Rethinking the European Innovation Scoreboard:
A New Methodology for 2008-2010

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Acknowledgement

0. Executive Summary

The European Innovation Scoreboard (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 provides an annual assessment of innovation performance across the EU and other leading innovative nations. The assessment is based on a wide range of indicators covering structural conditions, knowledge creation, innovation at the firm level, throughputs and outputs in terms of new products and services.

Since its introduction in 2000, the EIS has been both welcomed as a relevant tool for innovation benchmarking but has also been criticized for not capturing all relevant dimensions of the innovation process, for using improper indicators, for not taking into account structural differences between countries, and for its methodology of summarizing countries' innovation performance using composite indicators.

This Methodology Report summarizes the discussion of the main criticisms of the EIS, its challenges as highlighted in the EIS 2007 report, and will present a revised list of dimensions and indicators to be used in the European Innovation Scoreboard for the 3 forthcoming EIS reports in 2008, 2009 and 2010. This revised list of dimensions and indicators has taken into account the discussions at and the written comments received after the EIS workshop on "Improving the European Innovation Scoreboard methodology" which took place in Brussels the 16th of June. The workshop involved more than 40 stakeholders who discussed in detail the challenges for measuring innovation performance and the workshop input reports prepared by MERIT presenting a first draft of a revised list of innovation dimensions and indicators (Hollanders and van Cruysen, 2008a) and the Joint Research Centre (JRC) discussing a range of different composite indicator growth formulas measuring real progress over time (Tarantola, 2008). The workshop's discussions on dimensions and indicators resulted in revised output report discussing an updated draft of new dimensions and indicators (Hollanders and van Cruysen, 2008b). Further work by MERIT on the feasibility of adopting these new indicators and more discussions with some of the stakeholders has resulted in the final list of indicators as presented in this report.

The new methodology will include 29 innovation indicators, grouped over 7 different innovation dimensions and 3 major groups of dimensions (cf. Table I).

- The group of 'Enablers' captures the main drivers of innovation that are external to the firm and is divided into a 'Human resources' and a 'Finance and support' dimensions, capturing in total 9 indicators.
- 'Firm activities' captures innovation efforts that firms undertake recognising the fundamental importance of firms' activities in the innovation process. This group covers 3 dimensions: 'Firm investments', covering a range of different investments firms make in order to generate innovations; 'Linkages & entrepreneurship', capturing the entrepreneurial efforts and the related collaboration efforts among innovating firms and also the public sector; and 'Throughputs', capturing a.o. the Intellectual Property Rights (IPR) generated as a throughput in the innovation process. This group includes 11 indicators in total.
- 'Outputs' captures the outputs of firm activities and is divided into 2 dimensions using 9 indicators. 'Innovators' captures the success of innovation by the number of firms that have introduced innovations onto the market or within their organisations. 'Economic effects' captures the economic success of innovation in employment, exports and sales due to innovation activities.

This new methodology will be used in the forthcoming 2008 European Innovation Scoreboard, which will include more in-depth analyses of changes in innovation performance over time to identify for each country the key drivers for innovation improvements. The EIS 2008 report will also include a detailed comparison between the EU27 and the US and Japan using the results from the 2008 Global Innovation Scoreboard which will include a larger sample of non-EU countries using a more limited set of innovation indicators.

TABLE I: INDICATORS FOR THE EIS 2008-2010

		Cf. to EIS 2007	Data source
ENABLERS			
	Human resources		
1.1.1	S&E and SSH graduates per 1000 population aged 20-29 (first stage of tertiary education)	Revised	Eurostat
1.1.2	S&E and SSH doctorate graduates per 1000 population aged 25-34 (second stage of tertiary education)	Revised	Eurostat
1.1.3	Population with tertiary education per 100 population aged 25-64	Same	Eurostat
1.1.4	Participation in life-long learning per 100 population aged 25-64	Same	Eurostat
1.1.5	Youth education attainment level	Same	Eurostat
	Finance and support		
1.2.1	Public R&D expenditures (% of GDP)	Same	Eurostat
1.2.2	Venture capital (% of GDP)	Revised	EVCA/ Eurostat
1.2.3	Private credit (relative to GDP)	New	IMF
1.2.4	Broadband access by firms (% of firms)	Revised	Eurostat
FIRM ACTIVITIES			
	Firm investments		
2.1.1	Business R&D expenditures (% of GDP)	Same	Eurostat
2.1.2	IT expenditures (% of GDP)	Revised	EITO/Eurostat
2.1.3	Non-R&D innovation expenditures (% of turnover)	Revised	Eurostat (CIS)
	Linkages & entrepreneurship		
2.2.1	SMEs innovating in-house (% of SMEs)	Same	Eurostat (CIS)
2.2.2	Innovative SMEs collaborating with others (% of SMEs)	Same	Eurostat (CIS)
2.2.3	Firm renewal (SMEs entries + exits) (% of SMEs)	New	Eurostat
2.2.4	Public-private co-publications per million population	New	Thomson/ ISI
	Throughputs		
2.3.1	EPO patents per million population	Same	Eurostat
2.3.2	Community trademarks per million population	Same	OHIM
2.3.3	Community designs per million population	Same	OHIM
2.3.4	Technology Balance of Payments flows (% of GDP)	New	World Bank
OUTPUTS			
	Innovators		
3.1.1	Technological (product/service/process) innovators (% of SMEs)	New	Eurostat (CIS)
3.1.2	Non-technological (marketing/organisational) innovators (% of SMEs)	Revised	Eurostat (CIS)
3.1.3	Resource efficiency innovators (% of firms)	New	Eurostat (CIS)
	Economic effects		
3.2.1	Employment in medium-high & high-tech manufacturing (% of workforce)	Same	Eurostat
3.2.2	Employment in knowledge-intensive services (% of workforce)	Revised	Eurostat
3.2.3	Medium and high-tech exports (% of total exports)	Revised	Eurostat
3.2.4	Knowledge-intensive services exports (% of total services exports)	New	Eurostat
3.2.5	New-to-market sales (% of turnover)	Same	Eurostat (CIS)
3.2.6	New-to-firm sales (% of turnover)	Same	Eurostat (CIS)

1. Introduction

The European Innovation Scoreboard (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 provides an annual assessment of innovation performance across the EU and other leading innovative nations. The assessment is based on a wide range of indicators covering structural conditions, knowledge creation, innovation at the firm level, throughputs and outputs in terms of new products and services.

Since its introduction in 2000, the EIS has been both welcomed as a relevant tool for innovation benchmarking but has also been criticized for not capturing all relevant dimensions of the innovation process, for using improper indicators, for not taking into account structural differences between countries, and for its methodology of summarizing countries' innovation performance using composite indicators.

This Methodology Report summarizes the discussion of the main criticisms of the EIS, its challenges as highlighted in the EIS 2007 report, and will present the revised list of dimensions and indicators to be used in the European Innovation Scoreboard for the period 2008-2010. This revised list of dimensions and indicators take into account the discussions at and the written comments received after the EIS workshop on "Improving the European Innovation Scoreboard methodology" which took place in Brussels the 16th of June[2]. This Methodology Report also explains the calculation of the Summary Innovation Index and other composite indicators and the revised methodology of calculating changes over time for these composite indicators.

The following principles were applied in considering possibilities for improvement.

- **SIMPLICITY**

  Simplicity such that the number of indicators is limited as compared to other studies[3] and will not undergo unnecessary manipulations.

- **TRANSPARENCY**

  Transparency such that all results can be easily recalculated, based on a careful and detailed explanation of the methodology (e.g. normalisation for calculating composite indicators) and the calculation of the Summary Innovation Index (SII).

- **CONTINUITY**

  Continuity with previous years is required such that results between the new EIS 2008-2010 can be compared with those of the EIS 2000-2007.

For an overview on changes in the European Innovation Scoreboard from the 2000 pilot report until the 2007 report, please refer to Annex 1.

This report is structured as follows: Section 2 outlines the main challenges for improvements as identified in the EIS 2007 report. Section 3 summarises the criticism on the EIS. Section 4 discusses the innovation dimensions and innovation indicators which will be used for the EIS in 2008, 2009 and 2010. Section 5 will discuss the

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2 Workshop input (Hollanders and van Cruysen, 2008a) and output reports (Hollanders and van Cruysen, 2008b) are available at http://www.eis.eu/workshop
3 E.g. FORA's InnovationMonitor (FORA, 2007) which uses as many as 171 indicators, most of which are survey-based indicators.

methodology for calculating the composite innovation indexes and their changes over time. Section 6 concludes and briefly discusses some of the analyses in the forthcoming EIS 2008 report.

2. Main challenges[4]

Since the 2000 pilot report, seven full versions of the European Innovation Scoreboard have been published. The list and number of indicators has undergone several changes over time (cf. Annex 1). The number of indicators has increased from 18 to 25 and those derived from the Community Innovation Survey from 4 to 7[5]. With major revisions in 2003 and 2005 (the dissimilarity percentages exceed 30 in both years) only 13 indicators were used across all Scoreboards. The EIS indicators are grouped into 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 been revised several times, most recently in 2005 following the EIS 2005 Methodology Report (Sajeva et al., 2005).

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

- Measuring new forms of innovation
- Assessing overall innovation performance
- Improving comparability at national, regional and international 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 and the wider innovation community.

2.1 Measuring new forms of innovation

The changes in indicators used in the different EIS reports reflect changes in our understanding of the innovation process[6]. Firms can make use of different models of innovation, making it a complex phenomenon to measure and benchmark. Science-based innovation has been used by some industries and large firms for a long time. Innovation and technological progress are driven by firms and 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 has been introduced in the 1980s, states that consumers and end users shape the development of new innovations. More recently the model of open innovation has emerged: companies can no longer rely on their own research but must instead combine their own ideas and research with external research e.g. by buying

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4 This section is a revised version of the Future Challenges section of the EIS 2007 report.

