances as the clustering method) and SII scores for each year between 2003 and 2007. Cluster results for 2007 as shown in other sections of the EIS 2007 report were determined using SII scores for 5 years between 2003 and 2007 and thus differ from those shown in Figure 3 where the cluster results are for SII scores for 2007 only. Hence LU, LT and MT are in different groupings based on their 2007 SII than for the 5 year period shown in Figure 1.



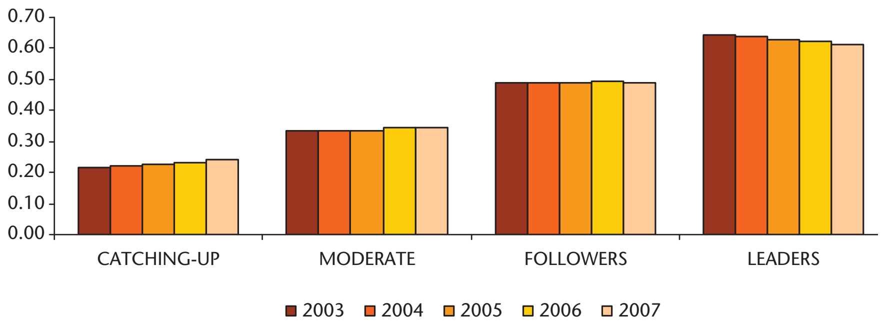
[11] The Technical Annex (section 7.4) provides more details.

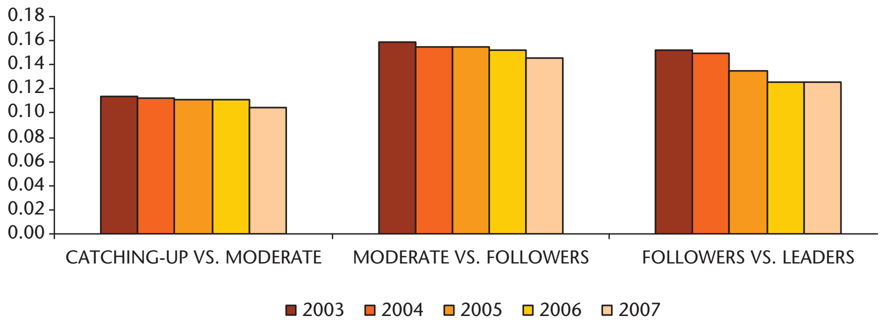
Republic, Lithuania and Cyprus. For Slovenia short-term convergence could be expected in about 15 year's time, for Poland, Portugal, Latvia, Bulgaria, Slovakia, Malta and Romania convergence would take at least 20 years. For Hungary and Italy the catching up process would take more than 30 years. On the other hand, countries like Belgium, France, the Netherlands and Denmark: these countries still show an average value of the SII above the EU average, but might regress to the EU average, possibly within the next 5 to 10 years, as the average EU performance increases faster than their individual innovation performance. Finally, based on this analysis, some countries seem to stay outside the convergence process (and are not therefore represented in the chart) as they are either moving away from the average in a negative direction (Spain, Greece, Croatia, Norway and Turkey) or in a positive direction (UK, Iceland, Austria and Luxembourg).

However, linear extrapolations of trends are likely to become less reliable over longer time periods, as maintaining the above EU growth rates will become more and more difficult when countries start to approach the EU average level of performance. A non-linear catching-up process was therefore modelled by assuming that the growth rate of each country would diminish over time[12]. The catching-up process now looks different, with only Estonia and the Czech Republic as likely candidates to complete their catching-up process in the short-run. Belgium, France and the Netherlands are still in danger of falling back to the average EU level of performance within a relatively short time period. While Sweden was predicted to fall back to the EU level in 17 years time using the linear approach, in the non-linear approach it would take more than 100 years.

Understanding how countries' innovation performance can change over time is one of the key future challenges identified in Section 6. The analysis conducted in this section shows that over a five year time period there has been a relatively stable grouping of countries, with each group at a different level of innovation performance. This finding points to the difficulty of bringing about major changes in overall innovation performance. This may be because innovation has many dimensions along which countries need to improve in order to increase their overall

Figure 5: Convergence between groups of countries





Average for moderate innovators does not include Australia, average for innovation followers does not include Canada and average for innovation leaders does not include Israel, Japan and the US.

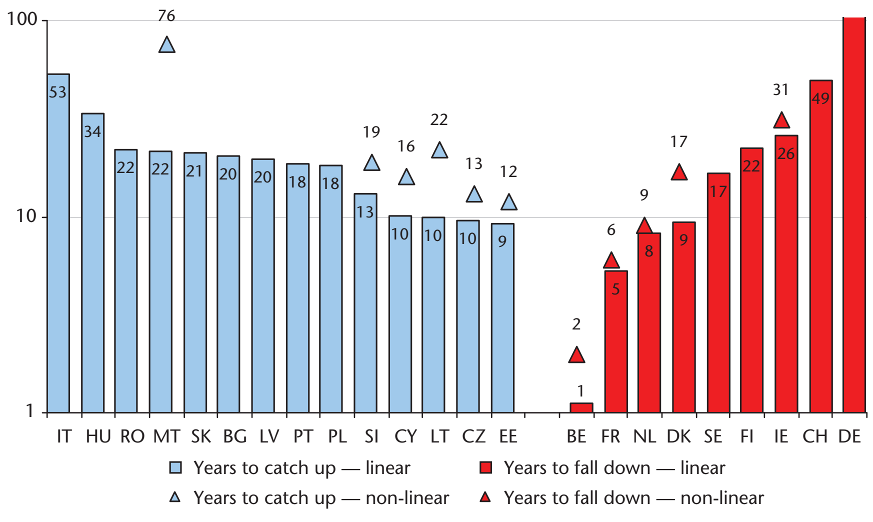
[12] The Technical Annex provides more details.

performance; but also because changing innovation performance simply takes time.

However, over a longer time period we do observe a more dynamic situation. First, there are some countries that appear to have made a transition between different levels of innovation performance and it would appear that some other countries are on track to making such a transition in future. Second, there appears to be a long-term trend towards convergence between the different groupings. If this continues, it may mean that the different groupings merge over time or alternatively it may lead to new patterns and trends emerging.

Figure 6: Time to catch up or fall back to EU average performance

For countries having either both above average SII and growth rates or both below average SII and growth rates, years to catch up could not be calculated as these countries are either expected to increase their lead, respectively gap, towards the EU (AT, EL, ES, HR, IS, LU, NO, TR AND UK). Time to catch up exceeding 100 years is not shown (linear: DE; non-linear: BG, CH, DE, FI, IE, HU, IT, LV, PL, PT, RO, SE, SK).



4. The EU Innovation Gap with the US and Japan

The data used for the 2007 EIS (Figure 7) shows that the US and Japan are still ahead of the EU, but the innovation gaps have been declining[13]. The EU-US gap has dropped significantly between 2003 and 2006 and shows a further but very modest reduction in 2007. The EU-Japan gap first increased in 2004 and then dropped more significantly between 2004 and 2006 and very modestly in 2007.

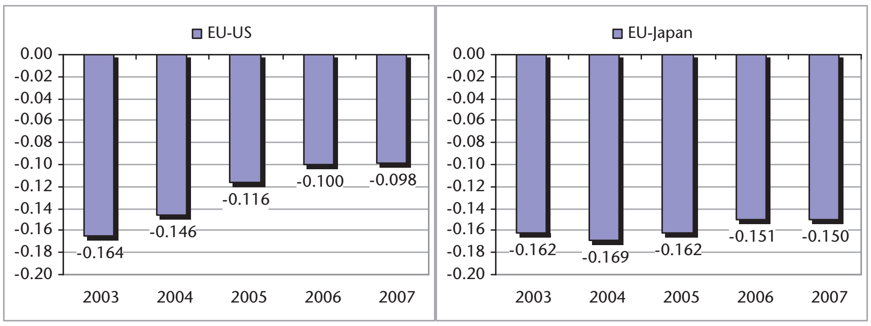
There are 15 indicators with full data for the US and EU, and of these the US performs better than the EU in 11 indicators (Table 1), while the EU scores above the US in 4 indicators (S&E graduates, employment in medium-high and high-tech manufacturing, community trademarks and community designs). Although the US is leading in 11 indicators, on 9 of these indicators the US is outperformed by at least one European country. Only in tertiary education and USPTO patents the US is performing better than any European country.

Japan performs better than the EU in 12 indicators, while the EU only scores above Japan in 2 indicators (community trademarks and community designs). Although Japan is leading in 12 indicators, on 9 of these indicators Japan is outperformed by at least one European country. Only in tertiary education, USPTO patents and triad patenting Japan is performing better than any European country.

For the EU, EU 'innovation leaders', US and Japan the latest available data are shown (cf. Annexes A and B). For indicator 3.4 for the EU and the EU 'innovation leaders' data for 2005 are used instead of the 2006 data as shown in Annex A. European early-venture capital data fluctuate on average by 150% between 2005 and 2006 turning a long-lasting EU-US gap suddenly in an EU-US lead assuming an the same US performance in 2006 as in 2005. Pending the release of 2006 US data showing the true nature of this possible lag reversal, we have adopted to compare performance levels in 2005.

Figure 8 shows those areas where there is an increasing or stable EU lead over the US, where there is a decreasing gap and where there is an increasing gap. The EU is experiencing a stable lead with the US in Community designs where it would be expected to have a home advantage over the US. The EU is increasing its lead in S&E graduates, medium-high and high-tech manufacturing employment and

Figure 7: EU Innovation Gap towards US and Japan



The vertical axis represents the difference between SII scores of EU and US and Japan respectively. SII scores are calculated using the re-scaled values for those indicators only for which data for the US respectively Japan are available. For the EU-US comparison these are the following indicators: S&E graduates, population with tertiary education, broadband penetration, public R&D, business R&D, share of medium/high-tech R&D, early-stage venture capital, ICT expenditures, high-tech exports, medium/high-tech manufacturing employment, EPO patents, USPTO patents, triad patent, trademarks and designs. For the EU-Japan comparison the same indicators are used except early-stage venture capital.

[13] A direct comparison of the 2003-2006 gaps shown in Figure 7 with those reported in the EIS 2006 report is not possible for several reasons. First, not for all indicators data has been updated with one year, for some indicators data either could not be updated or the update is for more than one year, so the gap shown for 2006 in Figure 2007 will be different from the gap shown in the EIS 2006 report. Second, last year the gap was calculated as the difference between the SII using all indicators, thus by comparing the SII for the EU with the estimated SII scores for the US and Japan. This year, in order to improve the comparability, the gap is calculated as the difference between the SII scores only using those indicators for which data are available for the US respectively Japan.

Community trademarks. For community trademarks a similar home advantage applies for Community designs, but here the EU is steadily increasing its lead from having about twice as many new Community trademarks in 2002 to more than 3 times as many new Community trademarks in 2006. The increase in the lead in S&E graduates and medium-high and high-tech manufacturing employment is more moderate.

The EU is experiencing a gap in all other indicators, but this gap is decreasing for the broadband penetration rate, early-stage venture capital[14], ICT expenditures and triad patents. The gap for the broadband penetration rate has almost disappeared in 2006, with the US having only about 10% more broadband lines per 100 population as compared to almost 100% in 2002-2003. The gap for ICT expenditures has also almost disappeared with the US GDP spending share on ICT only about 5% higher than that of the EU. For early-stage venture capital we first see an overall decline, but with some periods of increase which may reflect the cyclical nature of venture capital markets. Nevertheless the gap remains large, with the GDP share of early-stage venture capital still being more than 50% higher in the US. The gap for triad patents has been steadily decreasing since 2000, when the US had more than twice the amount of triad patents per million population. In 2006 the US still had 60% more triad patents per million population, the gap thus remains large.