5 Also see Arundel, A. and H. Hollanders (2008), "Innovation Scoreboards: Indicators and Policy Use", in Nauwelaers, C. 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.

6 Alternative indicators and approaches to measure innovation were explored in two thematic papers in 2003 and 2004. The 2003 NIS thematic report (Arundel, 2004) investigated various structural and socio-cultural indicators and their impact on a country's innovation performance. The 2004 EXIS 2004 thematic report (Arundel and Hollanders, 2005) 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 (Hollanders and Arundel, 2007).

licenses and other external knowledge or by collaborating with other firms or research institutes to jointly develop new products or processes. Being involved in formal and informal networks is also becoming more important, a.o. to increase the capacity to absorb 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.

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 organisational innovation. Services innovation is also becoming more and more prevalent within manufacturing sectors (and firms). 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 reflect and measure new forms of innovation in future editions of the EIS, we must develop and incorporate new indicators measuring open innovation, user innovation and non-R&D innovation[7]. New indicators can draw on new data, in particular the improved measurement of marketing and organisational innovation and services innovation from the latest editions of the Community Innovation Survey. But more improvements in indicator development are needed to fully capture all innovation processes in the European economies.

2.2 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 (Sajeva et al., 2005). The robustness analysis in the report showed that both country groupings and country ranks within these groups are stable using a large number of different weighting schemes. Both conclusions confirmed the use of a simple weighting scheme using equal weights for all indicators in the calculation of the SII. Recent developments in composite indicator theory may call for changes in the current scheme. The SII transforms each indicator on a relative basis, where each indicator is measured relative to the best and worst performing country. The distribution of some of these indicators is highly skewed, e.g. patent applications, and the question has emerged whether or not to transform these indicators. For some indicators clear outliers have been identified and better alternatives to the ad-hoc solution to replace these by the next-best highest value should be investigated.

In addition, the EIS provides innovation performance based on 5 groups of indicators, the innovation dimensions, which have helped 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, as for example, R&D expenditures. But the EIS should focus more on measuring the outputs of the innovation process. And it is no longer justified classifying the indicators between input and output indicators only, one should also consider introducing process or throughput indicators.

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7 Cf. Arundel et al. (2008) for the importance of non-R&D innovation.

Assessing innovation performance inherently implies assessing the efficiency of the innovation process[8]. 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 and to identify areas for improvement, drawing, for example, from academic studies in this area.

Moreover, countries differ in their state of economic development and in their industrial specialisation patterns. Not all countries need to invest as heavily in innovation as some of the innovation leaders do; other strategies for improving economic well-being might be more realistic for those countries, e.g. by relying on productivity improvements driven by increases in more traditional production factors. Differences in industrial structure may validate the calculation of industry-adjusted indicators and differences between countries may imply using different indicator weights for different groups of countries.

Another important question is if the EIS should 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. Similarly, countries innovate to improve their economic performance. One possibility is to include economic indicators as a second layer of output indicators to measure the effect of innovation on the economic performance of a country.

2.3 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 of the sales share of new-to-market products) between countries may hamper the comparability of the results between Member States. Further improvements are needed to ensure international comparability.

In a globalising world, the EU needs to compare itself with new and emerging global competitors. Therefore, the EIS may need to include more non-EU countries. For ensuring comparable benchmark results, data should be collected from harmonized databases supplied by international institutes such as the OECD and 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 EU and non-EU countries. A globalising EIS could either aim at including as many indicators as possible or selecting a core set of indicators for which data are available for all countries[9].

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8 Cf. the results different to measure innovation efficiency in the EIS 2007 thematic report on innovation efficiency (Hollanders and Celikel-Esser, 2007).
9 The latter approach was adopted in the EIS 2006 thematic report on Global Innovation Scoreboards (Hollanders and Arundel, 2006). The GIS report is seriously hampered by the lack of CIS data for most non-EU countries and the use of different non-harmonized databases as compared to those used in the EIS.

2.4 Measuring progress and changes over time

The current EIS is designed as a tool for comparing innovation performance across Member States and other countries. However, changes in innovation performance over time also need to be measured to allow countries and regions to monitor progress in their 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 can 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 change 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 can be improved if it also allows to measure improvements in absolute innovation performance, creating opportunities for (national and regional) 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, improvements in the timeliness of the indicators, so that policy makers have more up to date measurements of performance, are required.

Measuring the dynamics of innovation performance over time also requires 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.

3. The EIS 2007 methodology: summary and criticism

3.1 EIS 2007 innovation dimensions and indicators

One of the main criticisms over the years has been that the EIS lacks an underlying model of the innovation process. The main purpose of such a model would be to explain the innovation process, its inputs, throughputs and outputs, and how these are related. But explaining the innovation process has never been the direct purpose of the EIS. The aim of the EIS is to measure innovation performance, and for measuring such performance we do not need a detailed model fully explaining the innovation process. Sufficient is a more general understanding of the factors which play a role in the innovation process and how they might be related.

The EIS 2005-2007 used 5 innovation dimensions, of which 3 reflected innovation inputs (Innovation drivers, Knowledge creation and Innovation & entrepreneurship) and 2 innovation outputs (Applications and Intellectual property) (cf. Table 1). Several aspects of the innovation process are not covered by these 5 dimensions, in particular broader non-technological or non-R&D innovation, socio-economic conditions and the financing of innovation activities. In the following sections the criticism on the EIS will be discussed in more detail.

TABLE 1: EIS 2007 INDICATORS

	INNOVATION DRIVERS (INPUT DIMENSION)	**Data source**
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)	**Data source**
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)	**Data source**
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)	**Data source**
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)	**Data source**
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

3.2 General criticism on the EIS

A number of articles have been published which contain criticisms of the EIS. These relate to many of the challenges set out above and can be summarised under the following headings. A more detailed analysis of the published criticisms is provided in Annex 2.

- Lack of innovation model
  The EIS lacks an underlying model of innovation that would justify the choice of innovation dimensions and indicators, and reflect underlying causalities that could be influenced by policy[10].

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10 For example. Rammer (2005) states that "new indicators should be identified and selected on … a conceptual analysis rather than on a simple statistical correlation analysis". Furthermore, "adapting [the] EIS should also focus on the question of data quality (including reliability as well as availability for a large number of countries) and the link between indicators and policy (distinguishing between performance indicators and policy indicators, the latter may be directly linked to policy actions)". Schibany et al., 2007, p. 5 remark that "any concise inference regarding the selection of indicators and … their mutual interaction is mostly ignored".

- Composite indicator

    The use of a single composite indicator and ranking table leads to "naming and shaming" (Grupp, 2006), while missing the complexity of the process behind one simple number (e.g. Cherchye et al., 2004).

- High-tech criticism

    Too many indicators measure innovation in high-tech industries. This would bias innovation performance in favour of those countries with industries specialised in high-tech industries, in particular in high-tech manufacturing.

- Multicollinearity

    Many of the indicators are (highly) correlated and these indicators may thus capture and measure the same underlying aspect of the innovation process. This was addressed by the 2005 EIS methodology report. However, it is still argued that this may be a problem and could create a bias towards these aspects, of which one example is innovation involving R&D[11].

- Missing data and timeliness of the data

    For many indicators and countries data are not available. Missing data would jeopardize a robust comparison of countries' performance. Differences in the timeliness of the data between indicators but also between countries for the same indicator cause similar problems.

- More is not always better

    The underlying assumption of the EIS is that a higher score on an indicator implies a better innovation performance. However, for several indicators, such as the share of enterprises receiving public funding for innovation, this may not necessarily be the case. A related problem is to define the value that indicators would assume at their optimum (optimal innovation capacity), where "optimal" values may also differ across countries[12].

Annex 2 provides a more detailed summary of the criticism on the EIS and the EIS 2007 indicators.

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11 E.g. Schibany and Streicher (2008); Rammer (2005). Rammer explicitly recommends to drop indicator 2.3 (Share of medium-high-tech and high-tech R&D), 3.2 (Innovative SMEs co-operating with others), 4.2 (Exports of high technology products as a share of total exports) and 5.3 (Triad patents per million population). Older versions of the EIS did include an analysis per indicator about its relation to innovation and interpretation. A short version of such an analysis is also included in Annex C of the EIS 2007 report.

12 Rammer's (2005) criticises the EIS 2005 indicators "Business R&D expenditures finances by the government sector" and "University R&D expenditures financed by the business sector" that "neither a fully state financed business R&D system nor a fully business financed university sector can be regarded as the optimal way of funding R&D". It could also be argued that this applies to the indicators on Business R&D, Share of medium-high and tech-tech R&D, Innovation expenditures, Early-stage venture capital and ICT expenditures where high spending "could also be a waste of scarce resources" and for the "ratio-indicators" where for many of these indicators a ratio of 100% cannot be the optimal level (cf. Schibany and Streicher, 2008).

4. New EIS 2008-2010 methodology

4.1 EIS 2008-2010 innovation dimensions

For the EIS 2008-2010, following a better understanding of the innovation process and lessons learned from previous revisions of the EIS, the number of dimensions will be increased to 7 and grouped into 3 main blocks of dimensions. The purpose of this revision is to have dimensions that bring together a set of related indicators in order to give a balanced assessment of the innovation performance in that dimension. The blocks and dimensions have been designed to accommodate the diversity of different innovation processes and models that occur in different national contexts.

The three blocks of dimensions comprise Enablers, Firm activities and Outputs:

- **ENABLERS** captures the main drivers of innovation that are external to the firm and is divided into the following 2 dimensions:
    - o **Human resources** – the availability of high-skilled and educated people – are one of the most important innovation drivers.
    - o **Finance and support** – the availability of finance for innovation projects and the support of governments for innovation activities are also important drivers of innovation.

- **FIRM ACTIVITIES** captures innovation efforts that firms undertake recognising the fundamental importance of firms' activities in the innovation process. This is captured in the following 3 dimensions:
    - o **Firm investments** – This dimension covers a range of different investments firms make in order to generate innovations. It includes investments needed to generate new products or processes – i.e. technological innovation – as well as for introducing "softer" innovations as marketing and organisational innovations – i.e. non-technological innovation -. Such investments can be done by performing R&D but also by using already existing knowledge, e.g. by buying more efficient machinery and equipment.
    - o **Linkages & entrepreneurship** – This dimension captures the entrepreneurial efforts and the related collaboration efforts among innovating firms and also with the public sector.
    - o **Throughputs** – This dimension captures the Intellectual Property Rights (IPR) generated as a throughput in the innovation process including IPR relevant for both technological and non-technological innovation and Technology Balance of Payments flows.

- **OUTPUTS** captures, on the basis of available indicators, the outputs of firm activities and is divided into the following 2 dimensions:
    - o **Innovators** – This dimension captures the success of innovation by the number of firms that have introduced innovations onto the market or within their organisations. It covers both technological and non-technological innovations.
    - o **Economic effects** – This dimension captures the economic success of innovation in employment, exports and sales due to innovation activities.

It is considered that the above described dimensions form the core of national innovation performance. In addition, there are wider socio-economic factors that influence

innovation, such as the role of governments, markets, social factors and the demand and acceptance of innovation. These factors and their relationship with innovation performance have been explored in previous EIS thematic papers and will also be the subject of future thematic papers.

TABLE 2: INDICATORS FOR THE EIS 2008-2010

			Cf. to EIS 2007	Data source
ENABLERS				
	Human resources			
1.1.1	S&E and SSH graduates per 1000 population aged 20-29 (first stage of tertiary education)		Revised	Eurostat
1.1.2	S&E and SSH doctorate graduates per 1000 population aged 25-34 (second stage of tertiary education)		Revised	Eurostat
1.1.3	Population with tertiary education per 100 population aged 25-64		Same	Eurostat
1.1.4	Participation in life-long learning per 100 population aged 25-64		Same	Eurostat
1.1.5	Youth education attainment level		Same	Eurostat
	Finance and support			
1.2.1	Public R&D expenditures (% of GDP)		Same	Eurostat
1.2.2	Venture capital (% of GDP)		Revised	EVCA/ Eurostat
1.2.3	Private credit (relative to GDP)		New	IMF
1.2.4	Broadband access by firms (% of firms)		Revised	Eurostat
FIRM ACTIVITIES				
	Firm investments			
2.1.1	Business R&D expenditures (% of GDP)		Same	Eurostat
2.1.2	IT expenditures (% of GDP)		Revised	EITO/Eurostat
2.1.3	Non-R&D innovation expenditures (% of turnover)		Revised	Eurostat (CIS)
	Linkages & entrepreneurship			
2.2.1	SMEs innovating in-house (% of SMEs)		Same	Eurostat (CIS)
2.2.2	Innovative SMEs collaborating with others (% of SMEs)		Same	Eurostat (CIS)
2.2.3	Firm renewal (SMEs entries + exits) (% of SMEs)		New	Eurostat
2.2.4	Public-private co-publications per million population		New	Thomson/ ISI
	Throughputs			
2.3.1	EPO patents per million population		Same	Eurostat
2.3.2	Community trademarks per million population		Same	OHIM
2.3.3	Community designs per million population		Same	OHIM
2.3.4	Technology Balance of Payments flows (% of GDP)		New	World Bank
OUTPUTS				
	Innovators			
3.1.1	Technological (product/service/process) innovators (% of SMEs)		New	Eurostat (CIS)
3.1.2	Non-technological (marketing/organisational) innovators (% of SMEs)		Revised	Eurostat (CIS)
3.1.3	Resource efficiency innovators Unweighted average of the following 2 indicators:			
3.1.3a	○ Reduced labour costs (% of firms)		New	Eurostat (CIS)
3.1.3b	○ Reduced use of materials and energy (% of firms)		New	Eurostat (CIS)
	Economic effects			
3.2.1	Employment in medium-high & high-tech manufacturing (% of workforce)		Same	Eurostat
3.2.2	Employment in knowledge-intensive services (% of workforce)		Revised	Eurostat
3.2.3	Medium and high-tech exports (% of total exports)		Revised	Eurostat
3.2.4	Knowledge-intensive services exports (% of total services exports)		New	Eurostat
3.2.5	New-to-market sales (% of turnover)		Same	Eurostat (CIS)
3.2.6	New-to-firm sales (% of turnover)		Same	Eurostat (CIS)

4.2 EIS 2008-2010 innovation indicators

In this section we will discuss, for each of the new proposed dimensions, which indicators will be included in order to provide a better assessment of performance in each dimension. The selection of which indicators to include follows the principles of simplicity, transparency and continuity set out in Section 1. In addition, the choice of indicators is intended to provide a balance between different forms of innovation (e.g. technological and non-technological innovation) and different sectors (e.g. manufacturing and services). Annex 3 provides a summary of other indicator proposed by the participants at the EIS workshop on "Improving the European Innovation Scoreboard methodology" which, after careful consideration, were not selected for the new EIS methodology.

4.2.1 ENABLERS

Enablers capture innovation drivers external to the firm, including the supply of highly skilled human resources and availability of innovation finance and public support for innovation.

Human resources

This dimension captures the availability of high-skilled and educated people as a key input for innovation. It would correspond closely to the EIS 2007 "innovation drivers" dimension. Human Resources were considered a key condition for innovation according by the various workshop participants. The following indicators will be included:

- **1.1.1 S&E and SSH graduates per 1000 population aged 20-29**

  Numerator: Number of S&E (science and engineering) and SSH (social sciences and humanities) graduates at first stage of tertiary education (ISCED 5).

  S&E graduates are defined as all first-stage of tertiary education graduates (ISCED classes 5a and 5b) 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).

  SSH graduates are defined as all first-stage of tertiary education graduates (ISCED classes 5a and 5b) in arts (ISC21), humanities (ISC22), social and behavioural science (ISC 31), journalism and information (ISC32), business and administration (ISC34) and law (ISC38).

  Denominator: The reference population is all age classes between 20 and 29 years inclusive.

  Rationale: The indicator is a measure of the supply of new first-stage tertiary graduates with training in Science & Engineering (S&E) and Social Sciences & Humanities (SSH). Due to problems of comparability for educational qualifications across countries, this indicator uses broad educational categories. A broad coverage can be an advantage, since e.g. graduates of one-year programmes are of value to incremental innovation in manufacturing and in the service sector. The indicator is extended as compared to the EIS 2007 to include SSH graduates as these are considered highly relevant for services (activities) following a recommendation from one of the workshop participants. By broadening the definition of Human Resources in innovation, it is possible to established links not only with technological innovation but also with non-technological innovation, thus better capturing services innovation. The indicator has been limited to ISCED 5 only following the introduction of indicator 1.1.2 on doctorate graduates.

Data source: Eurostat

http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=REF_SI_IR&root=REF_SI_IR/si_ir/tsiir050

Metadata note:

http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/tsiir050_sm1.htm

- **1.1.2 S&E and SSH doctorate graduates per 1000 population aged 25-34**

  Numerator: Number of S&E (science and engineering) and SSH (social sciences and humanities) graduates at second stage of tertiary education (ISCED 6).

  S&E graduates are defined as all second-stage of tertiary education graduates (ISCED class 6) 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).

  SSH graduates are defined as all second-stage of tertiary education graduates (ISCED class 6) in arts (ISC21), humanities (ISC22), social and behavioural science (ISC 31), journalism and information (ISC32), business and administration (ISC34) and law (ISC38).

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

  Rationale: The indicator is a measure of the supply of new second-stage tertiary graduates with training in Science & Engineering (S&E) and Social Sciences & Humanities (SSH). For most countries ISCED 6 captures PhD graduates only, with the exception of Finland, Portugal and Sweden where also non-PhD degrees leading to an award of an advanced research qualification are included.

  Data source: Eurostat

  Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/tsiir050_sm1.htm

- **1.1.3 Population with tertiary education per 100 population aged 25-64**

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

  Denominator: The reference population is all age classes between 25 and 64 years inclusive.

  Rationale: This is a general indicator of the supply of advanced skills. It is not limited to science and technical fields because the adoption of innovations in many areas, in particular in the service sectors, depends on a wide range of skills. 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.

  Data source: Eurostat

  Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/lfsq_sm1.htm

- **1.1.4 Participation in life-long learning per 100 population aged 25-64**

  Numerator: 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.

Denominator: The reference population is all age classes between 25 and 64 years inclusive.

Rationale: A central characteristic of a knowledge economy is ongoing 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[13].

Data source: Eurostat

http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal &_schema=PORTAL&screen=detailref&language=en&product=REF_SI_EM&root=REF _SI_EM/si_em/tsiem080

Eurostat Metadata note:

http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/tsiem080_sm1.htm

- **1.1.5 Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)**

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

  Denominator: The reference population is all age classes between 20 and 24 years inclusive, excluding no answers to the questions 'highest level of education or training attained'.