Table 1: Differences in EU-US and EU-Japan Performance by Indicator

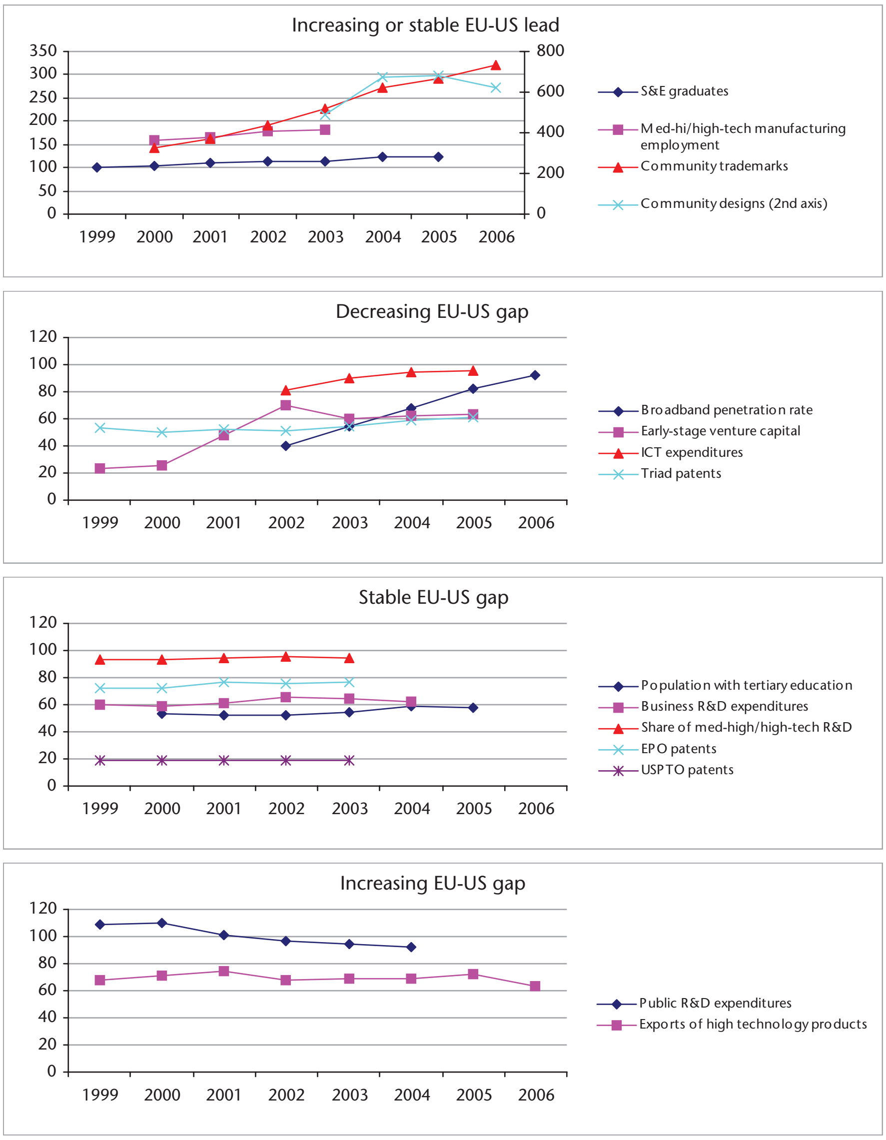
	EU	US	JP	European 'Innovation leaders'		
INNOVATION DRIVERS						
1.1 S&E graduates	12.9	10.6	13.7	IE (24.5)	FR (22.5)	LT (18.9)
1.2 Tertiary education	23.0	39.0	40.0	FI (35.1)	DK (34.7)	NO (33.6)
1.3 Broadband penetration rate	14.8	18.0	18.9	DK (29.6)	NL (29.0)	IS (28.1)
KNOWLEDGE CREATION						
2.1 Public R&D expenditures	0.65	0.69	0.74	IS (1.17)	FI (0.99)	SE (0.92)
2.2 Business R&D expenditures	1.17	1.87	2.40	SE (2.92)	FI (2.46)	CH (2.16)
2.3 Share of medium-high/high-tech R&D	85.2	89.9	86.7	SE (92.7)	DE (92.3)	CH (92.0)
INNOVATION & ENTREPRENEURSHIP						
3.4 Early-stage venture capital	0.022	0.035	–	DK (0.051)	UK (0.047)	FI (0.044)
3.5 ICT expenditures	6.4	6.7	7.6	BG (9.9)	EE (9.8)	LV (9.6)
APPLICATIONS						
4.2 High-tech exports	16.7	26.1	20.0	MT (54.6)	LU (40.6)	IE (28.9)
4.5 Employment in medium-high/ high-tech manufacturing	6.63	3.84	7.30	DE (10.75)	CZ (10.33)	SK (9.72)
INTELLECTUAL PROPERTY						
5.1 EPO patents	128.0	167.6	219.1	CH (425.6)	DE (311.7)	FI (305.6)
5.2 USPTO patents	49.2	273.7	274.4	CH (167.5)	FI (133.2)	DE (129.8)
5.3 Triad patents	19.6	33.9	87.0	CH (81.3)	DE (53.8)	NL (47.4)
5.4 Community trademarks	108.2	33.6	12.9	LU (902.0)	CH (308.3)	AT (221.5)
5.5 Community designs	109.4	17.5	15.2	DK (240.5)	CH (235.7)	AT (208.8)

[14] US data are available up until 2004, EU data up until 2005. Until 2004 the EU has been experiencing a lag which, as shown in Figure 8, has been decreasing. The early-stage venture capital performance of the EU improved with 150% in 2005, thus reversing this gap in a hypothetical lead as shown in Table 1 assuming that the US performance level in 2005 would remain unchanged.

The EU-US gap is stable for population with tertiary education, business R&D, medium-high and high-tech manufacturing R&D, EPO patents and USPTO patents. The gap is smallest for the share of medium-high and high-tech manufacturing R&D, but given the fact that most R&D expenditures in the manufacturing sector come from so-called high-tech and medium-high-tech manufacturing industries, it should not come as a surprise that these shares are almost equal in the US and the EU as both have similar R&D specialisation patterns. The EU is experiencing a gap in EPO patents despite its home advantage, and a large gap in USPTO patents where the US has a home advantage. The decreasing gap in Triad patents may therefore be a more important indicator. There is a large gap in business R&D expenditures, 1.17% of EU GDP as compared to 1.87% in the US which is not becoming smaller. The EU-US gap in the share of population with tertiary education is also large with almost 40% of US adults in 2005 having completed a tertiary education as compared to 23% in the EU in 2006. This gap might be an indicator of a relative shortage of the supply of advanced skills in Europe, but differences in US and European educational systems might lead to relatively overrated US scores on this indicator.

The EU-US gap is increasing in public R&D expenditures and exports of high-tech products. Up until 2001 the EU was leading in public R&D expenditures, but in

Figure 8: Convergence and Divergence in EU-US Innovation Gap



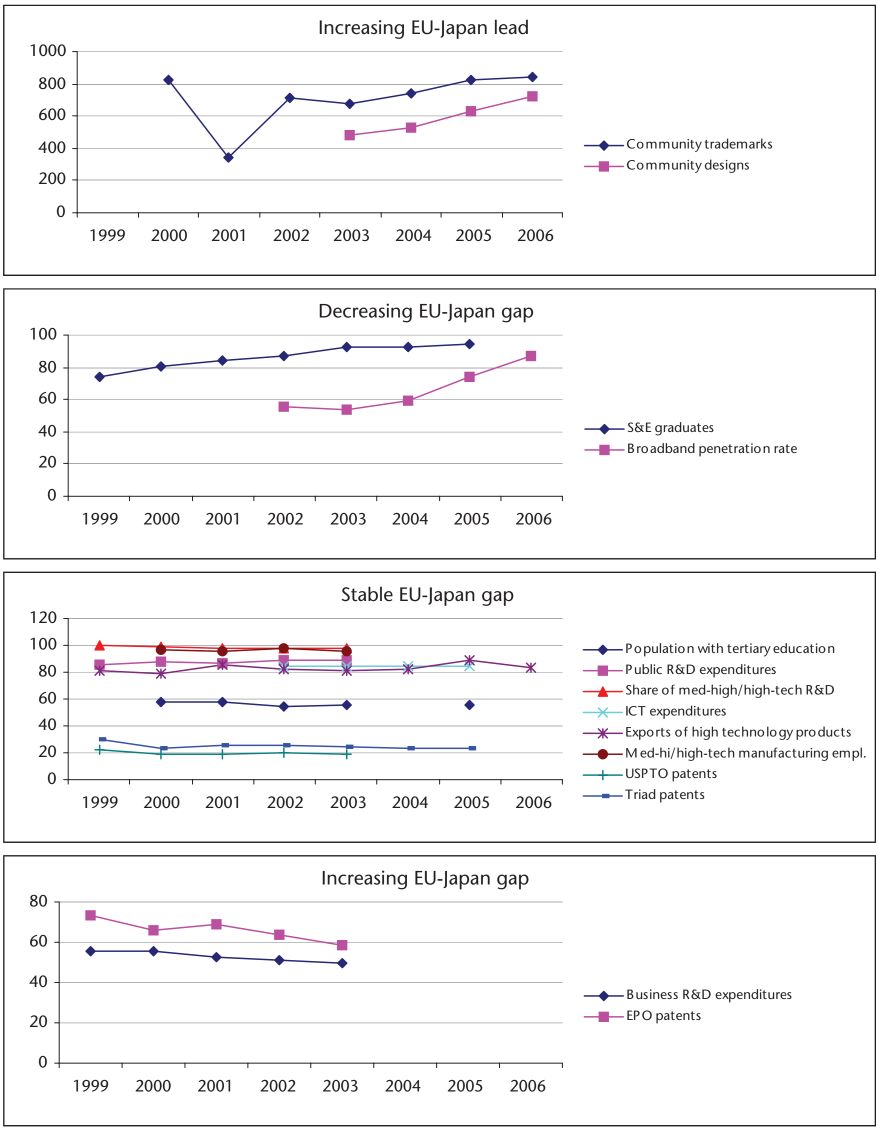
All values are relative to the US with the US = 100.

2002 this lead turned into a small but increasing gap. This switch in leadership was both caused by a decline in the public R&D intensity in the EU and an increase in public R&D intensity in the US, in particular by decreasing EU R&D expenditures and increasing US R&D expenditures in the government sector (GOVERD). The US is also increasing its lead in high-tech exports, in particular from 2005 to 2006.

The trends in the EU-Japan innovation gap show greater stability with no significant changes in the indicators for population with tertiary education, public R&D expenditures, medium/high-tech manufacturing R&D, ICT expenditures, exports of high-tech products, employment in medium/high-tech manufacturing, USPTO patents and triad patents. As is the case with the US, the EU is experiencing an increasing lead over Japan in Community trademarks and Community designs (Figure 9). The EU-Japan gap is decreasing in S&E graduates and broadband penetration. The share of S&E graduates is almost equal in the EU and Japan in 2006. Japan is still enjoying a lead in broadband penetration but this lead disappearing fast. The EU-Japan gap is increasing for business R&D expenditures and EPO patents.

Figure 9: Convergence and Divergence in EU-Japan Innovation Gap

All values are relative to Japan with Japan = 100.



5. Thematics

5.1. Innovation in services

This section provides a summary of the thematic paper on services innovation[15]. The services sector[16] is becoming more and more important in developed countries, both in terms of its share in total value-added or GDP and employment. On average, the services sector contributed to 40% of total EU25 employment in 2004 and to 46% of EU25 value-added. This contribution is over twice as large as the contribution of the manufacturing sector. Within the services sector, Knowledge Intensive Business Services (KIBS)[17] have attracted policy interest because of rapid rates of growth in some countries and because they are considered to be highly innovative. The relative economic contribution of KIBS has been increasing over time. The share of manufacturing value-added in real prices declined by 2.5% between 1999 and 2004 while the share of services sector value-added decreased by 0.3% and KIBS increased by 6.8%. Based on these trends and the larger contribution of services to the economy, KIBS are likely to be one of the main factors for future growth within the EU. The economic importance of services suggests that improvements in European living standards are likely to depend more on productivity improvements in the services sector than in manufacturing. This has been demonstrated for the US, where services contributed three-quarters of the increase in productivity after 1995[18]. Much of the productivity increase is due to different types of innovation, developed both in-house by service firms and from service firms adopting productivity enhancing innovations such as ICT.

Although both the economic weight of the services sector and the importance of service sector innovation to economic prosperity have been recognized for well over a decade, there has been a lag in the collection of European innovation statistics for services and in the development of innovation policies of relevance to service sector firms. There are partly good reasons for this. For instance, the manufacturing sector is the source of many of the technical product and process innovations that are adopted by services sector firms. However, a growing awareness of the role of non-technological innovation, software, and logistics in innovation has meant that the service sector is no longer (if it ever was) a passive adopter of manufacturing innovations. This is also leading to a rethink of European innovation policy and an evaluation of the steps that might be needed to remove or reduce the policy bias towards manufacturing[19].

A common concern is that innovation policy is not adequately serving the needs of service sector firms. By comparing innovation indicators for firms in the service and manufacturing sectors one can examine whether firms' responses to the CIS support this concern or not. This comparison indicates two areas where service firms' responses differ markedly from those of manufacturing firms: public procurement and support from innovation programmes. For three policy areas, support could be required under specific conditions: use of intellectual property, use of and access to public science, and availability of financing. For three areas there is no evidence to suggest that policy is biased against service firms: supply of qualified personnel, support for start-ups, and regulatory burdens. However, in

[15] http://www.proinno-europe.eu/index.cfm?fuseaction=page.display&topicID=282&parentID=51

[16] The Services Sector is defined as NACE classes G (Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods), H (Hotels and restaurants), I (Transport, storage and communication), J (Financial intermediation), and K (Real estate, renting and business activities). Not included are the services included in NACE classes L (Public administration and defence; compulsory social security), M (Education), N (Health and social work) and O (Other community, social and personal service activities) as these sectors are not covered by the Community Innovation Survey (CIS).

[17] KIBS includes Computer and related activities (NACE K72), Research and development (NACE K73), Architectural and engineering activities and consultancy (NACE K74.2) and Technical testing and analysis (NACE K74.3).

[18] Bosworth BP, Triplett, J. The early 21st Century US productivity expansion is still in services. *International Productivity Monitor*, No. 14, pp 3-19, Spring 2007.

[19] Examples include the report by the European Commission, *Staff working document on innovation in Services, 2007* and the report by the Expert Group on Innovation in Services, *Fostering Innovation in Services - Final Report*, 2007.

these areas the particular needs of services firms may differ from manufacturing firms even though the overall levels of concern are similar.

Another important concern for policy is whether innovation performance differs significantly between manufacturing and services sectors. Analyzing composite innovation indicators using CIS-4 data shows that several of the new Member States perform better on service sector innovation than on general innovation as measured by the Summary Innovation Index. The results suggest that innovative service sector firms in the new Member States could benefit as much from innovation as firms in more innovative countries, even though the nature of the 'innovation' could be very different. The results of an analysis of Knowledge Intensive Business Services (KIBS) provide no evidence that KIBS drive overall innovative performance, as measured by a change in the Summary Innovation Index. However, the KIBS share of total employment and value-added in 2004 is positively correlated with innovative performance on the 2006 Summary Innovation Index. This is probably because of the high level of innovative activity within KIBS itself, such as in software development. The lack of evidence for a driving role for KIBS could be due to a lack of data for many countries for NACE 73, which is a key KIBS sector that includes R&D services and high technology start-up firms.