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

  Data source: Eurostat

  http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal &_schema=PORTAL&screen=detailref&language=en&product=REF_SI_IR&root=REF_ SI_IR/si_ir/tsiir110

  Eurostat Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/tsiem080_sm1.htm

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13 A concern was raised at the EIS Workshop about the timing of the survey as life-long learning is assessed by participation in any type of education or training course during the four weeks prior to the survey: "Life-long learning courses are very seasonal, i.e. most are done during the autumn and winter months rather than spring and summer months. If the survey is completed during the latter two periods, no true reflection will be obtained." However, from 27 October 2006, the indicator is based on annual averages of quarterly data instead of one unique reference quarter in spring. This will improve the accuracy and reliability of the indicator thanks to a better coverage of all weeks of the year and an increased sample size.

Finance and support

This dimension captures indicators measuring the availability of innovation finance and public support for innovation. The following indicators will be included:

- ### 1.2.1 Public R&D expenditures (% of GDP)

  <u>Numerator</u>: 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.

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

  <u>Rationale</u>: 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.

  <u>Data source</u>: Eurostat

  http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/data/science/research/rd/rd_e&language=en&product=EU_MAIN_TREE&root=EU_MAIN_TREE&scrollto=53

  <u>Eurostat Metadata note</u>:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/rd_base.htm

- ### 1.2.2 Venture capital (% of GDP)

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

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

  <u>Rationale</u>: The amount of venture capital is a proxy for the relative dynamism of new business creation. In particular for enterprises using or developing new (risky) technologies venture capital is often the only available means of financing their (expanding) business. By broadening the definition from early-stage VC only (EIS 2007) to early-stage and expansion and replacement VC the indicator will provide a better picture on the availability of a domestic VC industry and will also decrease volatility.

  <u>Comment</u>: Venture capital is a highly volatile indicator. Therefore two-year averages will be used to reduce volatility rates. In addition an indicator of private credit is

included to capture national contexts where such credit is important for financing innovation (cf. indicator 1.2.3).

Data source: EVCA (European Venture Capital Association)/Eurostat

http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=REF_SI_IR&root=REF_SI_IR/si_ir/tsiir080

Eurostat Metadata note:

http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/htec_vci_base.htm

- **1.2.3 Ratio of credit towards the private sector from deposit-taking financial institutions relative to GDP**

  Numerator: Claims on the private sector by commercial banks and other financial institutions that accept transferable deposits such as demand deposits (line 22d of IMF International Financial Statistics).

  Denominator: Gross domestic product (line 99b of IMF International Financial Statistics).

  Rationale: Following FORA's InnovationMonitor (FORA, 2007), the availability of private credit is used as an indicator for the supply of start-up capital. This indicator is the most reliable available indicator for finance for innovation other than venture capital and given the importance of finance as an enabler for innovation it is included as an innovation indicator. A study by Lederman and Maloney (2003) also shows that deeper capital markets as measured by the availability of private credit facilitate R&D investments.

  Data source: IMF, International Financial Statistics

- **1.2.4 Broadband access**

  Numerator: Number of enterprises (excluding the financial sector) with 10 or more employees with broadband access.

  Denominator: Total number of enterprises (excluding the financial sector) with 10 or more employees.

  Rationale: Realising Europe's full e-potential depends on creating the conditions for electronic commerce and the Internet to flourish. This indicator captures the relative use of this e-potential by the number of enterprises that have access to broadband.

  Comment: The preferred indicator would also capture mobile broadband access but such data are not yet available.

  Data source: Eurostat

  Eurostat Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/isoc_pi_base.htm

4.2.2 FIRM ACTIVITIES

Firm activities capture innovation efforts at the firm level. The following indicators will be included.

Firm investments

This dimension replaces the "Knowledge creation" dimension of the EIS 2007 and focuses on the relative size and distribution between sectors of performance of countries' R&D expenditures. R&D performance depends on the industrial structure and firms' size distribution and may be criticised as having a high tech bias. However, this bias should

be balanced out by the 'non-technological innovation' dimension[14]. The following indicators will be included:

- **2.1.1 Business R&D expenditures (% of GDP)**

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

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

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

  Data source: Eurostat

  http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/data/science/research/rd/rd_e&language=en&product=EU_MAIN_TREE&root=EU_MAIN_TREE&scrollto=53

  Eurostat Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/rd_base.htm

- **2.1.2 IT expenditures (% of GDP)**

  Numerator: Total expenditures on IT, in national currency and current prices. IT expenditures capture hardware, software and other services. The data cover the total market, including expenditure of the public and private sector (enterprises, as well as those of individuals and households).

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

  Rationale: IT is a fundamental feature of knowledge-based economies and the driver of current and future productivity improvements. An indicator of IT 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.

  Comment: The EIS 2007 indicator captured all ICT expenditures, thus both IT and Communications expenditure. The Communications component is no longer included as these expenditures appear to capture carrier services not related to innovation, in particular in several of the new member states[15].

  Data source: EITO/Eurostat

  http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=REF_SI_IR&root=REF_SI_IR/si_ir/tsiir090

  Eurostat Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/tsiir090_base.htm

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14 Future thematic papers under the EIS could investigate the use of industry adjusted indicators.

15 Cf. the two graphs on IT and communication expenditure relative to the 2007 Summary Innovation Index on page 13 in the EIS Workshop output report (Hollanders and van Cruysen, 2008b).

- **2.1.3. Non-R&D innovation expenditures (% of total turnover)**

  <u>Numerator</u>: Sum of total innovation expenditure for enterprises, in national currency and current prices excluding intramural and extramural R&D expenditures. (Community Innovation Survey: CIS-4 question 5.2, sum of variables RMACX and ROEKX)

  <u>Denominator</u>: Total turnover for all enterprises (both innovators and non-innovators), in national currency and current prices. (Community Innovation Survey: CIS-4 question 11.1, variable TURN04)

  <u>Rationale</u>: This indicator measures non-R&D innovation expenditure[16] 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. Compared to the EIS 2007 the indicator no longer captures intramural and extramural R&D expenditures and thus no longer overlaps with the indicator on business R&D expenditures.

  <u>Data source</u>: Eurostat (Community Innovation Survey)

  <u>Eurostat Metadata note</u>:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/inn_cis4_sm1.htm

Linkages & entrepreneurship

Entrepreneurship, networks and linkages between actors have been considered key concepts in innovation by workshop participants. Participants stressed the importance of co-operation not only at national but also at international level, reflecting diffusion of innovation among actors. Indicators of scientific publications and co-patents are indicative of levels of cooperation. The following indicators will be included:

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

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

  Data are taken from CIS4 question 2.2 and 3.2, i.e. those SMEs which are either:
    - A product innovator who, to the question "Who developed these product innovations", answered Yes to at least one of the following categories of CIS4 question 2.2: "Mainly your enterprise or enterprise group" or "Your enterprise together with other enterprises or institutions".
    - A process innovator who, to the question "Who developed these process innovations", answered Yes to at least one of the following categories of CIS4 question 3.2: "Mainly your enterprise or enterprise group" or "Your enterprise together with other enterprises or institutions".

  <u>Denominator</u>: Total number of SMEs (both innovators and non-innovators).

  <u>Rationale</u>: 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 towards larger firms tend to do better.

  <u>Data source</u>: Eurostat (Community Innovation Survey)

  <u>Metadata note</u>:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/inn_cis4_sm1.htm

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16 This strategy of "non-R&D innovation" is more prevalent amongst services and low-tech manufacturing sectors (cf. Huang et al. (2008) for a discussion on why firms decide not to invest in R&D and Arundel et al. (2008) for a detailed analysis of non-R&D innovators). This analysis also shows that there is no significant difference in performance (growth in revenue) between R&D innovators and non-R&D innovators.

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

  Numerator: Sum of SMEs with innovation co-operation activities. Firms with co-operation activities are those that had any co-operation agreements on innovation activities with other enterprises or institutions in the three years of the survey period (i.e. those SMEs who replied Yes to CIS-4 question 6.2).

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

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

  Data source: Eurostat (Community Innovation Survey)

  Eurostat Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/inn_cis4_sm1.htm

- ## 2.2.3 Firm renewal (SMEs entries and exits as a % of all SMEs)

  Definition: The indicator is defined as the sum of the number of births and deaths of enterprises divided by the number of all firms. Only firms with at least 5 employees and who are active in NACE classes C, D, E, G51, I, J and K are included.

  Numerator: A birth amounts to the creation of a combination of production factors with the restriction that no other enterprises are involved in the event. Births do not include entries into the population due to mergers, break-ups, split-off or restructuring of a set of enterprises. It does not include entries into a sub-population resulting only from a change of activity. A birth occurs when an enterprise starts from scratch and actually starts activity. An enterprise creation can be considered as an enterprise birth if new production factors, in particular new jobs, are created. If a dormant unit is reactivated within two years, this event is not considered a birth. A death amounts to the dissolution of a combination of production factors with the restriction that no other enterprises are involved in the event. Deaths do not include exits from the population due to mergers, take-overs, break-ups or restructuring of a set of enterprises. It does not include exits from a sub-population resulting only from a change of activity. An enterprise is included in the count of deaths only if it is not reactivated within two years. Equally, a reactivation within two years is not counted as a birth.

  Denominator: Total number of SMEs.

  Rationale: An important aspect of this dimension is the existence of new firms in an economy which would signal to an innovative environment, where enterprise births (creation) take place in parallel with enterprises death (discontinuation) and survival, reflecting what is known as "creative destruction". According to a recent Eurostat report (Eurostat, 2008) on enterprises birth, survival and death, based on data of 15 Member States for 2005, enterprises born in 2005 represented about 10% of all active enterprises. Employment in newly born enterprises tended to offset employment losses as a result of enterprises death. As for surviving firms, those that survive employed more persons than the initial employment levels among all newly born enterprises in 2000. These statistics point to the relevance of new firms in the economy, even though there were significant differences among member states and economic sectors.

  Comment: Following comments from the EIS workshop 16 June 2008, only firms with at least 5 employees and who are active in NACE classes C, D, E, G51, I, J and K are included "in order to avoid measuring firm turbulence in retail trade, restaurants,

construction services and other sectors that are predominantly based on non-innovation competition".

<u>Data source</u>: Eurostat (Business demography indicators presented by size class)

- **2.2.4 Scientific public-private co-publications per million population**

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

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

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

  <u>Comment</u>: Data are two-year averages. The quantity of public-private co-publications is highly skewed across countries and this indicator has no pre-determined maximum value: a square root transformation will therefore be used to reduce the volatility and skewed distribution of scores on this indicator.

  <u>Data source</u>: Thomson Reuters/CWTS *Web of Science* database. All data manipulations will be done by CWTS (Leiden University, http://www.cwts.nl).

Throughputs

This dimension should capture some of the intermediate results from the innovation process. The IPR indicators from the EIS 2007 "intellectual property" dimension could be included in this dimension, including patents resulting from technological innovation and trademarks and industrial designs also resulting from non-technological and services innovation. Workshop participants suggested that differences among sectors should be considered in the EIS. This sectoral approach is captured by using both technological and non-technological throughput indicators, reflecting different types of innovation, innovation modes and economic specialization of countries. The following indicators will be included:

- **2.3.1 EPO patents per million population**

  <u>Numerator</u>: 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.

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

  <u>Rationale</u>: 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.

  <u>Comment</u>: This is a rapidly increasing and highly skewed indicator with no pre-determined maximum value. A square root transformation will be used to reduce the volatility and skewed distribution of this indicator.

Data source: Eurostat

http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=REF_SI_IR&root=REF_SI_IR/si_ir/tsiir060

Eurostat Metadata note:

http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/pat_epo_base.htm

- **2.3.2 Community trademarks per million population**

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

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

  Rationale: "Trademarks are an important innovation indicator, especially for the service sector" (Frietsch, 2005). The Community trademark gives its proprietor a uniform right applicable in all Member States of the European Union through a single procedure which simplifies trademark policies at European level. It fulfils the three essential functions of a trademark: it identifies the origin of goods and services, guarantees consistent quality through evidence of the company's commitment vis-à-vis the consumer, and is a form of communication, a basis for publicity and advertising. 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.

  Comment: This is a rapidly increasing and highly skewed indicator with no pre-determined maximum value: a square root transformation will be used to reduce the volatility and skewed distribution of this indicator.

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

  http://oami.europa.eu/ows/rw/pages/OHIM/statistics.en.do

- **2.3.3 Community designs per million population**

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

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

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

Comment: This is a rapidly increasing and highly skewed indicator with no pre-determined maximum value. A square root transformation will be used to reduce the volatility and skewed distribution of this indicator.

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

http://oami.europa.eu/ows/rw/pages/OHIM/statistics.en.do

- **2.2.4 Technology Balance of Payments flows (receipts plus payments) (% of GDP)**

  Numerator: Royalty and license fees, receipts (BoP, current US$) plus Royalty and license fees, payments (BoP, current US$).

  Denominator: GDP (current US$).

  Rationale (OECD, Science, Technology and Industry Scoreboard 2007): Technology receipts and payments constitute the main form of disembodied technology diffusion. Trade in technology comprises four main categories: Transfer of techniques (through patents and licences, disclosure of know-how); Transfer (sale, licensing, franchising) of designs, trademarks and patterns; Services with a technical content, including technical and engineering studies, as well as technical assistance; and Industrial R&D. TBP payments capture disembodied technology acquisition, TBP receipts capture disembodied technology exports. We do not use the balance of receipts and payments as this would hide the underlying size of technology flows. For many catching-up countries technology imports are as important for improving the efficiency of the production processes as technology exports are for the "innovation leaders" in the commercialisation of their close-to-the-frontier technological activities[17].

  Data source: World Bank, World Development Indicators

  http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:217 25423~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html

  Workshop recommendations: COTEC (Simões, 2008) recommends including TBP payments and receipts as separate indicators. TBP payments would be included under firm activities capturing disembodied technology acquisition. TBP receipts would be included under outputs capturing disembodied technology exports.

4.2.3 OUTPUTS

Outputs capture the results of innovation both the relative prominence of innovating firms and by several economic effects of innovation activities and the results of innovation in high-tech and knowledge-intensive industries. The following indicators will be included:

Innovators

In terms of types of innovators (technological, non-technological, organizational and marketing), workshop participants suggested reflecting both embodied and disembodied technologies, but with special care when using "perception based" indicators, which are collected in the CIS – Community Innovation Survey. For this reason, these indicators received a lower weight when compared to other indicators.

Furthermore, different types of innovators reflect different innovation modes and take into account sector differences (both tangibles and intangibles outputs). These differences were also considered in the sub-dimension "throughputs" within the dimension "Firm activities".

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17 Simões (2008) recommends including TBP payments and receipts as separate indicators. TBP payments should be included under firm activities capturing disembodied technology acquisition. TBP receipts should be included under outputs capturing disembodied technology exports. For the EIS we prefer to use one TBP indicator capturing technology flows.

- **3.1.1 Technological (product or process) innovators (% of all SMEs)**

  <u>Numerator</u>: The number of SMEs who introduced a new product or a new process to one of their markets.

  Data are taken from CIS-4 questions 2.1 and 3.1, i.e. those SMEs which have either introduced:
    - A product innovation, i.e. have introduced either "New or significantly improved goods" or "New or significantly improved services".
    - A process innovation, i.e. have introduced either "New or significantly improved methods of manufacturing or producing goods or services", "New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services" or "New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing".

  <u>Denominator</u>: Total number of SMEs.

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

  <u>Data source</u>: Eurostat (Community Innovation Survey)

  <u>Eurostat Metadata note</u>:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/inn_cis4_sm1.htm

- **3.1.2 Non-technological (marketing or organisational) innovators (% of all SMEs)**

  <u>Numerator</u>: The number of SMEs who introduced a new marketing innovation and/or organisational innovation to one of their markets.

  Data are taken from CIS-4 question 10.1, i.e. those SMEs which have either introduced:
    - A marketing innovation, i.e. have introduced either "'Significant changes to the design or packaging of a good or service" or "New or significantly changed sales or distribution methods, such as internet sales, franchising, direct sales or distribution licenses".
    - An organisational innovation, i.e. have introduced either "New or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within your enterprise", "A major change to the organisation of work within your enterprise, such as changes in the management structure or integrating different departments or activities" or "New or significant changes in your relations with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting".

  <u>Denominator</u>: Total number of SMEs.

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

  <u>Data source</u>: Eurostat (Community Innovation Survey)

  <u>Eurostat Metadata note</u>:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/inn_cis4_sm1.htm

- **3.1.3 Resource efficiency innovators**

  This indicator is captured by the following two sub-indicators each contributing for 50% of the overall score for resource efficiency innovators:

  - **3.1.3a Reduced labour costs resulting from process innovations**

    Numerator: Number of innovating firms who replied that their product or process innovation had a highly important effect on reducing labour costs per unit of output (CIS-4 question 7.1, variable ELBR).

    Denominator: Total number of innovating firms.

    Rationale: This indicator captures the cost savings from process innovation.

    Comment: This indicator will be included jointly with indicator 3.1.3b using a relative weight of 50%.

    Data source: Eurostat (Community Innovation Survey)

    Metadata note:

    http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/inn_cis4_sm1.htm

  - **3.1.3b Reduced use of materials and energy resulting from process innovations**

    Numerator: Number of innovating firms who replied that their product or process innovation had a highly important effect on reducing materials and energy per unit of output (CIS-4 question 7.1, variable EMAT).

    Denominator: Total number of innovating firms.

    Rationale: This indicator captures the energy savings from process innovation and is thus a partial proxy for eco-innovation.

    Comment: This indicator will be included jointly with indicator 3.1.3a using a relative weight of 50%.

    Data source: Eurostat (Community Innovation Survey)

    Eurostat Metadata note:

    http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/inn_cis4_sm1.htm

Economic performance

This dimension would correspond to the EIS 2007 "Applications" dimension. A criticism of this dimension is that it focuses too much on high-tech performance (Schibany et al., 2007). Here one could better integrate the economic outputs of innovation, e.g. level and/or growth in labour productivity with several of the current EIS indicators. The following indicators will be included:

- **3.2.1 Employment in knowledge-intensive services (% of total workforce)**

  Numerator: Number of employed persons in the knowledge-intensive services sectors. These include water transport (NACE 61), air transport (NACE 62), post and telecommunications (NACE64), financial intermediation (NACE 65), insurance and pension funding (NACE 66), activities auxiliary to financial intermediation (NACE 67), real estate activities (NACE 70), renting of machinery and equipment (NACE 71), computer and related activities (NACE72), research and development (NACE73) and other business activities (NACE 74).

  Denominator: The total workforce includes all manufacturing and service sectors.

  Rationale: Knowledge-intensive 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.

Data source: Eurostat (High-tech industry and knowledge-intensive services: Economic, Science & Technology and Employment statistics)

Eurostat Metadata note:

http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/htec_sm1.htm

- **3.2.2 Employment in medium-high and high-tech manufacturing (% of total workforce)**

  Numerator: 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).

  Denominator: The total workforce includes all manufacturing and service sectors.

  Rationale: The share of employment in 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.

  Data source: Eurostat (High-tech industry and knowledge-intensive services: Economic, Science & Technology and Employment statistics)

  Eurostat Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/htec_sm1.htm

- **3.2.3 Exports of medium and high technology products as a share of total exports**

  Numerator: Value of medium and high-tech exports, in national currency and current prices. High-tech exports include exports of the following SITC Rev.3 products: 266, 267, 512, 513, 525, 533, 54, 553, 554, 562, 57, 58, 591, 593, 597, 598, 629, 653, 671, 672, 679, 71, 72, 731, 733, 737, 74, 751, 752, 759, 76, 77, 78, 79, 812, 87, 88 and 891 (cf. Hollanders, 2006).