A final important concern is whether current indicators properly capture services innovation. The Community Innovation Survey (CIS) is the main source of innovation indicators and was at first designed to measure technological innovation in the manufacturing sector. Over time improvements have been made to cover a large share, but not all, of the business services sector and improve questions dealing with both technological and non-technological innovation. But further improvements are needed to measure services innovation in the future, either through modifications to the CIS or through other surveys:

1. Research on service sector innovation (and on innovation in the manufacturing sector) would be considerably improved if disaggregated results were available for the CIS questions on firms introducing new or significantly improved goods and/ or services. Results for these two options could be used to obtain a better measure of the types of new products introduced both by manufacturing and service firms. Similarly, disaggregated results are needed on firms introducing new or improved methods of manufacturing or producing goods or services, new or significantly improved logistics, delivery or distribution methods, and new or improved supporting activities such as maintenance systems or purchasing operations.
2. CIS data are missing for far too many countries. Every effort should be made to ensure full coverage for all CIS questions.
3. All countries should be encouraged to survey NACE sector 73 to improve the measurement of innovation in KIBS.

Many other new indicators could be constructed using CIS data, such as a measure of new to market innovations that controls for large differences in what constitutes a 'market'[20].

5.2. Socio-economic and regulatory environment

This section provides a summary of the thematic paper on socio-economic and regulatory environment[21]. Economic growth is at the heart of increases in people's well-being. Innovation including technological progress is one of the main sources of economic growth. Variations in economic growth and well-being can be partially explained by variations in innovation performance. This section seeks to identify factors that can help explain why countries' innovation performance varies so markedly.

[20] See Arundel, A., Innovation Survey Indicators: What Impact on Innovation Policy?, in: *Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs*, OECD, September 2007.

[21] http://www.proinno-europe.eu/index.cfm?fuseaction=page.display&topicID=282&parentID=51

Previous EIS Thematic Papers — the NIS 2003 and EXIS 2004 report — have identified innovation categories and indicators which explained variations in innovation performance as measured by the Summary Innovation Index (SII). This section builds upon the findings of the NIS 2003 and EXIS 2004 report and extends the analysis to the 5 innovation dimensions as identified in the EIS: Innovation drivers, Knowledge creation, Innovation & entrepreneurship, Applications and Intellectual property. Based on the findings of the NIS 2003 report, the EXIS 2004 report, the World Economic Forum's 'Global Competitiveness Report 2006-2007' and the World Bank's 'Worldwide Governance Indicators' project 7 categories of 'policy indicators'

Table 3 Relative importance of socio-economic and regulatory environment for explaining differences in innovation performance

	SII	Innovation drivers	Knowledge creation	Innovation & entrepreneurship	Appli-cations	Intellectual property
DEMAND CONDITIONS						
Youth share						
Buyer sophistication		+				
Government procurement	++			+		
Demanding regulatory standards	++					
SOCIAL CAPITAL						
Trust	+++	+++		++		+
Perception of corruption	+++	++		+++		
INSTITUTIONAL FRAMEWORK						
Burden of administration	+	++		++		
Quality of educational system	+			+		
Intellectual property protection	+					
Price stability	++					++
MARKET EFFICIENCY						
Intensity of local competition	++			+	+	
Foreign ownership restrictions	+				++	
Flexibility of wage determination	++	+++				
Financial market sophistication						
TECHNOLOGY FLOWS						
Brain drain						
Firm-level technology absorption	+++			+++	++	+
University-industry research collaboration	+++	++	+	+++	+	
SOCIAL EQUITY						
Social protection expenditure						
Income equality	++		++		+++	
Employment rate		++		+++		
(INNOVATION) GOVERNANCE						
Voice and accountability						
Political stability	+			+		
Government effectiveness	+	+++		+		
Regulatory quality	+	+		+		
Rule of law					+	
Control of corruption	+					

+++: Strong correlation between variation in indicator and innovation performance; ++: Moderate correlation; +: Weak correlation.

have been identified covering 26 indicators. The explanatory power of each of these on the five different innovation dimensions was explored using linear regressions controlling for differences in per capita GDP[22]. Table 3 summarises for each of the innovation dimensions the explanatory power of the indicators.

The main conclusions of the analysis are as follows. The two categories that seem to correlate best with differences in overall innovation performance are social capital and technology flows. These categories are also highly significant for the Innovation & entrepreneurship aspect of innovation performance. This is important because this aspect is not highly correlated with GDP, meaning that factors other than overall income level are important in determining country performance. This finding suggests that policies that build trust and collaboration — such as promoting innovation networks and collaborations — should be relevant for countries at various income levels that under perform on innovation and entrepreneurship.

Social capital and technology flows are also highly correlated with innovation drivers, but in this case the causality may be in the other direction. For example investments in innovation drivers (education, public research, broadband access) may help build social capital which in turn improves technology flows and innovative performance.

The other five categories investigated also appear to have some influence on overall innovation performance, but here the linkages are less clear. Within the demand category, the indicators for government procurement and demanding regulatory standards appear to be most important, suggesting an important role for government in raising innovation performance through these mechanisms. These indicators are not strongly correlated with any of the innovation dimensions, suggesting that their impact is diffused over different parts of the innovation process.

Most indicators of market efficiency and the institutional framework have some correlation with differences in innovation performance, of which price stability, intensity of local competition and flexibility of wage determination appear to be the most important. This result might be related to the importance of macroeconomic stability and strong competition for raising innovation performance. The indicator for burden of administration is particularly correlated with the innovation drivers and innovation & entrepreneurship dimensions, suggesting the need for governments to reduce administrative burdens in order to foster innovation and entrepreneurship.

The result for flexibility of wage bargaining is more curious, particular as it is most strongly correlated with the innovation drivers dimension of innovation performance. Linked to this, the indicators of social equity also correlate relatively strongly with some dimensions of innovation performance, with the notable exception of social protection expenditure. There are no clear cut causal explanations for this, but it is consistent with earlier work (e.g. NIS paper) and could warrant further examination.

There are some correlations between indicators of governance and overall innovation performance. This is particularly the case between government effectiveness and innovation drivers, and to some extent for explaining differences in innovation and entrepreneurship[23].

It is noticeable that relatively few of the indicators correlate with the applications dimension of innovation performance (which includes employment in high tech services, exports of high tech products, sales of new to firm and of new to market

[22] Correlation analyses show that innovation performance measured by the SII and innovation performance in each of the innovation dimensions correlates moderately to highly with the level of per capita GDP. By controlling for variations in per capita GDP, we minimize the risk of so-called spurious correlations where two unrelated occurrences would show a significant correlation coefficient due to the a third, unseen factor, i.e. per capita GDP, which is correlated with each of the two occurrences.

[23] See Celikel Esser, F. 2007, 'The Link between Innovation Performance and Governance', JRC Scientific and Technical Reports (JRC42104), for an analysis between innovation and governance for a sample including many more non-EU countries.

products, and employment in medium high and high tech manufacturing), particularly as this is the dimension which is least correlated with GDP. The most highly correlated indicator with applications is that for income equality. One possible explanation might be that more equal societies have a higher demand for innovative products and services, i.e. that income equality creates innovation friendly demand conditions. Another explanation is that this dimension of innovation performance is the most difficult to measure, and hence improvements in the indicators are needed before causal factors can be properly identified.

5.3. Innovation efficiency: linking inputs to outputs

This section provides a summary of the thematic paper on innovation efficiency[24]. Following the Lisbon strategy and the Barcelona target of an R&D intensity of 3% in 2010, many countries have taken steps to increase their innovation efforts. Innovation efficiency is related to the concept of productivity. Higher productivity is achieved when more outputs are produced with the same amount of inputs or when the same output is produced with less input. Innovation efficiency will here be defined similarly: innovation efficiency is improved when with the same amount of innovation inputs more innovation outputs are generated or when less innovation inputs are needed for the same amount of innovation outputs. Although innovation is not a linear process where inputs automatically transfer into outputs, it is worthwhile to examine differences in efficiency by assuming that efficiency can be defined as the ratio of outputs over inputs. In the EIS the indicators are divided into 3 innovation input dimensions covering 15 indicators and 2 innovation output dimensions covering 10 indicators[25]. Innovation efficiency will be measured by comparing the ratio between the composite indicator scores for one or more input dimensions and one or more output dimensions. Inputs and outputs can be plotted in a multidimensional space where the most efficient performers will be on or close to the 'efficiency frontier'. The larger the distance to this frontier, the smaller will be the level of innovation efficiency[26]. In a two-dimensional graph with inputs on one axis and outputs on the other axis, the frontier can be visualised as the envelope curve connecting those dots with the most efficient output/input ratios.

In our analysis we have employed a constant-returns-to-scale output-oriented DEA (Data Envelopment Analysis[27]) on all combinations of the 3 input and 2 output dimensions. Missing values have been imputed using the techniques used in the 2005 EIS Methodology Report. The analyses were done separately for the most innovative countries (Sweden, the innovation leaders and innovation followers) and for the least innovative countries (moderate innovators and catching-up countries). Average efficiency scores for both output dimensions are shown in Figure 10.

All *innovation leaders* except Sweden have above average efficiency in transforming inputs into Applications. Despite its overall leadership in innovation performance, Sweden has the lowest efficiency in Applications of these countries indicating that despite its very good overall performance it has room to make improvements here. Germany and Switzerland show high efficiency in generating Intellectual property. Some of the innovation leaders, in particular the UK, have relatively low efficiency in transforming inputs into Intellectual property outputs. This may because the type of their innovation activities does not lead to formal IPRs but it could also indicate that these countries could be creating more IPRs for their level of inputs.

[24] http://www.proinno-europe.eu/index.cfm?fuseaction=page.display&topicID=282&parentID=51

[25] Intellectual property, one of the output dimensions, can also be seen as an intermediate dimension with the revenues earned from the use of patents, trademarks and designs in the production process or the licensing of these representing the final output.

[26] For an introduction into and more detailed discussions of efficiency measures see Coelli, Timothy J., D.S. Prasada Rao, Christopher J. O'Donnell and George E. Battese, 'An Introduction into Efficiency and Productivity Analysis', Springer, 2de edition, 2005.

[27] 'DEA involves the use of linear programming methods to construct a non-parametric piece-wise surface (or frontier) over the data. Efficiency measures are then calculated relative to this surface.' (Coelli et al., 2005, p.162).

The *innovation followers* have above average efficiency in transforming inputs into Applications, with Luxembourg and Belgium showing highest efficiency rates. Only Austria, the Netherlands and Luxembourg show above average efficiency in Intellectual property, and hence Belgium, France and Iceland could seek to improve their efficiency rates by generating more IPRs from their innovation inputs.

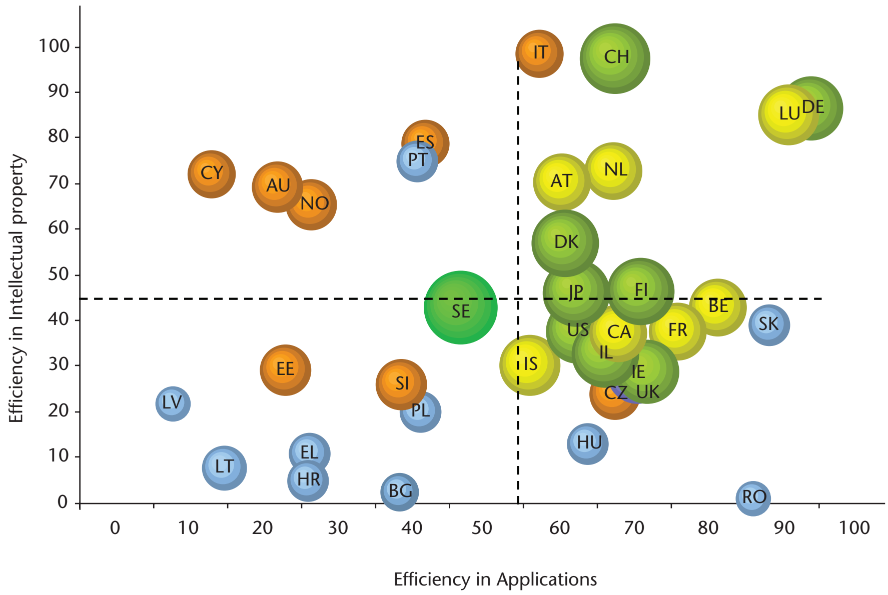
The *moderate innovators* show a range of different efficiencies: we find these countries in all four quadrants in Figure 10 combining above or below average efficiency performance. Italy combines above average efficiency scores in both output dimensions. This result suggests that it may be difficult for Italy to improve its innovation performance without increasing innovation inputs. Australia, Cyprus, Norway and Spain show above average efficiency in Intellectual property[28] and the Czech Republic shows above average efficiency in Applications. Estonia and Slovenia combine below average efficiency in both Applications and Intellectual property.

The *catching-up countries* also show a variety of efficiencies in transforming innovation inputs into Applications. On Intellectual property efficiency all countries are significantly below average with the exception of Portugal. This may be because IPR is of less relevance for the innovative activities of these countries or that there is the potential to generate higher levels of IPR from the existing inputs. Some of these countries are also still in a process of replacing national patent applications by EPO patent applications. For Slovakia and Romania the efficiencies for Applications are relatively high, suggesting that these countries need to increase inputs to increase performance in generating more Applications. The majority of catching up countries have below average efficiencies and this suggests that for these countries an important focus should be improving innovation efficiencies.

Based on their relative position in Figure 10, peer countries in efficiency terms can be identified as those countries with higher efficiency scores in either Applications or Intellectual property. For example, Austria's possible peer countries include Germany, Luxembourg, the Netherlands and Switzerland, which combine higher efficiency scores in both Applications and Intellectual property. The innovation

Figure 10: Efficiencies between innovation inputs and application and intellectual property outputs

Colour coding is conform the groups of countries as identified in the EIS 2007: bright green is Sweden, green are the innovation leaders, yellow are the innovation followers, orange are the moderate innovators, blue are the catching-up countries. The size of the bubble gives the value of the 2007 Summary Innovation Index (SII). The dotted lines give the unweighted average of the efficiency scores for the EU27 Member States.



[28] We also have to keep in mind that the efficiency scores for the moderate innovators were calculated within the group of least innovative countries thus not including the innovation leaders and innovation followers.

policies implemented in these countries could be compared with those in Austria to identify options for policy improvements to increase the efficiency of transforming innovation inputs into outputs[29].

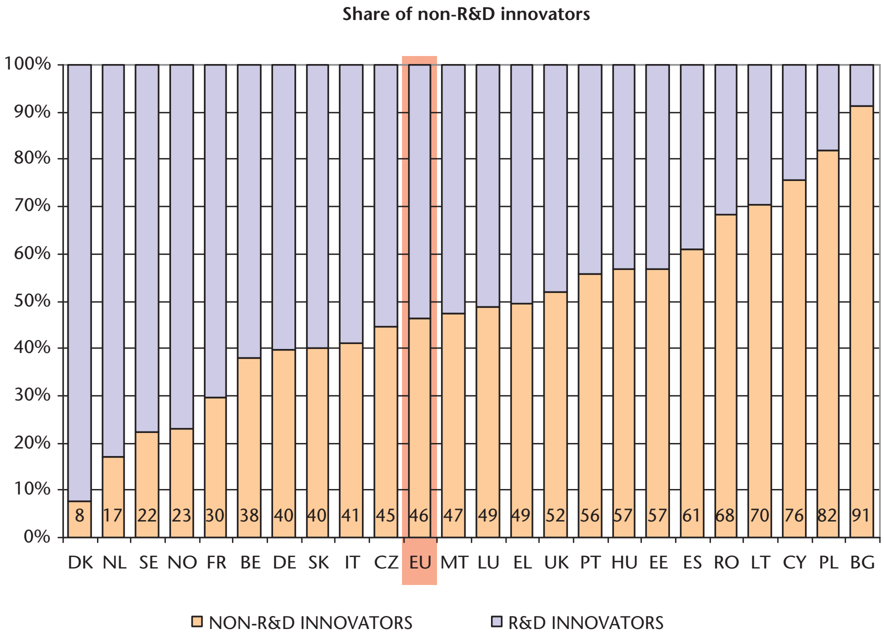
5.4. Non-R&D innovators

This section provides a preliminary summary of a forthcoming thematic paper on non-R&D innovators[30]. Until recently R&D has been synonymous with technology and innovation in many discussions on science, technology and innovation. Most support measures for innovation on the national and the EU level are for R&D activities. The Lisbon strategy, which aims to build Europe by 2010 the most competitive and dynamic knowledge-based economy in the world, incorporates a policy goal that the R&D expenditure in the European economies should reach 3 percent of GDP by 2010. As emphasized in the Lisbon strategy, R&D intensity is extensively used by scholars and policy makers as a benchmark for measuring the innovativeness of a firm, an industry, a region and a country.

There is no doubt about the importance of R&D: it is the source of many productivity enhancing innovations; it is essential to competitiveness in fast-growing high technology industries such as pharmaceuticals, it is critical to the absorptive capacity of a firm or an industry and is associated with terms of trade advantages of a country; and R&D activities create demand and supply for high skilled people which give impetus to the development of the education system in a country.

However, although R&D is vital for many innovation activities of firms and the competitiveness of an industry and a country, the Community Innovation Survey shows that almost half of the European innovators do not conduct intramural or in-house R&D (Figure 11). Such non-R&D innovation includes the purchase of advanced machinery and computer hardware specifically purchased to implement new or significantly improved products or processes, the purchase of rights to use

Figure 11: Share of innovators not performing R&D



Results based on CIS-4 data. R&D innovators are defined as all innovators performing in house or intramural R&D. Non-R&D innovators innovate by acquiring or by buying extramural R&D (i.e. R&D performed by other companies or research organisations), by buying advanced machinery, equipment and computer hardware or software, by buying or licensing patents and non-patented inventions, by training their personnel, or by spending resources on the design and market introduction of new goods or services.

[29] The INNO-Policy Trendchart provides a database of innovation policies, see http://www.proinno-europe.eu/index.cfm?fuseaction=page.display&topicID=52&parentID=52

[30] http://www.proinno-europe.eu/index.cfm?fuseaction=page.display&topicID=282&parentID=51 (forthcoming January 2008)

patents and non-patented inventions, licenses, know-how, trademarks and software, internal or external training activities for firm's personnel aimed at the development or introduction of innovations, and internal and external marketing innovations aimed at the market introduction of new or significantly improved products.[31] The shares of non-R&D innovators tend to be higher in the new Member States. Breaking down the data of non-R&D innovators by sector, we find that non-R&D innovators are concentrated in low technology manufacturing and service sectors. The distribution of these non-R&D innovators is also skewed towards small and medium sized firms (or SMEs).

Non-R&D and R&D innovators are similar and dissimilar. The effect on innovation activities on the performance of the enterprise is not that much different (Table 4), but non-R&D innovators do consider universities and government research institutes as less important sources of information for their innovation activities. Non-R&D innovators also introduce less products which are also new to their market and the share of non-R&D innovators receiving public support from their central government or the EU is less than half that of the R&D innovators. Both non-R&D and R&D innovators face almost the same barriers to innovation and share similar objectives of innovation. The fact whether or not a firm engages in R&D is still an extremely important firm characteristic from a policy perspective as R&D performers are the target of most policy actions. A failure to differentiate between non-R&D and R&D innovators reduces the effectiveness of both (academic) analyses of innovative firms and the effectiveness of public policies to stimulate innovation.

Given that a significant number of firms innovate without any R&D, non-R&D innovation activities should have drawn considerable attention from academics and policy makers. In fact, the Oslo Manual provides a broad definition of innovation in

Table 4 Differences between Non-R&D and R&D innovators

	Non-R&D innovators	R&D innovators	Ratio
Percentage of firms:			
Receiving funding from local governments	10	13	0.77
Receiving funding from central government	5	16	**0.33**
Receiving funding from the EU	3	8	**0.44**
Reported that information source was used for innovation:			
Internal sources — within the enterprise	75	92	0.82
Internal sources — other enterprises within the same group	16	28	0.59
Market sources — suppliers	70	77	0.90
Market sources — clients or customers	67	83	0.81
Market sources — competitors	61	72	0.85
Institutional sources — universities	21	45	**0.46**
Institutional sources — research institutes	15	31	**0.48**
Other sources — conferences, meetings	58	76	0.76
Other sources — fairs, exhibitions	68	81	0.85
Sales share due to:			
New to firm products	25	29	0.86
New to market products	5	10	**0.54**

Results based on CIS-3 data.

[31] Non-R&D innovation is not the same as non-technological innovation. The latter includes organisational and marketing innovations, where an organisational innovation is the implementation of new or significant changes in firm structure or management methods intended to improve a firm's knowledge, quality of goods and services or the efficiency of work flows and a marketing innovation is the implementation of new or significantly improved designs or sales methods intended to increase the appeal of goods or services or to enter new markets.

recognition of the facts that diffusion is crucial to realizing the economic benefits of innovation and that R&D only covers a part of all of the different methods that firms use to innovate. However, there is lack of systematic studies on other means that firms use to innovate and through research that links different types of innovation to performances of firms.

The Community Innovation Survey (CIS) collects only a limited amount of information on precisely how non-R&D innovators innovate. In order to provide more statistical information on how these firms innovators, the Innobarometer (IB) 2007 survey was performed to delve further into the methods used by non-R&D performing firms to innovate and to see if one of the methods is based on 'user driven' innovation. The forthcoming EIS thematic paper on non-R&D based innovation provides results based on an econometric analysis of the IB data.

Table 5: Changes in the European Innovation Scoreboard

	EIS 2000 (Pilot)	EIS 2001	EIS 2002	EIS 2003	EIS 2004	EIS 2005	EIS 2006	EIS 2007
Number of indicators	16	18	18	22	22	26	25	25
Dissimilarity with previous EIS		(28%)	3%	34%	14%	35%	4%	0%
Number of groups/dimensions	4	4	4	4	4	5	5	5
Indicators based on CIS	4	4	4	5	6	7	7	7
Summary Innovation Index	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Countries	17: EU15, US, JP	17: EU15, US, JP	33: EU25, US, JP, IS, NO, CH, BG, RO, TR	33: EU25, US, JP, IS, NO, CH, BG, RO, TR	33: EU25, US, JP, IS, NO, CH, BG, RO, TR	33: EU25, US, JP, IS, NO, CH, BG, RO, TR	34: EU25, US, JP, IS, NO, CH, BG, RO, HR, TR	37: EU27, US, JP, IS, NO, CH, HR, TR, AU, CA, IL
Input — Innovation drivers (EIS 2005)								
S&E (Science and Engineering) graduates	Share of post-secondary graduates	Share of population aged 20-29	←	←	←	←	←	←
Share of working-age population with tertiary education	←	←	←	←	←	←	←	←
Broadband penetration rate						←	←	←
Participation in life-long learning		←	←	←	←	←	←	←
Youth education attainment level						←	←	←
Input — Knowledge creation (EIS 2005)								
Public R&D expenditures (% of GDP)	GOVERD only	GOVERD + HERD	GERD — BERD	←	←	←	GOVERD + HERD	←
Business R&D expenditures (% of GDP)	←	←	←	←	←	←	←	←
Share of medium-high/high-tech R&D in manufacturing						←	←	←
Share of enterprises that receive public funding for innovation (CIS)						←	←	←
Share of university R&D funded by private sector						←		
Input — Innovation & entrepreneurship (EIS 2005)								
Share of SMEs innovating in-house (CIS)	Manufacturing sector	←	←	← + Services sector	Total business sector	←	←	←
Share of SMEs co-operating in innovation (CIS)	Manufacturing sector	←	←	← + Services sector	Total business sector	←	←	←
Innovation expenditures (% of turnover) (CIS)	Manufacturing sector	←	←	← + Services sector	Total business sector	←	←	←
Venture capital (% of GDP)	Early stage and expansion stage			Early stage only	←	←	←	←

ICT expenditures (% of GDP)	←	←	←	←	←	←	←	←
Share of SMEs using organisational innovations (CIS)					Using non-technological change	←	Using organisational innovation	←
High-tech venture capital		Share of GDP	←	←	Share of venture capital			
Internet use	Users per 100 population	Share of households	←	Composite indicator for households and firms	←			
Capitalisation of new markets (% of GDP)	←	←	←					
Volatility rates of SMEs				←				
Output - Applications (EIS 2005)								
Share of high-tech services employment	←	←	←	←	←	←	←	←
Share of high-tech exports						←	←	←
New-to-market products (% of turnover) (CIS)	Manufacturing sector	←	←	← + Services sector	Total business sector	←	←	←
New-to-firm products (% of turnover) (CIS)				Manufacturing + Services sector	Total business sector	←	←	←
Share of medium-high/high-tech manufacturing employment	←	←	←	←	←	←	←	←
Share of high-tech manufacturing value-added	Percent change	Share of value-added	←	←	←			
Output — Intellectual property (EIS 2005)								
EPO patents per million population				←	←	←	←	←
USPTO patents per million population				←	←	←	←	←
Triad patents per million population						←	←	←
Community trademarks per million population						←	←	←
Community designs per million population						←	←	←
High-tech EPO patents per million population	←	←	←	←	←			
High-tech USPTO patents per million population		←	←	←	←			

6. Future Challenges

Since the 2000 pilot report, seven full versions of the European Innovation Scoreboard have been published. The list and number of indicators has undergone major changes over time as highlighted in Table 5. The number of indicators has increased from 18 to 25 and those derived from the Community Innovation Survey from 4 to 7[32]. With major revisions in 2003 and 2005 (the dissimilarity percentages exceed 30 in both years), only 13 indicators feature in all Scoreboards. The number of countries has increased to 37, although actual data availability varies from very good (90% or more) for most EU27 countries, Norway and Switzerland, to good for Bulgaria, Cyprus, Latvia, Slovenia, UK and Iceland (between 75% and 90%), to moderate for US, Israel and Australia (between 60% and 70%) and to poor for Croatia, Turkey, Japan and Canada (less than 60%). The EIS indicators are grouped in different categories to capture key dimensions of the innovation process. In 2005 the current five dimensions were introduced. Overall innovation performance is captured by a composite index, the Summary Innovation Index, which has also been revised several times, most recently in 2005 following the EIS 2005 Methodology Report.

Current and past versions of the EIS and accompanying thematic papers have continuously tried to improve measurement of innovation performance by countries, sectors and regions. Future editions of the EIS will have to deal with a number of existing and new challenges under the following four headings:

- Measuring new forms of innovation
- Assessing overall innovation performance
- Improving comparability at national, international and regional levels
- Measuring progress and changes over time

Across these areas, there is a need to maximise the relevance and utility of the EIS for policy makers, programme managers, and the wider innovation community.

Measuring new forms of innovation

The changes in indicators and definitions of indicators used in the different EIS reports all reflect changes in our perception and understanding of the innovation process[33]. Innovation is a complex phenomenon where firms can use different models of innovation. Science-based innovation has been used by certain industries and large firms for a long time. Innovation and technological progress is here driven by firms by their new scientific discoveries. Innovation surveys were at first designed to measure science-based or R&D-based innovation. But new concepts of the innovation process have emerged. The model of user innovation, which was introduced in the 1980s, states that consumers and end users develop innovations. More recently the model of open innovation has emerged: companies can no longer rely on their own research but must instead combine own ideas and research with external research e.g. by buying licenses and other external knowledge. Many of the current EIS indicators are better suited to capture science-based innovation. Therefore, new indicators are increasingly required to better capture new trends in innovation as portrayed in the models of user and in particular open innovation, for example on measuring knowledge flows.