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

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

  Data source: Eurostat/UN Comtrade

  http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=REF_SI_IR&root=REF_SI_IR/si_ir/tsiir160

  Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/tsiir160_base.htm

- **3.2.4 Exports of knowledge-intensive services as a share of total services exports**

  Numerator: Exports of knowledge-intensive services are measured by the sum of credits in EBOPS (Extended Balance of Payments Services Classification) 207, 208,

211, 212, 218, 228, 229, 245, 253, 254, 260, 263, 272, 274, 278, 279, 280 and 284. Total KIS exports will be overestimated as EBOPS 284 also covers activities in ISIC 90 Sewage and refuse disposal, sanitation and similar activities but it is expected that this overestimation is marginal.

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

Rationale: The indicator measures the competitiveness of the knowledge-intensive services sector. The indicator is comparable to indicator 3.2.3 on high-tech manufacturing export performance. Knowledge-intensive services are defined as NACE classes 61-62 and 64-72. These can be related to the above-mentioned EBOPS classes using the correspondence table between NACE, ISIC and EBOPS as provided in the UN Manual on Statistics of International Trade in Services (UN, 2002) (cf. Annex 4 for more details).

Data source: Eurostat (Balance of Payments statistics)

Metadata note:

http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/bop_q_sm1.htm

- **3.2.5 Sales of new-to-market products (% of total turnover)**

  Numerator: Sum of total turnover of new or significantly improved products for all enterprises. (Community Innovation Survey, CIS-4 question 2.3, variable TURNMAR)

  Denominator: Total turnover for all enterprises (both innovators and non-innovators), in national currency and current prices. (Community Innovation Survey: CIS-4 question 11.1, variable TURN04)

  Rationale: 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.

  Data source: Eurostat (Community Innovation Survey)

  Eurostat Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/inn_cis4_sm1.htm

- **3.2.6 Sales of new-to-firm products (% of total turnover)**

  Numerator: Sum of total turnover of new or significantly improved products to the firm but not to the market for all enterprises. (Community Innovation Survey, CIS-4 question 2.3, variable TURNIN)

  Denominator: Total turnover for all enterprises (both innovators and non-innovators), in national currency and current prices. (Community Innovation Survey: CIS-4 question 11.1, variable TURN04)

  Rationale: 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 for 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.

  Data source: Eurostat (Community Innovation Survey)

  Eurostat Metadata note:

  http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/inn_cis4_sm1.htm

5. Methodology for calculating composite innovation indexes

For each of the 7 innovation dimensions average performance will be summarized by calculating a composite innovation index. For each of the 3 blocks of dimensions average performance will be summarized by calculating a weighted composite index using the composite innovation indexes for those dimensions belonging to a specific block. Overall innovation performance will be summarized in the Summary Innovation Index. The methodology of calculating these composite innovation indexes will now be explained in detail.

Note that compared to the EIS 2007 methodology, we no longer use relative to EU scores. This follows the suggestion by Tarantola (2008) that "to obtain meaningful growth rate figures, each component indicator should be relative to the EU score at the starting year … before the normalization". As dividing all scores by one common value would not change the relative performance between countries, we have, for reasons of simplicity, decided not to use relative to EU scores.

Step 1: Transforming data

> Most of the EIS indicators are fractional indicators with values between 0% and 100%. Some EIS indicators are unbound indicators, where values are not limited to an upper threshold. These indicators can be highly volatile and have skewed data distributions (where most countries show low performance levels and a few countries show exceptionally high performance levels. For these indicators – scientific public-private co-publications, EPO patents, Community trademarks and Community designs, all measured per million population – data will be transformed using a square root transformation, i.e. by replacing the original value by its square root.

Step 2: Identifying outliers

> Positive outliers are identified as those relative scores which are higher than the EU mean plus 3 times the standard deviation[18]. Negative outliers are identified as those relative scores which are smaller than the EU mean minus 3 times the standard deviation. These outliers are not included in determining the Maximum and Minimum scores in the normalisation process (cf. Step 5).

Step 3: Setting reference years

> For each indicator a reference year is identified based on data availability for all core EIS countries, i.e. those countries for which data availability is at least 70%. For most indicators this reference year will be lagging 1 or 2 years behind the year to which the EIS refers. Thus for the EIS 2008 the reference year will be 2006 or 2007 for most indicators.

Step 4: Sorting data over time

> Reference year data are then used for "2008", etc. If data for a year-in-between is not available we substitute with the value for the previous year. If data are not available at the beginning of the time series, we replace missing values with the

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18 This approach follows the well-adopted Chauvenet's Criterion in statistical theory, but we use a range of 3 standard deviations around the mean instead of the usual range of 2 standard deviations.

latest available year. The following examples will clarify this step and will show how 'missing' data are imputed:

Example 1 (latest year missing)					
	"2008" or reference year	"2007"	"2006"	"2005"	"2004"
Available relative to EU score	Missing	150	120	110	105
Use most recent year	**150**	150	120	110	105
Example 2 (year-in-between missing)					
	"2008"	"2007"	"2006"	"2005"	"2004"
Available relative to EU score	150	Missing	120	110	105
Substitute with previous year	150	**120**	120	110	105
Example 3 (beginning-of-period missing)					
	"2008"	"2007"	"2006"	"2005"	"2004"
Available relative to EU score	150	130	120	Missing	Missing
Substitute with latest available year	150	130	120	**120**	**120**

If for any of these 'missing' data real data will become available for the EIS 2009 or EIS 2010, then the 'imputed' values will be replaced by these real data. This might cause some marginal deviations between the composite index scores between the EIS 2008, 2009 and 2010 reports.

Step 5: Extrapolating data

For all indicators and countries we extrapolate data for 2009 and 2010 by assuming the same percentage increase between "2008" and "2007", where for all fractional indicators extrapolated data can never be above 100. The rationale for this extrapolation is to take account of further increases in indicator values beyond the maximum or below the minimum values found within the observed 5 year time period using real data. This way we can fix the Maximum and Minimum scores (cf. Step 6) for the EIS 2009 and EIS 2010 to ensure full comparability of SII scores between the EIS 2008 report and future EIS reports so that there will be no break in series between these different EIS reports for the various composite innovation indexes.

Step 6: Determining Maximum and Minimum scores

The Maximum score is the highest relative score found for the whole time period (including the two extrapolated years) within the group of core EIS countries (i.e. those countries for which data availability is at least 70%[19]) excluding positive outliers and 'small' countries with populations of 1 million or less (i.e. Cyprus, Iceland, Luxembourg and Malta) as these small countries are 1) responsible for some of the observed outliers (cf. Step 2) and 2) due to their small size cannot be taken as representative for most of the other (larger) countries. Similarly, the Minimum score is the lowest relative score found for the whole time period within the group of core EIS countries excluding negative outliers and 'small' countries.

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19 Note that this criterion of data availability of at least 70% only applied for the EIS 2008. If overall data availability improves in future versions of the EIS this criterion can be tightened.

<u>Step 7: Calculating re-scaled scores</u>

Re-scaled scores of the relative scores for all years are calculated by first subtracting the Minimum score and then dividing by the difference between the Maximum and Minimum score. The maximum re-scaled score is thus equal to 1 and the minimum re-scaled score is equal to 0. For positive and negative outliers, small core countries and non-core countries where the value of the relative score is above the Maximum score or below the Minimum score, the re-scaled score is set equal to 1 respectively 0.

<u>Step 8: Calculating composite innovation indexes</u>

For each year and for each innovation dimension (Human resources, Finance and support, Firm investments, Linkages & entrepreneurship, Throughputs, Innovators, Economic effects) a dimension composite innovation index (DCII) is calculated as the unweighted average of the re-scaled scores for all indicators within the respective dimension. These DCI's will only be calculated if data are available for a sufficient amount of indicators within each dimension.

For each year and for each block of dimensions (Enablers, Firm activities, Outputs) a block composite innovation index (BCII) is calculated as the unweighted average of the re-scaled scores for all indicators within the respective block. These BCI's will only be calculated if data are available for a sufficient amount of indicators within each block.

For each year the Summary Innovation Index (SII) is calculated as the unweighted average of the re-scaled scores for all indicators. The SII will only be calculated if data are available for at least 70% of the indicators.

It is important to point out that due to the fact that all scores are no longer relative to that of the EU, growth formulas will capture real rates of improvement whereas the growth formulas used in the EIS 2007 captured rates of improvement relative to the EU.

6. Conclusions and forthcoming analyses

In the previous sections we have presented the new set of dimensions and indicators for the EIS 2008, EIS 2009 and EIS 2010. Compared to the EIS 2007, the number of indicators has increased from 25 to 29, of which 15 have remained the same, 9 have been revised and 5 are new. One of the principles for the current revision for the EIS 2008-2010 was to guarantee a good level of continuity with the results of previous years, and with a dissimilarity index of 33%, the introduction of this new methodology is not that different as the introduction of revised methodologies in 2003 and 2005 (cf. the dissimilarity indexes for the EIS 2003 and EIS 2005 in Annex 1).

The new set of indicators takes into account the main challenges discussed in the EIS 2007 report (cf. Section 2). Discussions with stakeholders (a.o. at the EIS Workshop in June 2008 in Brussels) have proven that the new (and revised) indicators are seen by most of these stakeholders as valuable additions to the EIS approach.