Services innovation is becoming more and more important as the relative size of the services sector in the economy is continuously increasing. Innovation in services may differ from that in manufacturing e.g. by greater use of marketing and

[32] Also see Arundel, A. and H. Hollanders, 'Innovation Scoreboards: Indicators and Policy Use', in C. Nauwelaers and R. Wintjes (eds.), Innovation Policy in Europe, Edward Elgar: Cheltenham, 2008 for a history of the EIS and a comparison with other (innovation) scoreboards.

[33] Alternative indicators and approaches to measure innovation were explored in two thematic papers in 2003 and 2004. The 2003 NIS thematic report investigated various structural and socio-cultural indicators and their impact on a country's innovation performance. The 2004 EXIS 2004 thematic report developed an alternative scoreboard with a focus on innovation at the firm-level including a more diverse range of non-technological innovative activities (e.g. market and organisational innovation). This approach is followed up in the 2007 thematic report on innovation and socio-economic and regulatory environment.

organisational innovation. Also service innovations may be increasingly prevalent within manufacturing sectors. Current statistics and innovation policies are biased towards measuring technological innovation and therefore new developments in both statistics and policies may be needed for better understanding and stimulating non-technological innovation.

To improve the measurement of new forms of innovation in future editions of the EIS we need to develop and implement new indicators measuring e.g. open innovation, user innovation and non-R&D innovation. New indicators can draw on new data, in particular the improved measurement on marketing and organisational innovation and services innovation in the latest editions of the Community Innovation Survey, but more improvements are needed to fully capture all innovation process in the European economies.

Assessing overall innovation performance

The EIS provides a composite index, the Summary Innovation Index, which summarises innovation performance by aggregating the various indicators for each country in one single number. The 2005 Methodology Report studied in detail alternative computation schemes for the SII, but recent developments in composite indicator theory may call for changes in the scheme. The SII transforms each indicator on a relative basis, i.e. each indicator is measured relative to the best and worst performing country. Some of the indicators are highly skewed, e.g. patent applications. The question emerges whether or not to transform the indicators as for many of the indicators the distribution of the data differ from the normal distribution on which composite indicator theory is based.

In addition, the EIS provides innovation performance by 5 groups of indicators, the innovation dimensions. This helps to capture the overall innovation environment in a country. But with the innovation process becoming more complex, new innovation dimensions may emerge which should be included in the EIS. The current EIS distinguishes between input and output indicators, with about 50% more indicators measuring innovation inputs then outputs. This is due to the greater number and maturity of many input indicators, such as R&D expenditures. But just as companies are more interested in their profits or the final results of their production activities, should the EIS not focus more in the future on measuring the outputs of the innovation process? And is it justified to classify the indicators in input and output indicators only or should be also introduce process or throughput indicators? In particular for the patent indicators it is questionable if these are true output indicators instead of input or process indicators.

Assessing innovation performance inherently also covers assessing the efficiency of the innovation process[34]. Countries can increase their innovation performance by improving the efficiency of their innovation process without having to increase their innovation inputs. It is essential to continue to improve the measurement of the level of innovation efficiency correctly and to identify areas of improvement, drawing on academic studies in this area?[35]

Countries also differ in their state of economic development, in their industrial specialisation patterns and in their need for innovation driving their current and future well-being. Clearly not all countries have to invest as heavily in innovation as some of the innovation leaders do; other strategies for improving economic well-being are more realistic for those countries relying on productivity improvements driven by increases in other production factors. How could differences in the industrial structure between countries be taken better into account when benchmarking their innovation performance? Should different measures of innovation performance be applied depending on the type and/ or level of innovative activity in a country?

[34] Cf. the first attempts to measure innovation efficiency in the EIS 2007 thematic report on innovation efficiency.

[35] Cf. Coelli, Timothy J., D.S. Prasada Rao, Christopher J. O'Donnell and George E. Battese, An Introduction to Efficiency and Productivity Analysis, Springer, 2nd edition, 2005.

Should the EIS include wider socio-economic factors? For example governance and market indicators could provide useful information for policy makers about the environment for innovation. Innovation as such is not a goal in itself, companies innovate to improve their performance and countries similarly innovate to improve their economic performance. Should the EIS include economic indicators as a second layer of output or outcome indicators to measure the effect of innovation on the economic performance of a country?

Improving comparability at national, international and regional levels

Comparability issues arise within the EU due to differences between Member States in methodologies or sampling methods for collecting their data. Some of the EIS indicators are subject to national contexts (e.g. what constitutes tertiary education) which makes cross country comparisons difficult. In addition, the indicator of early stage venture capital investments fluctuates greatly between different countries and different years and hence may affect the robustness of comparisons. Particular comparability difficulties arise in the Community Innovation Survey, where differences in the perception of innovativeness (e.g. the perception the sales share of new-to-market products) between countries may hamper the comparability of the results between the Member States. Further improvements are needed to ensure that differences in people's and firms' perception across Europe do not bias the comparisons of innovation performance.

In a globalising world, the EU needs to compare itself with emerging competitors and the EIS therefore may need to include more non-EU countries. For ensuring comparable benchmark results, data should be collected from harmonized databases supplied by international institutes as the OECD or the World Bank. There is also a need to eliminate biases between the EU and other regions in IP data, with EU Member States experiencing home advantages in EPO patents, Community trademarks and Community designs and the US in USPTO patents. Other comparability problems arise from the non-existence of innovation surveys in many non-EU countries or differences in the survey questions or methodologies between the EU countries and non-EU countries. How should the globalising EIS deal with these issues? Should it aim at including as many indicators as possible or select a core set of indicators for which data are available for all countries?[36]

At present, innovation at the regional level is captures in the Regional Innovation Scoreboard (RIS)[37] which attempts to use the same methodology as the EIS, but with significantly reduced data availability. The RIS is seriously hampered by the non-availability of regional CIS data and regional data for many of the other indicators. Data are not available as these are either not collected as such the national statistical offices (NSO) or they are considered to be unreliable due to sampling methods. Another problem arises from the location of the headquarters of a company and where the regional activities of a company are reported, at the respective region or at the headquarters' region? What could be done to improve data availability and its accuracy in assigning inputs and outputs to the correct geographical region?

Measuring progress and changes over time

The EIS is currently designed as a tool for comparing innovation performance across Member States and other countries. In the past there have also been country specific assessments. However, changes in innovation performance over time also need to be measured to allow countries and regions to monitor progress in their

[36] The latter approach was adopted in the EIS 2006 thematic report on Global Innovation Scoreboards:
http://www.proinno-europe.eu/doc/eis_2006_global_innovation_report.pdf
The GIS report is seriously hampered by the lack of CIS data for most non-EU countries and the use different non-harmonized databases as those used in the EIS complicating a direct comparison between EIS and GIS results.

[37] http://www.proinno-europe.eu/doc/eis_2006_regional_innovation_scoreboard.pdf

innovation performance and to analyse the impacts of innovation policies on aggregate performance. At the EU level, better measurement of changes in innovation performance over time could be used to further assess progress against national reform programmes under the Lisbon strategy, and to underpin the Open Method of Coordination approach whereby countries benchmark their performance and set voluntarily targets.

All of this requires a sound and robust measurement of innovation performance over time. The current EIS is constructed as a measure of relative changes in innovation performance vis-à-vis other countries in the sample, where, due to the observed general process of convergence, the best performing countries show a relative decline in their SII scores and the worst performing countries an increase in their SII scores. The overall policy-relevance of the EIS could improve if it also allowed to measure improvements in absolute innovation performance, creating opportunities for policy makers to use the EIS as a tool to set objectives, monitor performance and evaluate past policies so as to improve future innovation policies. In addition, there is currently a constraint in using the EIS to monitor progress due to the delays of several years in the availability of many indicators. Therefore ways should be explored to improve the timeliness of the indicators such that policy makers have more up to date measurements of performance.

Measuring the dynamics of innovation performance over time may also require new approaches, such as considering trends over longer time periods, whether time lags should be introduced for some input indicators, and whether it would be appropriate to model stocks of innovative capabilities that accumulate over time.

7. Technical Annex: Choice of Indicators and Methodology

7.1. Indicators

The European Innovation Scoreboard (EIS) covers the 27 EU Member States, Croatia and Turkey, the associate countries Iceland, Norway and Switzerland, as well as Australia, Canada, Israel, Japan and the US. The indicators of the EIS summarise the main elements of innovation performance.

In 2005, the EIS has been revised in collaboration with the Joint Research Centre[38]. The number of categories of indicators was increased from four to five and the set of innovation indicators was modified and increased to 26. The EIS 2005 Methodology Report (MR) (available on the INNO Metrics website[39]) describes and explains all changes in full detail. The EIS 2006 implemented three changes. The indicator measuring the share of university R&D expenditures financed by the business sector was removed; the indicator on public R&D expenditures, which was defined as the differences between total R&D expenditures and business R&D expenditures, was redefined as the sum of government R&D expenditures and university R&D expenditures only; and the indicator on the share of SMEs using non-technological change was changed into the share of SMEs using organisational innovation following the change in the survey questions on non-technological change from the third Community Innovation Survey (CIS-3) to the fourth Community Innovation Survey (CIS-4).

The EIS 2007 fully implements the list of indicators from the EIS 2006. The innovation indicators are assigned to five dimensions and grouped in two main themes: inputs and outputs. Table 6 shows the 5 main categories, the 25 indicators[40], and the primary data sources for each indicator[41]. Innovation inputs cover three innovation dimensions: *Innovation drivers* measure the structural conditions required for innovation potential; *Knowledge creation* measures the investments in R&D activities, considered as key elements for a successful knowledge-based economy; and *Innovation & entrepreneurship* measures the efforts towards innovation at firm level. Innovation outputs cover two innovation dimensions: *Applications* measures the performance, expressed in terms of labour and business activities, and their value added in innovative sectors; and *Intellectual property* measures the achieved results in terms of successful know-how.

7.2. Methodology of calculating the Summary Innovation Index

The SII 2007 is calculated as follows:

1. Calculate for every indicator and for every country the most recent relative to the EU score. E.g. if for country A the most recent data point is 500 for year 2005, for country B 400 for year 2004, and the EU scores for 2004 and 2005 are respectively 100 and 125, then the relative to EU score for country A is 100*(500/125)=400 and for country B 100*(400/100)=400. By calculating relative to EU scores business cycles effects will be minimized when timeliness

[38] Joint Research Centre (JRC), Unit of Econometrics and Applied Statistics of the Institute for the Protection and Security of the Citizen (IPSC).

[39] See http://www.proinno-europe.eu/metrics

[40] Annex C gives full definitions for all indicators and also briefly explains the rational for selecting these indicators.

[41] National data sources were used for several indicators where Eurostat or OECD data were not available. In particular, the statistical offices from Israel, Malta and Switzerland provided valuable support.

of data availability differs between countries (cf. Annex B for differences in most recent years between countries). Possible outliers are identified as those scores which are higher than the EU mean plus 3 times the standard deviation. These outliers are not included determining the maximum relative to EU scores.

2. Calculate re-scaled scores of the indicator data by first subtracting the lowest value found within the group of EU27 countries, Iceland, Norway and Switzerland (thus excluding non-European countries and European countries where data availability is less than 75%) and then dividing by the difference between the highest and lowest values found within the group of EU27 countries, Iceland, Norway and Switzerland. The maximum re-scaled score is thus equal to 1 and the minimum value is equal to 0. For Croatia, Turkey, Australia, Canada, Israel, Japan and the US for those cases where the value of an indicator is above the maximum relative to EU score or below the minimum

Table 6: EIS 2007 Indicators

INNOVATION DRIVERS (INPUT DIMENSION)		
1.1	S&E graduates per 1000 population aged 20-29	Eurostat
1.2	Population with tertiary education per 100 population aged 25-64	Eurostat, OECD
1.3	Broadband penetration rate (number of broadband lines per 100 population)	Eurostat, OECD
1.4	Participation in life-long learning per 100 population aged 25-64	Eurostat
1.5	Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	Eurostat
KNOWLEDGE CREATION (INPUT DIMENSION)		
2.1	Public R&D expenditures (% of GDP)	Eurostat, OECD
2.2	Business R&D expenditures (% of GDP)	Eurostat, OECD
2.3	Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	Eurostat, OECD
2.4	Share of enterprises receiving public funding for innovation	Eurostat (CIS4)
INNOVATION & ENTREPRENEURSHIP (INPUT DIMENSION)		
3.1	SMEs innovating in-house (% of all SMEs)	Eurostat (CIS4)
3.2	Innovative SMEs co-operating with others (% of all SMEs)	Eurostat (CIS4)
3.3	Innovation expenditures (% of total turnover)	Eurostat (CIS4)
3.4	Early-stage venture capital (% of GDP)	Eurostat
3.5	ICT expenditures (% of GDP)	Eurostat, World Bank
3.6	SMEs using organisational innovation (% of all SMEs)	Eurostat (CIS4)
APPLICATIONS (OUTPUT DIMENSION)		
4.1	Employment in high-tech services (% of total workforce)	Eurostat
4.2	Exports of high technology products as a share of total exports	Eurostat
4.3	Sales of new-to-market products (% of total turnover)	Eurostat (CIS4)
4.4	Sales of new-to-firm products (% of total turnover)	Eurostat (CIS4)
4.5	Employment in medium-high and high-tech manufacturing (% of total workforce)	Eurostat, OECD
INTELLECTUAL PROPERTY (OUTPUT DIMENSION)		
5.1	EPO patents per million population	Eurostat, OECD
5.2	USPTO patents per million population	Eurostat, OECD
5.3	Triad patents per million population	Eurostat, OECD
5.4	New community trademarks per million population	OHIM, Eurostat, OECD
5.5	New community designs per million population	OHIM, Eurostat, OECD

OHIM: Office of Harmonization for the Internal Market relative to EU score the re-scaled score is set equal to 1 respectively 0. Countries where indicator scores were identified as a possible outlier (cf. Step 1) receive a re-scaled score of 1.

3. The SII 2007 is then calculated as the average value of all re-scaled scores where indicators for which data are available receive the same weight. The SII is by definition between 0 and 1 for all countries.

For the CIS indicators EU mean values are available from Eurostat. EU mean scores are calculated separately for each CIS indicator dividing the sum of all numerator data for those countries for which CIS data are available by the sum of all denominator data. In fact, as only CIS-4 data are used, these EU mean values are not necessary for calculating the re-scaled indicator scores but they illustrative purposes as shown in the relative to EU performance charts for each country.

The SII values for those countries where data is missing for 8 or more indicators — Croatia, Turkey, Australia, Canada, Israel, Japan and the US — are estimated as follows:

4. Calculate for all countries a summary innovation index using only data for the 18 non-CIS indicators ('non-CIS SII').
5. For the EU27 countries, Iceland, Norway and Switzerland a simple linear regression is performed with the 'non-CIS SII' as the dependent variable and the SII as the independent variable. The estimated regression coefficient equals 1.0742, the estimated constant -0.0478 and the R^2 equals 0.950. The regression coefficients are significant at the 1% level and 5% level respectively.
6. For Australia, Croatia, Canada, Japan, Israel, Turkey and the US the SII 2007 is then calculated by dividing the difference between the 'non-CIS SII' and the value for the estimated constant by the value for estimated regression coefficient: SII 2007 = ('non-CIS SII' — (-0.0478)) / 1.0742.

7.3. Methodology of calculating the SII growth rate

The SII growth rate is based on SII values over a 5-year period. These SII values are calculated differently than the SII 2007 as we use maximum and minimum scores of the full 5 years (denoted as T-4, T-3, T-2, T-1 and T, where T comes closest to the years used for calculating the SII 2007) so the SII scores will also identify changes in improvement for those countries showing highest performance in individual indicators.

The procedure is as follows:

7. Calculate for every indicator and for every country the relative to EU scores (cf. Step 1 above).
8. Most recent data are then used for year T etc. If data for a year-in-between is not available we substitute with the value for the next year. If data are not available for all 5 years, we replace missing values with the latest available year. Two examples will clarify this step.

Example 1	T	T-1	T-2	T-3	T-4
Available relative to EU score	150	Missing	120	110	105
Substitute with next year	150	**150**	120	110	105
Example 2	T	T-1	T-2	T-3	T-4
Available relative to EU score	150	130	120	Missing	Missing
Substitute with latest available year	150	130	120	**120**	**120**

9. Calculate re-scaled scores of the indicator data by first subtracting the lowest value found for all 5 years within the group of EU27 countries, Iceland, Norway and Switzerland and then dividing by the difference between the highest and lowest values found for all 5 years within the group of EU27 countries, Iceland, Norway and Switzerland. The maximum re-scaled score is thus equal to 1 and

the minimum value is equal to 0. For Croatia, Turkey, Australia, Canada, Israel, Japan and the US for those cases where the value of an indicator is above the maximum relative to EU score or below the minimum relative to EU score the re-scaled score is set equal to 1 respectively 0. Note that these scores can differ from those calculate under Step 1 if either the maximum or minimum value within the group of EU27 countries, Iceland, Norway and Switzerland is found for a year prior to the most recent year.

10. The SII scores are then calculated as the average value of all re-scaled scores where indicators for which data are available receive the same weight.

For the CIS indicators the CIS-4 results are used for all 5 years. The SII values for those countries where data is missing for 8 or more indicators — Croatia, Turkey, Australia, Canada, Israel, Japan and the US — are estimated for each year using the procedure as outlined in Steps 4 to 6 above.

The growth rate of the SII is then calculated as the annual percentage change between the SII in year T and the average over the preceding three years, after a one-year lag (i.e. T-4, T-3 and T-2). The three-year average is used to reduce year-to-year variability; the one-year lag is used to increase the difference between the average for the three base years and the final year and to minimize the problem of statistical/sampling variability.

7.4. Calculation of time to convergence

The time to convergence can be calculating using a linear and non-linear approach. The linear approach assumes a simple extrapolation of the current SII trend rate:

$$SII_X^T = SII_X^{T-1} * \left(1 + \frac{TREND\_SII_X}{100}\right)$$

is the growth rate of the SII for country X and equals the SII 2007 at time T. The SII for country X at time T equals the current SII for country X multiplied by the current SII growth rate to the power T.

The non-linear approach takes into account that it will become more and more difficult to maintain high growth rates. The non-linear approach assumes that the growth rate of each country will diminish over time with the rate of decrease depending on the size of the initial gap (i.e. the larger the initial gap, the faster the subsequent rate of decline):

$$SII_X^T = SII_X^{T-1} * \left(1 + \left(\sqrt{ABS\left(\frac{SII_{EU}^{2007}}{SII_X^{2007}}\right)}\right)^{\sqrt{T}} * \frac{TREND\_SII_X}{100}\right)$$

The SII for country X at time T equals the SII of the previous year for country X multiplied by a reduced version of the SII growth rate where the size of the reduction depends on the initial gap with the EU and decreases over time with a diminishing rate of decrease.

8. Annexes

Country data sheets for all of the countries covered in the 2007 EIS are available separately on the INNO Metrics website: http://www.proinno-europe.eu/metrics

Annex A: European Innovation Scoreboard 2007 — Current performance

The data used in this report is the most recent available from the sources shown in Annex C as on 18 October 2007.

For the EU the average value shown is that of the EU27, except, due to missing data for EU27 respectively EU25, EU25 for indicators 1.3, 3.5, 5.2 and 5.3 and EU15 for indicator 3.4. For the indicators based on CIS-4 data, EU averages are not available from Eurostat. The EU averages for indicators 2.4, 3.1, 3.2, 3.3, 3.6, 4.3 and 4.4 are weighted estimates based on CIS-4 country data available from Eurostat. The EU averages for these CIS indicators are thus not official Eurostat estimates.

	EU	BE	BG	CZ	DK	DE	EE	IE	EL	ES	FR	IT	CY	LV	LT	LU	HU	MT	NL
1.1 S&E graduates	12.9	10.9	8.6	8.2	14.7	9.7	12.1	24.5	10.1	11.8	22.5	9.7	3.6	9.8	18.9	1.8	5.1	3.4	8.6
1.2 Population with tertiary education	23.0	31.8	21.9	13.5	34.7	23.8	33.3	30.8	21.5	29.9	25.5	12.9	30.5	21.1	26.8	24.0	17.7	12.0	29.5
1.3 Broadband penetration rate	14.8	20.7	—	8.4	29.6	15.3	16.6	8.8	2.7	13.2	18.0	13.1	6.6	6.8	8.4	17.4	7.5	12.8	29.0
1.4 Participation in life-long learning	9.6	7.5	1.3	5.6	29.2	7.5	6.5	7.5	1.9	10.4	7.5	6.1	7.1	6.9	4.9	8.2	3.8	5.5	15.6
1.5 Youth education attainment level	77.8	82.4	80.5	91.8	77.4	71.6	82.0	85.4	81.0	61.6	82.1	75.5	83.7	81.0	88.2	69.3	82.9	50.4	74.7
2.1 Public R&D expenditures	0.65	0.55	0.38	0.50	0.76	0.76	0.50	0.43	0.43	0.51	0.79	0.56	0.28	0.34	0.61	0.21	0.50	0.19	0.76
2.2 Busines s R&D expenditures	1.17	1.24	0.11	0.92	1.67	1.76	0.42	0.82	0.18	0.61	1.32	0.55	0.09	0.23	0.16	1.34	0.41	0.42	1.02
2.3 Share of medium-high/high-tech R&D	85.2	79.5	85.8	85.4	84.7	92.3	—	85.0	81.0	77.0	86.8	87.8	—	—	—	—	90.9	71.4	87.9
2.4 Enterprises receiving public funding for innovation	9.0	11.7	0.8	6.1	7.8	9.2	0.3	27.8	10.4	9.0	6.6	14.0	16.3	—	3.6	39.3	5.7	3.5	12.9
3.1 SMEs innovating in-house	21.6	31.4	—	24.0	28.5	32.0	29.5	37.3	27.0	18.4	19.7	18.9	24.0	—	14.6	33.1	9.3	—	18.6
3.2 Innovative SMEs co-operating with others	9.1	16.6	3.1	12.9	20.8	8.6	16.0	15.6	8.4	5.7	11.5	4.3	16.5	6.1	14.8	14.8	6.6	5.3	12.3
3.3 Innovation expenditures	2.15	1.96	0.73	2.15	2.40	2.93	1.59	1.68	3.08	0.94	2.23	1.81	2.92	—	1.57	1.62	1.16	1.08	1.25
3.4 Early -stage venture capital	0.053	0.012	—	0.000	0.015	0.011	—	0.015	0.002	0.027	0.030	0.002	—	0.000	—	—	0.005	—	0.012
3.5 ICT expenditures	6.4	6.3	9.9	6.6	6.5	6.2	9.8	5.2	4.9	5.5	6.0	5.3	—	9.6	7.8	6.8	8.1	8.5	7.6
3.6 SMEs using organizational innovation	34.0	38.1	11.0	35.0	57.1	53.2	39.2	49.6	39.6	27.6	35.9	32.2	42.8	—	23.6	58.4	19.1	29.3	26.2
4.1 Employment in high-tech services	3.26	3.95	2.63	3.00	4.22	3.48	2.77	3.87	1.95	2.68	3.70	2.97	1.94	2.34	2.15	3.32	3.37	2.50	4.08
4.2 Exports of high technology produc ts	16.7	6.6	3.3	12.7	12.8	13.6	8.1	28.9	5.7	4.7	17.8	6.4	21.4	4.2	4.7	40.6	20.2	54.6	18.3
4.3 Sales of new -to-market products	7.3	4.8	8.5	7.7	5.2	7.5	4.4	5.6	4.8	3.8	6.2	6.3	1.9	3.5	4.4	6.4	4.2	13.6	4.0
4.4 Sales of new -to-f irm products	6.2	8.2	4.1	7.8	5.8	10.0	7.6	4.5	6.2	10.0	5.6	5.6	3.7	1.6	5.3	9.1	2.5	8.7	4.3
4.5 Employment in medium-high/high-tech manufacturing	6.63	6.60	4.81	10.33	5.80	10.75	3.49	5.65	2.23	4.53	6.33	7.37	0.98	1.58	2.42	1.38	8.41	6.08	3.25
5.1 EPO patents per million population	128.0	144.5	4.3	15.9	235.8	311.7	15.5	77.3	11.2	30.6	149.1	87.3	16.4	5.9	5.8	200.5	18.9	8.8	244.3
5.2 USPTO patents per million population	52.2	55.7	0.0	3.2	64.0	129.8	0.0	42.4	1.4	6.5	52.4	30.8	0.3	0.9	0.5	97.7	3.5	3.8	84.2
5.3 Triad patents per million population	20.8	20.0	0.3	1.1	25.3	53.8	1.4	11.4	0.3	2.7	25.1	8.3	0.0	1.2	0.1	47.2	1.8	3.9	47.4
5.4 Community trademarks per million population	108.2	103.7	8.4	33.1	191.5	164.6	42.5	164.2	34.4	143.0	83.9	105.2	187.3	13.6	20.9	902.0	20.5	157.5	172.3
5.5 Community industrial designs per million population	109.4	103.8	1.9	51.6	240.5	202.7	19.4	58.0	3.1	103.7	98.6	179.4	55.9	19.2	4.4	95.4	11.3	19.7	138.8

Annex A: European Innovation Scoreboard 2007 — Current performance (continued)