The methodology for calculating the composite innovation indexes has been revised. The previous EIS reports focused on measuring performance relative to the EU and thus were not able to track absolute changes over time in innovation performance. The new methodology no longer uses a relative to EU performance and the composite innovation index scores can now be used to track real changes over time in innovation performance. The normalisation procedure has also been fixed for the forthcoming EIS 2009 and EIS 2010 reports, improving greatly the comparability in results between the current EIS 2008 report and these two future reports. The 2008 EIS will include time series data for the new set of indicators and the Summary Innovation Indicator for a five-year period.

The EIS 2008 report will also include more in-depth analyses of changes in innovation performance over time. This analysis will consider growth rates over different periods of time, e.g. both the latest annual percentage change and the average annual percentage change over a longer time period. It will also examine some of the other growth formulas as discussed in Tarantola (2008) in order to determine for each country the key drivers for their changes in innovation performance.

The EIS 2008 report will also make a difference between core and non-core countries. Core countries are those countries with relatively good data availability, including the EU27 Member States, the EFTA countries and some other European countries. For these countries composite innovation indexes will be calculated using the new set of indicators. For non-core countries, mostly non-European countries lacking e.g. comparable statistics from the Community Innovation Survey (CIS), the analysis will be based on the results from the 2008 Global Innovation Scoreboard (GIS) which will include a larger sample of non-EU countries using a more limited set of innovation indicators. The EIS 2008 report will include a detailed comparison between the EU27 and the US and Japan based on the 2008 GIS results.

References

Arundel, Anthony (2004), "NIS Indicators and Innovation: Are there European modes of innovation?", Brussels: European Commission, DG Enterprise.

Arundel, Anthony and Hugo Hollanders (2005), "EXIS: An Exploratory Approach to Innovation Scoreboards", Brussels: European Commission, DG Enterprise.

Arundel, Anthony and Hugo Hollanders (2008), "Innovation Scoreboards: Indicators and Policy Use", in Claire Nauwelaers and René Wintjes (eds.), "Innovation Policy in Europe", Edward Elgar: Cheltenham, February 2008.

Arundel, Anthony, Catalina Bordoy and Minna Kanerva (2008), "Neglected innovators: How do innovative firms that do not perform R&D innovate? Results of an analysis of the Innobarometer 2007 survey No. 215", INNO Metrics 2007 report, Brussels: European Commission, DG Enterprise.

Cherchye, L., W. Moesen and T. van Puyenbroeck (2004), "Legitimately Diverse, Yet Comparable: On Synthesizing Social Inclusion Performance in the EU", Journal of Common Market Studies, 42 (5), pp. 919 - 955.

Eurostat (2008), "Enterprise births, survivals and deaths - employment effects", Statistics in focus 44/2008.

FORA (2007), "InnovationMonitor 2007", Danish Enterprise and Construction Authority's Division for Research and Analysis.

Frietsch, Rainer (2005), "Comments on the European Innovation Scoreboard 2005", Fraunhofer ISI.

Grupp, Hariolf (2006), "How robust are composite innovation indicators for evaluating the performance of national innovation systems?", University of Karlsruhe and Fraunhofer ISI.

Grupp, Hariolf and Mary Ellen Mogee (2004), "Indicators for national science and technology policy: How robust are composite indicators", Research Policy 33(9), pp. 1373-1384.

Hollanders, Hugo (2006), "Review of the Industrial Development Scoreboard", unpublished report for the United Nations Industrial Development Organization (UNIDO).

Hollanders, Hugo and Adriana van Cruysen (2008a), "Rethinking the European Innovation Scoreboard: Recommendations for further improvements", Input paper for the workshop on "Improving the European Innovation Scoreboard methodology", Brussels, 16 June 2008.

Hollanders, Hugo and Adriana van Cruysen (2008b), "Rethinking the European Innovation Scoreboard: A revised methodology for 2008-2010", Output paper for the workshop on "Improving the European Innovation Scoreboard methodology", Brussels, 16 June 2008.

Hollanders, Hugo and Anthony Arundel (2006), "2006 Global Innovation Scoreboard", Brussels: European Commission, DG Enterprise.

Hollanders, Hugo and Anthony Arundel (2007), "Differences in socio-economic conditions and regulatory environment: explaining variations in national innovation performance and policy implications", INNO Metrics 2007 report, Brussels: European Commission, DG Enterprise.

Hollanders, Hugo and Funda Celikel-Esser (2007), "Measuring innovation efficiency", INNO Metrics 2007 report, Brussels: European Commission, DG Enterprise.

Huang, Can, Anthony Arundel and Hugo Hollanders (2008), "Non-R&D Innovation of Manufacturing Firms: Theory and evidence from the Third European Community Innovation Survey", Innovation Watch/Systematic report, Brussels: European Commission, DG Enterprise.

Lederman, Daniel and William F. Maloney (2004), "R&D and Development", World Bank Policy Research Working Paper 3024.

OECD (2007), "Science, Technology and Industry Scoreboard 2007: Innovation and Performance in the Global Economy", Paris: OECD.

Peters, Bettina, Sandra Gottschalk and Christian Rammer (2007), "Improving indicators for the European Sector Innovation Scoreboard (ESIS)", Innovation Watch/Systematic report, Brussels: European Commission, DG Enterprise.

Rammer, Christian (2005), "Comments on EIS Improvements for 2005", Centre for European Economic Research (ZEW).

Sajeva, Maurizio, Debora Gatelli, Stefano Tarantola and Hugo Hollanders (2005), "2005 European Innovation Scoreboard - Methodology Report", Brussels: European Commission, DG Enterprise.

Schibany, Andreas and Gerhard Streicher (2008), "How not to compare innovation performance: A critical assessment of the European Innovation Scoreboard", Joanneum Research, mimeo.

Schibany, Andreas, Gerhard Streicher and Helmut Gassler (2007), "Der European Innovation Scoreboard: Vom Nutzen und Nachteil indikatorgeleiteter Länderrankings", InTeReg Research Report Nr. 65-2007.

Schubert, Torben (2006), "How Robust are Rankings of Composite Indicators when Weights are Changed: Proposing a new Methodology". Presented at the conference, "Neoschumpeterian Economics: An Agenda for the 21st century", Trest, June 2006.

Simões, Vitor Corrado (2008), "Improving Innovation Scoreboards: Finding a Way Forward", Report prepared for IV Symposium COTEC Europa, Napoli, 27 June 2008.

Tarantola (2008), "EIS: Strategies to measure country progress over time", Report prepared for the workshop on "Improving the European Innovation Scoreboard methodology", Brussels, 16 June 2008.

United Nations (2002), "Manual on Statistics of International Trade in Services", Statistical Papers Series M. No. 86.

Annex 1: Changes in the European Innovation Scoreboard 2000-2007

	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	33: + 10 NMS, IS, NO, CH, BG, RO, TR	33	33	33	34: + HR	37: + AU, CA, IL
Input – Innovation drivers								
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								
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								
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								
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								
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		←	←	←	←			

Annex 2: Summary of criticism on the EIS

The following sections provide a summary of the criticism expressed in a.o. Frietsch (2005), Grupp and Mogee (2004), Peters et al., 2007, Rammer (2005), Sajeva et al., (2005), Schibany et al. (2007), Schibany and Streicher (2008) and Schubert (2006).

1. TECHNOLOGY AND SECTOR BIAS

Many of the EIS indicators are supposedly biased towards high-tech sectors thereby favouring those countries with an industrial structure specialised in high-tech activities (a.o. Frietsch, 2005; Schibany and Streicher, 2008).

Table A.2.1: Technology and sector bias related indicators
- o Business R&D expenditures
- o Share of medium-high & high-tech R&D
- o Exports of high technology products
- o Employment in medium-high & high-tech manufacturing
- o EPO patents per million population
- o USPTO patents per million population
- o Triad patents per million population

Description:

- High-tech bias, even though innovation can take place outside high tech sectors. Innovation in non-tech sectors is also relevant for a country's competitiveness, although it is not reflected in the EIS.

- High correlation between high-technology and number of patents gives excessive weight to these indicators.

- Multicollinearity, technology oriented indicators are highly correlated, possibly measuring the same latent innovation determinant. Examples include:
  - o Indicators with strong focus on country's performance in high tech industries. For example, high tech export performance is highly correlated with employment and R&D in medium-high & high-tech manufacturing.
  - o Share of medium-high & high-tech R&D in total manufacturing R&D measures basically the same specialization of the manufacturing sector that is already provided by the indicator on business R&D expenditures as percentage of GDP. Medium–high & high-tech sectors are defined by their R&D intensity (cf. OECD, 2007) and a high share of these sectors in total manufacturing R&D automatically results in high R&D expenditures relative to GDP.
  - o Indicators related to patents. EPO patents, USPTO patents and triad patents. These indicators are highly correlated. They also correlate (but to a lesser extend) with the other indicators in the IP group (community trademarks and industrial designs).

Effects:

- There is a difference between EPO and USPTO due to legal differences in the system, which in turn affects the statistical validity of these indicators. The US data cover only grants while the EPO data count applications. As a consequence, granted patents are a subset of all patents applications, and do not reflect total innovative capacity.

- The year of grants has no relation to the point in time when the innovation took place, but only reflects the processing capacity of the patent office.

- Even if granted patents are assigned to their year of application, it is only possible to draw a picture of the situation five to six years before this point. Consequently, it can not be compared with the present situation.

- USPTO is a national patent office, and countries have home advantage at the national office. Consequently, national applicants from the home country are overrepresented in relation to applicants from other countries.

- European countries do not have the same "home advantage" at the EPO, as there are many patent offices in Europe that receive a large number of important and innovative patent applications.

- The inclusion of EPO and USPTO may explain the increasing gap between US and the EU.