	AT	PL	PT	RO	SI	SK	FI	SE	UK	HR	TR	IS	NO	CH	US	JP	IL	CA	AU
1.1 S&E graduates	9.8	11.1	12.0	10.3	9.8	10.2	17.7	14.4	18.4	5.7	5.7	10.1	9.0	13.4	10.6	13.7	8.0	—	17.2
1.2 Population with tertiary education	17.6	17.9	13.5	11.7	21.4	14.5	35.1	30.5	30.7	16.2	9.3	29.5	33.6	29.9	39.0	40.0	45.0	46.0	32.0
1.3 Broadband penetration rate	15.8	3.9	12.9	—	11.4	4.0	24.9	22.9	19.2	—	3.0	28.1	24.7	26.3	18.0	18.9	20.0	22.4	16.5
1.4 Participation in life-long learning	13.1	4.7	3.8	1.3	15.0	4.3	23.1	32.1	26.6	2.1	2.0	25.7	18.7	22.2	—	—	—	—	—
1.5 Youth education attainment level	85.8	91.7	49.6	77.2	89.4	91.5	84.7	86.5	78.8	93.8	44.7	50.8	93.3	78.1	—	—	86.0	—	—
2.1 Public R&D expenditures	0.75	0.39	0.43	0.17	0.35	0.25	0.99	0.92	0.58	0.70	0.52	1.17	0.69	0.70	0.69	0.74	0.89	0.90	0.76
2.2 Busines s R&D expenditures	1.60	0.18	0.29	0.21	0.87	0.25	2.46	2.92	1.09	0.51	0.27	1.59	0.82	2.16	1.87	2.40	3.43	1.07	0.94
2.3 Share of medium-high/high-tech R&D	82.3	80.0	—	68.1	89.3	—	86.4	92.7	91.7	—	—	—	69.7	92.0	89.9	86.7	94.6	80.6	68.4
2.4 Enterprises receiving public funding for innovation	17.8	3.1	4.5	2.1	—	2.8	15.2	—	—	—	—	—	16.1	4.7	—	—	—	—	—
3.1 SMEs innovating in-house	32.4	13.8	24.0	13.4	—	11.6	24.7	30.0	—	—	—	—	19.4	34.4	—	—	—	—	—
3.2 Innovative SMEs co-operating with others	7.7	9.1	7.4	2.8	10.5	6.8	17.3	20.0	12.6	—	—	14.0	11.3	12.1	—	—	—	—	—
3.3 Innovation expenditures	—	1.56	1.40	1.52	—	1.90	—	3.47	—	—	—	—	1.01	1.35	—	—	—	—	3.30
3.4 Early -stage venture capital	0.003	0.001	0.039	0.004	—	0.001	0.027	0.058	0.224	—	—	0.024	0.013	0.024	0.035	—	0.040	—	0.011
3.5 ICT expenditures	6.3	7.2	7.4	8.2	5.4	6.7	7.0	8.6	8.0	—	3.2	—	5.2	7.7	6.7	7.6	8.3	5.9	6.2
3.6 SMEs using organizational innovation	48.1	19.3	40.7	15.5	—	13.4	—	—	—	—	—	—	23.2	—	—	—	—	—	—
4.1 Employment in high-tech services	2.89	2.37	1.85	1.43	2.87	2.53	4.59	5.06	4.20	2.18	—	4.97	3.90	3.81	—	—	5.90	—	—
4.2 Exports of high technology produc ts	11.3	3.1	7.0	3.9	4.5	5.4	18.1	12.8	26.5	6.8	1.4	8.9	3.0	20.4	26.1	20.0	22.5	8.5	2.8
4.3 Sales of new -to-market products	5.2	8.1	4.4	7.1	7.4	12.8	9.7	8.3	6.4	—	—	4.9	2.1	4.9	—	—	—	—	—
4.4 Sales of new -to-f irm products	5.4	5.4	5.6	9.5	6.9	6.4	5.1	5.1	7.6	—	—	7.8	5.1	5.8	—	—	—	—	—
4.5 Employment in medium-high/high-tech manufacturing	6.75	5.13	3.17	5.67	8.50	9.72	6.81	6.29	5.52	4.87	—	2.12	4.27	7.25	3.84	7.30	4.40	3.89	3.28
5.1 EPO patents per million population	195.1	4.2	7.5	1.2	50.4	8.1	305.6	284.9	121.4	18.2	1.9	153.6	117.1	425.6	167.6	219.1	237.2	86.4	98.0
5.2 USPTO patents per million population	63.4	0.6	1.2	0.3	7.0	0.4	133.2	113.9	50.6	3.1	0.2	68.5	51.3	167.5	273.7	274.4	131.3	161.6	79.6
5.3 Triad patents per million population	30.0	0.2	0.4	0.0	2.7	0.0	29.3	42.7	15.8	0.7	0.2	13.7	11.2	81.3	33.9	87.0	34.6	25.4	20.2
5.4 Community trademarks per million population	221.5	24.7	98.0	5.6	30.5	16.7	119.0	164.1	139.0	1.6	1.9	164.1	41.5	308.3	33.6	12.9	36.3	27.0	36.9
5.5 Community industrial designs per million population	208.8	30.2	57.5	0.9	51.5	27.3	97.9	144.9	75.0	1.8	3.7	10.0	36.6	235.7	17.5	15.2	10.8	6.0	14.1

Annex B: European Innovation Scoreboard 2007 — Years used for current performance

The data used in this report is the most recent available from the sources shown in Annex C as on 18 October 2007.

	EU	BE	BG	CZ	DK	DE	EE	IE	EL	ES	FR	IT	CY	LV	LT	LU	HU	MT	NL
1.1 S&E graduates	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2000	2005	2005	2005
1.2 Population with tertiary education	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006
1.3 Broadband penetration rate	2006	2006	—	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006
1.4 Participation in life-long learning	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006
1.5 Youth education attainment level	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006
2.1 Public R&D expenditures	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2004	2005	2005	2005	2005	2005	2005	2004
2.2 Business R&D expenditures	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005
2.3 Share of medium-high/high-tech R&D	2004	2004	2002	2004	2004	2004	—	2004	2003	2004	2003	2004	—	—	—	—	2002	2002	2004
2.4 Enterprises receiving public funding for innovation	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	—	2004	2004	2004	2004	2004
3.1 SMEs innovating in-house	2004	2004	—	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	—	2004	2004	2004	—	2004
3.2 Innovative SMEs co-operating with others	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004
3.3 Innovation expenditures	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	—	2004	2004	2004	2004	2004
3.4 Early-stage venture capital	2006	2006	—	2006	2006	2006	—	2006	2006	2006	2006	2006	—	2001	—	—	2006	—	2006
3.5 ICT expenditures	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	—	2005	2005	2002	2005	2004	2005
3.6 SMEs using organizational innovation	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	—	2004	2004	2004	2004	2004
4.1 Employment in high-tech services	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2005	2006	2006	2006
4.2 Exports of high technology produc ts	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006
4.3 Sales of new -to-market products	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004
4.4 Sales of new -to-f irm products	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004
4.5 Employment in medium-high/high-tech manufacturing	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2005	2006	2006	2006
5.1 EPO patents per million population	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003
5.2 USPTO patents per million population	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003
5.3 Triad patents per million population	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005
5.4 Community trademarks per million population	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006
5.5 Community industrial designs per million population	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006

Annex B: European Innovation Scoreboard 2007 — Years used for current performance (continued)

	AT	PL	PT	RO	SI	SK	FI	SE	UK	HR	TR	IS	NO	CH	US	JP	IL	CA	AU
1.1 S&E graduates	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	—	2002
1.2 Population with tertiary education	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2005	2005	2004	2005	2005
1.3 Broadband penetration rate	2006	2006	2006	—	2006	2006	2006	2006	2006	—	2006	2006	2006	2006	2006	2006	2006	2006	2006
1.4 Participation in life-long learning	2006	2006	2006	2006	2006	2006	2006	2005	2006	2005	2006	2005	2006	2006	—	—	—	—	—
1.5 Youth education attainment level	2006	2006	2006	2006	2006	2006	2006	2006	2006	2005	2006	2005	2006	2006	—	—	2006	—	—
2.1 Public R&D expenditures	2005	2005	2005	2004	2005	2005	2005	2005	2004	2004	2005	2004	2005	2004	2004	2003	2005	2005	2004
2.2 Business R&D expenditures	2005	2005	2005	2004	2005	2005	2005	2005	2004	2004	2005	2004	2005	2004	2004	2003	2005	2005	2004
2.3 Share of medium-high/high-tech R&D	2002	2004	—	2003	2004	—	2004	2003	2004	—	—	—	2004	2004	2003	2003	2004	2004	2003
2.4 Enterprises receiving public funding for innovation	2004	2004	2004	2004	—	2004	2004	—	—	—	—	—	2004	2005	—	—	—	—	—
3.1 SMEs innovating in-house	2004	2004	2004	2004	—	2004	2004	2004	—	—	—	—	2004	2005	—	—	—	—	—
3.2 Innovative SMEs co-operating with others	2004	2004	2004	2004	2004	2004	2004	2004	2004	—	—	2004	2004	2005	—	—	—	—	—
3.3 Innovation expenditures	—	2004	2004	2004	—	2004	—	2004	—	—	—	—	2004	2005	—	—	—	—	2004
3.4 Early-stage venture capital	2006	2006	2005	2006	—	2005	2006	2006	2006	—	—	2002	2006	2006	2005	—	2006	—	2004
3.5 ICT expenditures	2005	2005	2005	2005	2005	2005	2005	2005	2005	—	2003	—	2005	2005	2005	2005	2005	2005	2005
3.6 SMEs using organizational innovation	2004	2004	2004	2004	—	2004	—	—	—	—	—	—	2004	—	—	—	—	—	—
4.1 Employment in high-tech services	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	—	2005	2006	2005	—	—	2006	—	—
4.2 Exports of high technology produc ts	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2005	2006	2006	2006	2006	2006	2006	2006	2006
4.3 Sales of new-to-market products	2004	2004	2004	2004	2004	2004	2004	2004	2004	—	—	2004	2004	2005	—	—	—	—	—
4.4 Sales of new-to-firm products	2004	2004	2004	2004	2004	2004	2004	2004	2004	—	—	2004	2004	2005	—	—	—	—	—
4.5 Employment in medium-high/high-tech manufacturing	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	—	2005	2006	2005	2003	2003	2006	2003	1999
5.1 EPO patents per million population	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003
5.2 USPTO patents per million population	2003	2003	2003	2003	2003	2003	2003	2003	2003	2000	2003	2003	2003	2003	2003	2003	2003	2003	2003
5.3 Triad patents per million population	2005	2005	2005	2004	2005	2005	2005	2005	2005	2000	2005	2005	2005	2005	2005	2005	2005	2005	2005
5.4 Community trademarks per million population	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006
5.5 Community industrial designs per million population	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006

Annex C: European Innovation Scoreboard 2007 — Definitions and interpretation

#	EIS 2007 indicators	Numerator	Denominator	Interpretation
1.1	New S&E graduates per 1000 population aged 20-29	Number of S&E (science and engineering) graduates. S&E graduates are defined as all post-secondary education graduates (ISCED classes 5a and above) in life sciences (ISC42), physical sciences (ISC44), mathematics and statistics (ISC46), computing (ISC48), engineering and engineering trades (ISC52), manufacturing and processing (ISC54) and architecture and building (ISC58).	The reference population is all age classes between 20 and 29 years inclusive.	The indicator is a measure of the supply of new graduates with training in Science & Engineering (S&E). Due to problems of comparability for educational qualifications across countries, this indicator uses broad educational categories. This means that it covers everything from graduates of one-year diploma programmes to PhDs. A broad coverage can also be an advantage, since graduates of one-year programmes are of value to incremental innovation in manufacturing and in the service sector.
1.2	Population with tertiary education per 100 population aged 25-64	Number of persons in age class with some form of post-secondary education (ISCED 5 and 6).	The reference population is all age classes between 25 and 64 years inclusive.	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. Furthermore, it includes the entire working age population, because future economic growth could require drawing on the non-active fraction of the population. 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. Differences among countries should be interpreted with caution.
1.3	Broadband penetration rate (number of broadband lines per 100 population)	Number of broadband lines. Broadband lines are defined as those with a capacity equal to or higher than 144 Kbit/s.	Total population as defined in the European System of Accounts (ESA 1995).	Realising Europe's full e-potential depends on creating the conditions for electronic commerce and the Internet to flourish, so that the Union can catch up with its competitors by hooking up many more businesses and homes to the Internet via fast connections. The Community and the Member States are to make available in all European countries low cost, high-speed interconnected networks for Internet access and foster the development of state-of-the-art information technology and other telecom networks as well as the content for those networks (Lisbon European Council, 2000). The Barcelona European Council (2002) attached priority to the widespread availability and use of broadband networks throughout the Union by 2005 and the development of Internet protocol IPv6. Further development in this area requires accelerated broadband deployment; in this respect the Brussels European Council (2003) called on Member States to put in place national broadband / high speed Internet strategies by end 2003 and aim for a substantial increase in high speed Internet connections by 2005.

#	EIS 2007 indicators	Numerator	Denominator	Interpretation
1.4	Participation in life-long learning per 100 population aged 25-64)	Number of persons involved in life-long learning. Life-long learning is defined as participation in any type of education or training course during the four weeks prior to the survey. The information collected relates to all education or training whether or not relevant to the respondent's current or possible future job. It includes initial education, further education, continuing or further training, training within the company, apprenticeship, on-the-job training, seminars, distance learning, evening classes, self-learning etc. It includes also courses followed for general interest and may cover all forms of education and training as language, data processing, management, art/ culture, and health/medicine courses.	The reference population is all age classes between 25 and 64 years inclusive	A central characteristic of a knowledge economy is continual technical development and innovation. Individuals need to continually learn new ideas and skills or to participate in life-long learning. All types of learning are valuable, since it prepares people for 'learning to learn'. The ability to learn can then be applied to new tasks with social and economic benefits.
1.5	Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	Youth education attainment level is defined as the percentage 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). The denominator consists of the total population of the same age group, excluding no answers to the questions 'highest level of education or training attained'.	The reference population is all age classes between 20 and 24 years inclusive	The indicator measures the qualification level of the population aged 20-24 years in terms of formal educational degrees. So far 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. A study for OECD countries suggests a positive link between education and economic growth. According to this study an additional year of average school attainment is estimated to increase economic growth by around 5% immediately and by further 2.5% in the long run (De la Fuente and Ciccone, 'Human capital in a global and knowledge-based economy', Final report for DG Employment and Social Affairs, 2002). Completed upper secondary education is generally considered to be the minimum level required for successful participation in a knowledge-based society. It is increasingly important not just for successful entry into the labour market, but also to allow students access to learning and training opportunities offered by higher education. School attainment is a primary determinant of individual income and labour market status. Persons who have completed at least upper secondary education have access to jobs with higher salaries and better working conditions. They also have a markedly higher employment rate than persons with at most lower secondary education (Employment in Europe 2004).

#	EIS 2007 indicators	Numerator	Denominator	Interpretation
2.1	Public R&D expenditures (% of GDP)	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.	Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.	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. Recognising the benefits of R&D for growth and being aware of the rapidly widening gap between Europe's R&D effort and that of the principal partners of the EU in the world, the Barcelona European Council (March 2003) set the EU a target of increasing R&D expenditure to 3 per cent of GDP by 2010, two thirds of which should come from the business enterprise sector.
2.2	Business R&D expenditures (% of GDP)	All R&D expenditures in the business sector (BERD), according to the Frascati-manual definitions, in national currency and current prices.	Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.	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.
2.3	Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	R&D expenditures in medium-high and high-tech manufacturing, in national currency and current prices. These include chemicals (NACE24), machinery (NACE29), office equipment (NACE30), electrical equipment (NACE31), telecommunications and related equipment (NACE32), precision instruments (NACE33), automobiles (NACE34) and aerospace and other transport (NACE35).	R&D expenditures in total manufacturing, in national currency and current prices.	This indicator captures whether a country invests in future technologies (medium-high and high-tech manufacturing industries) or rather in historical industries (medium-low and low-tech manufacturing industries). This follows a recent report published by the JRC (R&D expenditure scoreboard), which highlights that the R&D problem observed in Europe is more a business structure problem. In most sectors R&D intensity is as high in the EU as in the rest of the world, however the relative importance of R&D intensive sectors in the total business is relatively low in Europe.
2.4	Share of enterprises receiving public funding for innovation	Number of innovative enterprises that have received public funding. Public funding includes financial support in terms of grants and loans, including a subsidy element, and loan guarantees. Ordinary payments for orders of public customers are not included. (*Community Innovation Survey*)	Total number of enterprises, thus both innovating and non-innovating enterprises. (*Community Innovation Survey*)	This indicator measures the degree of government support to innovation. The indicator gives the percentage of all firms (innovators and non-innovators combined) that received any public financial support for innovation from at least one of three levels of government (local, national and the European Union).

#	EIS 2007 indicators	Numerator	Denominator	Interpretation
3.1	SMEs innovating in-house (% of SMEs)	Sum of SMEs with in-house innovation activities. Innovative firms are defined as those firms which have introduced new products or process either 1) in-house or 2) in combination with other firms. This indicator does not include new products or processes developed by other firms. (*Community Innovation Survey*)	Total number of SMEs. (*Community Innovation Survey*)	This indicator measures the degree to which SMEs, that have introduced any new or significantly improved products or production processes during the period 2002-2004, have innovated in-house. The indicator is limited to SMEs because almost all large firms innovate and because countries with an industrial structure weighted to larger firms would tend to do better.
		Note: data for this indicator are not available on Eurostat's online database. The indicator has been estimated as the average of the share of product innovators with in-house innovation activities and the share of process innovators with in-house innovation activities. As product innovators can also have introduces process innovations and vice versa, there would be a serious problem of double-counting when adding both shares. By taking the average of both shares it is expected that this problem will be minimized, but there could still be significant deviations with the data for this indicator based on Member States' national databases.		
3.2	Innovative SMEs co-operating with others (% of SMEs)	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. (*Community Innovation Survey*)	Total number of SMEs. (*Community Innovation Survey*)	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.
3.3	Innovation expenditures (% of turnover)	Sum of total innovation expenditure for enterprises, in national currency and current prices. Innovation expenditures includes the full range of innovation activities: in-house R&D, extramural R&D, machinery and equipment linked to product and process innovation, spending to acquire patents and licenses, industrial design, training, and the marketing of innovations. (*Community Innovation Survey*)	Total turnover for all enterprises, in national currency and current prices. (*Community Innovation Survey*)	This indicator measures total 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. Overall, the indicator measures total expenditures on many activities of relevance to innovation. The indicator partly overlaps with the indicator on business R&D expenditures.

#	EIS 2007 indicators	Numerator	Denominator	Interpretation
3.4	Early-stage venture capital (% of GDP)	Venture capital investment is defined as private equity raised for investment in companies. Management buyouts, management buyins, and venture purchase of quoted shares are excluded. Early-stage capital includes seed and start-up 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 time, but have not yet sold their product commercially.	Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.	The amount of early-stage 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.
3.5	ICT expenditures (% of GDP)	Total expenditures on information and communication technology (ICT), in national currency and current prices. ICT includes office machines, data processing equipment, data communication equipment, and telecommunications equipment, plus related software and telecom services.	Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.	ICT is a fundamental feature of knowledge-based economies and the driver of current and future productivity improvements. An indicator of ICT investment is crucial for capturing innovation in knowledge-based economies, particularly due to the diffusion of new IT equipment, services and software. One disadvantage of this indicator is that it is ultimately obtained from private sources, with a lack of good information on the reliability of the data. Another disadvantage is that part of the expenditures is for final consumption and may have few productivity or innovation benefits.
3.6	SMEs using organizational innovation (% of SMEs)	CIS question 10.1 asks firms if, between 2000 and 2002, they introduced 'new or significantly improved knowledge management systems', 'a major change to the organisation of work within their enterprise' or 'new or significant changes in their relations with other firms or public institutions'. A 'yes' response to at least one of these categories would identify a SME having introduced an organisational innovation. (*Community Innovation Survey*)	Total number of SMEs. (*Community Innovation Survey*)	The Community Innovation Survey mainly asks firms about their technical innovation, Many firms, in particular in the services sectors, innovate through other non-technical forms of innovation. Examples of these are organisational innovations. This indicator tries to capture the extent that SMEs innovate through non-technical innovation.

#	EIS 2007 indicators	Numerator	Denominator	Interpretation
4.1	Employment in high-tech services (% of total workforce)	Number of employed persons in the high-tech services sectors. These include post and telecommunications (NACE64), information technology including software development (NACE72) and R&D services (NACE73).	The total workforce includes all manufacturing and service sectors.	The high technology services provide services directly to consumers, such as telecommunications, and provide inputs to the innovative activities of other firms in all sectors of the economy. The latter can increase productivity throughout the economy and support the diffusion of a range of innovations, in particular those based on ICT.
4.2	Exports of high technology products as a share of total exports	Value of high-tech exports, in national currency and current prices. High-tech exports include exports of the following products: aerospace; computers and office machinery; electronics-telecommunications; pharmaceuticals; scientific instruments; electrical machinery; chemistry; non-electrical machinery and armament (cf. OECD STI Working Paper 1997/2 for the SITC Revision 3 codes).	Value of total exports, in national currency and current prices.	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 is vital for the competitiveness of a country in the modern economy. This is because high technology sectors are key drivers for economic growth, productivity and welfare, and are generally a source of high value added and well-paid employment. The Brussels European Council (2003) stressed the role of public-private partnerships in the research area as a key factor in developing new technologies and enabling the European high-tech industry to compete at the global level.
4.3	Sales of new-to-market products (% of turnover)	Sum of total turnover of new or significantly improved products for all enterprises. (*Community Innovation Survey*)	Total turnover for all enterprises, in national currency and current prices. (*Community Innovation Survey*)	This indicator measures the turnover of new or significantly improved products, which are also new to the market, as a percentage of total turnover. The product must be new to the firm, which in many cases will also include innovations that are world-firsts. The main disadvantage is that there is some ambiguity in what constitutes a 'new to market' innovation. Smaller firms or firms from less developed countries could be more likely to include innovations that have already been introduced onto the market elsewhere.
4.4	Sales of new-to-firm products (% of turnover)	Sum of total turnover of new or significantly improved products to the firm but not to the market for all enterprises. (*Community Innovation Survey*)	Total turnover for all enterprises, in national currency and current prices. (*Community Innovation Survey*)	This indicator measures the turnover of new or significantly improved products to the firm as a percentage of total turnover. These products are not new to the market. Sales of new to the firm but not new to the market products are a proxy of the use or implementation of elsewhere already introduced products (or technologies). This indicator is thus a proxy for the degree of diffusion of state-of-the-art technologies.

#	EIS 2007 indicators	Numerator	Denominator	Interpretation
4.5	Employment in medium-high and high-tech manufacturing (% of total workforce)	Number of employed persons in the medium-high and high-tech manufacturing sectors. These include chemicals (NACE24), machinery (NACE29), office equipment (NACE30), electrical equipment (NACE31), telecommunications and related equipment (NACE32), precision instruments (NACE33), automobiles (NACE34) and aerospace and other transport (NACE35).	The total workforce includes all manufacturing and service sectors.	The share of employment in medium-high and high technology manufacturing sectors is an indicator of the manufacturing economy that is based on continual innovation through creative, inventive activity. The use of total employment gives a better indicator than using the share of manufacturing employment alone, since the latter will be affected by the hollowing out of manufacturing in some countries.
5.1	EPO patents per million population	Number of patents applied for at the European Patent Office (EPO), by year of filing. The national distribution of the patent applications is assigned according to the address of the inventor.	Total population as defined in the European System of Accounts (ESA 1995).	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 patent applications at the European Patent Office.
5.2	USPTO patents per million population	Number of patents granted by the US Patent and Trademark Office (USPTO), by year of grant. Patents are allocated to the country of the inventor, using fractional counting in the case of multiple inventor countries.	Total population as defined in the European System of Accounts (ESA 1995).	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 patents granted by the US Patent and Trademark Office.
5.3	Triad patents per million population	Number of triad patents. A patent is a triad patent if, and only if, it is filed at the European Patent Office (EPO), the Japanese Patent Office (JPO) and is granted by the US Patent & Trademark Office (USPTO).	Total population as defined in the European System of Accounts (ESA 1995).	The disadvantage of both the EPO and USPTO patent indicator is that European countries and the US respectively have a ‘home advantage’ as patent rights differ among countries. A patent family is a group of patent filings that claim the priority of a single filing, including the original priority filing itself, and any subsequent filings made throughout the world. Trilateral patent families are a filtered subset of patent families for which there is evidence of patenting activity in all trilateral blocks (USPTO, EPO and JPO). No country will thus have a clear ‘home advantage’.

#	EIS 2007 indicators	Numerator	Denominator	Interpretation
5.4	Number of new community trademarks per million population	Number of new community trademarks. A trademark is a distinctive sign, which identifies 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 on the strength of a single registration procedure with the Office for Harmonization.	Total population as defined in the European System of Accounts (ESA 1995).	The Community trademark gives its proprietor a uniform right applicable in all Member States of the European Union on the strength of a single procedure which simplifies trademark policies at European level. It fulfils the three essential functions of a trademark at European level: 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. The Community trademark may be used as a manufacturer's mark, a mark for goods of a trading company, or service mark. It may also take the form of a collective trademark: properly applied, the regulation governing the use of the collective trademark guarantees the origin, the nature and the quality of goods and services by making them distinguishable, which is beneficial to members of the association or body owning the trademark.
5.5	Number of new community designs per million population	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.	Total population as defined in the European System of Accounts (ESA 1995).	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.

Annex D: European Innovation Scoreboard 2007 — SII scores over a 5 year time period

	2003	2004	2005	2006	2007
EU27	0.45	0.45	0.45	0.45	0.45
BE	0.51	0.49	0.49	0.48	0.47
BG	0.20	0.21	0.20	0.22	0.23
CZ	0.32	0.33	0.33	0.34	0.36
DK	0.68	0.66	0.65	0.64	0.61
DE	0.59	0.59	0.59	0.59	0.59
EE	0.35	0.34	0.35	0.37	0.37
IE	0.50	0.49	0.50	0.49	0.49
EL	0.26	0.26	0.26	0.25	0.26
ES	0.32	0.31	0.32	0.32	0.31
FR	0.48	0.48	0.48	0.48	0.47
IT	0.32	0.33	0.33	0.33	0.33
CY	0.29	0.29	0.30	0.32	0.33
LV	0.16	0.16	0.17	0.18	0.19
LT	0.23	0.24	0.24	0.26	0.27
LU	0.50	0.50	0.53	0.57	0.53
HU	0.24	0.25	0.25	0.25	0.26
MT	0.27	0.27	0.28	0.29	0.29
NL	0.50	0.49	0.49	0.48	0.48
AT	0.47	0.46	0.48	0.48	0.48
PL	0.21	0.21	0.22	0.23	0.24
PT	0.21	0.24	0.23	0.25	0.25
RO	0.16	0.15	0.16	0.17	0.18
SI	0.32	0.34	0.34	0.36	0.35
SK	0.23	0.22	0.23	0.24	0.25
FI	0.69	0.68	0.65	0.67	0.64
SE	0.82	0.80	0.78	0.76	0.73
UK	0.57	0.57	0.56	0.55	0.57
HR	0.24	0.23	0.23	0.23	0.23
TR	0.09	0.09	0.08	0.08	0.09
IS	0.49	0.50	0.49	0.49	0.50
NO	0.40	0.39	0.38	0.37	0.36
CH	0.68	0.69	0.68	0.67	0.67
US	0.60	0.59	0.57	0.55	0.55
JP	0.60	0.61	0.61	0.60	0.60
IL	0.63	0.63	0.64	0.63	0.62
CA	0.48	0.48	0.45	0.44	0.44
AU	0.35	0.35	0.35	0.35	0.36

Annex E: European Innovation Scoreboard 2007 — Country abbreviations

BE	Belgium
BG	Bulgaria
CZ	Czech Republic
DK	Denmark
DE	Germany
EE	Estonia
IE	Ireland
EL	Greece
ES	Spain
FR	France
IT	Italy
CY	Cyprus
LV	Latvia
LT	Lithuania
LU	Luxembourg
HU	Hungary
MT	Malta
NL	Netherlands
AT	Austria

PL	Poland
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
FI	Finland
SE	Sweden
UK	United Kingdom

HR	Croatia
TR	Turkey
IS	Iceland
NO	Norway
CH	Switzerland
US	United States
JP	Japan
IL	Israel
CA	Canada
AU	Australia

European Commission

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