- Including triadic patents does not overcome all problems. The definition of triadic patents (USPTO, JPO + EPO vs. USPTO, JPO + National European offices) and the method of counting them can also affect the indicator. The OECD approach uses the first definition (USPTO, JPO + EPO) reflecting a 5 to 6 years old situation.

- Moreover, patent application in a foreign country is not only guided by the innovative capacity, but also by other factors, such as export portfolio, attractiveness of foreign markets, and expectations of development of these markets.

2. WRONG OR MISSING SELECTION CRITERIA

The EIS has been criticized that a clear rationale for including some indicators is missing. Criticism also focuses on the inclusion of some indicators which do not measure innovation (cf. a.o. Frietsch, 2005; Grupp and Mogee, 2004; Rammer, 2005; Sajeva et al., 2005; Schibany and Streicher, 2008; Schubert, 2006).

Description:
- There is an ambiguity of definitions. In particular the classification of sectors into low, medium and high tech is not convincing.

- There is a lack of a clear link with innovation. In particular the indicator SMEs cooperating with others is difficult to use as there would be no clear indication that this cooperation is always better for innovation.

- Trademarks and industrial designs do not have the same quality as an innovation indicator as patents for two reasons. First, there are different procedures to apply for trademarks. Trademarks have been supported by some researchers as an important innovation indicator, specifically for the service sector. But "the community trademark is only one system that can be used to gain trademark protection in EU countries". Apart from national offices, it is possible to apply internationally through the "Madrid System for the International Registration of Marks", which is administered by WIPO. There are indications that companies and countries favour only one of these two procedures. Moreover, countries that did not sign the Madrid Systems are not allowed to apply for trademarks at WIPO. As a consequence, it is said not to be appropriate to count registration only under the community trademarks system.

  Second, there is a lack of sufficient knowledge related to trademarks and industrial designs. Scholars have shown that the total number of trademarks is not appropriate to reflect innovative capacity. Both trademarks and industrial designs are more linked to marketing than to innovation. Marketing may be associated with innovation but not necessarily (cf. Rammer, 2005, who therefore suggests not using trademarks as an innovation indicator). More information on the link between trademark and industrial design and innovation is necessary. If the trademarks indicator is used, it "should be restricted to the service classes of the Nice Classification or even only some selected subgroups" (Frietsch, 2005).

  Frietsch (2005) suggests not using the indicator on designs as "a deep and extensive scientific analysis of industrial designs as an innovation indicator does

not exist". Rammer (2005) also suggests not using this indicator as there is no clear evidence about the possible link between designs and innovation.

- Short term vs. long term / microeconomic and structural facts

  EIS indicators are influenced by other variables, which have a different temporal behaviour:

  o Some indicators refer to narrow, microeconomic facts (proportion of subsidized companies, proportion of cooperating enterprises) while others address structural facts of an entire national economy (high tech focus).

  o Some indicators are "structural" by nature and change only over a long period of time, such as industrial structures, education. Strong short term changes in these indicators may be caused by re-definitions, changes in survey sample, etc.

  o Some indicators (such as innovation expenditures, sales shares with new to market products) are affected by business cycle developments.

  o Some indicators (broadband penetration and ICT expenditure) are likely to move towards a saturation level in some developed countries. The interpretation of these indicators will demand knowledge on the shape of a country specific diffusion curve and country specific saturation level.

  o Some indicators (for example, early stage venture capital) show high short-term fluctuations.

- Multicollinearity

  Some indicators are highly correlated, meaning that they could possibly be measuring the same latent innovation determinant.

3. DATA AVAILABILITY AND DATA QUALITY

Not only the selection of proper indicators is relevant, but also their data availability for a large number of countries. In specific, data availability is an issue for the indicators based on the CIS, as CIS data might be hampered with comparability problems.

For some countries, some indicators are based on more recent data than for other countries. Timeliness of data is a severe problem, in particular where data for patents are less recent than those for R&D where over time investments in R&D precede patents.

Another problem is the fact that for several indicators data are not available for most non-EU countries, in particular for the CIS based indicators and the LFS (Labour Force Survey) based indicators (e.g. the indicator on the participation in life-long learning).

4. "MORE IS NOT ALWAYS BETTER"

The EIS indicators assume that "more is better", which is not always the case. Variables may have an "optimal" value, which can also differ across countries. Another problem is to define the value that indicators would assume at their optimum (optimal innovation capacity).

The logic "more is better" is not straight forward applied to expenditure-related indictors. For these types of indicators, high values could also point to suboptimal allocation of scarce resources. It is also not straight forward applied to "fractional indicators" such as the share of population with tertiary education.

Table A.2.2: "More is not always better" related indicators

- o Share of population having completed tertiary education
- o Business R&D expenditure (% GDP)
- o Share of medium-high & high-tech R&D (% of manufacturing R&D expenditure)
- o Shares of enterprises receiving public funding for innovation
- o Innovation expenditures
- o Early-stage venture capital (% GDP)
- o ICT expenditures (% GDP)
- o High-tech exports

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5. STATISTICAL PROBLEMS

- Outliers

  This is specific relevant for structural indicators. Small countries tend to show outlier-like values due to historical specificities.

  - o High-tech exports as proportion of exports

    This indicator has other implications: changes over time will be affected by changes in relative price of commodities and by changes in exchange rates, which are partly (and in the short run, almost not at all) linked to innovation.

- Statistical issues

  - o *International comparability*, in specific for CIS indicators that represent about one-fourth of EIS indicators. CIS-3 and CIS-4 are to a certain extent not comparable. Moreover, CIS indicators tend to show highest variability in the short term. Possible explanations are that the CIS takes a random sample and that the sampling methods are frequently subject to revisions.

  - o *"Pockets of variability":* Indicators may also have significant differences between countries. These differences may be due to artefacts based on lack of statistical quality or they may be actually real. In any case, they do not reflect the correct distances between countries along common dimensions and cultural distances. Moreover, differences in the industrial designs indicator may be due to legal differences, as industrial designs have different meaning in different countries. Consequently, there is not a common dimension.

  - o Contamination with statistical artefacts

    - Indicators could be affected by isolated factors. For example, the indicator on early-stage venture capital more than doubled from 2005 to 2006, although this increase took place in the UK.

    - Surprising behaviour: Indicators that should change slowly along time, but that show non-credible changes, e.g. Population with tertiary education aged 25-64.

  - o Missing data

    - Lacking of data or restricted availability in some countries: some of the indicators used in the EIS 2007 only cover 2/3 of all countries. This should have an impact on the results for those countries with a lot of missing data, as the SII for these countries has been estimated using an OLS (Ordinary Least Squares) regression approach.

  - o Normalization

    The SII is a composite indicator and represents a multitude of diverse indicators in a single number.

    - Measurement in different scales – Need to normalize

      - Fractional indicators: have values between 0 and 100%, but their likely values vary widely

        - Share of R&D expenditures to GDP (between 1 and 4%)

        - Share of Medium-high-tech R&D (between 60 and 90%)

- Unbound indicators, i.e. indicators with no upper limit:
  - Number of patent applications
  - Number of trademarks
  - Number of industrial designs
  - There is an additional problem of "blurring of the scale". Due to re-scaling differences between indicator values become more pronounced. The rate of dispersion (standard deviation/mean) could be used to identify indicators where this problem might arise.
  - Equal weighting

Effects:

- Data availability

  Studies on data availability indicated that positions in the middle and lagging groups are exchangeable, with the exact position depending more on "luck" than "ability" while positions at the very top or bottom are more "settled".

- Short term vs. long term

  As the different cycles and developments that affect EIS indicators may not run in parallel for all countries, comparing trends among countries can be misleading.

- Multicollinearity

  If there is Multicollinearity and indicators are in fact measuring the same latent innovation determinants, then this determinant is given too much weight, to the benefit of countries that score high in this field. As a result, these countries will have better ranks.

- More is better

  To expand beyond a country's "optimal" value can be inefficient or counter-productive.

- Outliers

  May affect a country's ranking, in specific for small countries due to historical specificities.

- Statistical issues

  - *International comparability:* Results may be explained more due to statistical artefacts than by economic or innovation-related factors.
  - *"Pockets of variability":* There is not a common dimension and consequently, the indicator does not measure the underlying latent variable.
  - *Normalization*: How indicators are aggregated affect the final results.
  - *Weighting*: the 25 indicators are aggregated into a single number. In this process, all indicators get the same weigh (1/25 = 0.04). It means that all indicators are "equally important", even though they have different coverage.

6. ECONOMIC OUTPUTS FROM INNOVATION

The EIS indicators have been classified into input and output indicators. However, some of these could be classified differently (e.g. Schibany and Streicher, 2008):

- Although innovation drives economic performance and has an effect on productivity, innovation is only one factor among several others that impact GDP growth and wealth. GDP growth and wealth are also influenced by other economic variables, such as volume of accumulated capital, volume of labour input, macroeconomic stability, functioning of factor (capital, labour) markets, international relations, deregulation and financial stability. These economic variables are not included in the EIS.

- The indicators SMEs successfully innovating in house and SMEs using non-technological changes are closer to output than input as they measure successful innovation activities.

- Patent indicators measure a direct outcome of R&D activities, but may be away from commercial successful innovation.

7. POLICY RELEVANCE

Many indicators have been identified of not being relevant as a policy tool (e.g. Frietsch, 2005; Grupp and Mogee, 2004; Rammer, 2005; Schibany and Streicher, 2008; Schibany et al., 2007).

Description:

National systems of innovation differ from each other, consequently policy making differs accordingly. Composite indicators do not show the structure of countries. Most indicators used in the EIS can not be improved in the short term, but only on the long term. Structural characteristics can only undergo slow and gradual change. This affects indicators related to education and to economic structures:

- New S&E graduates per 1000 population aged 20-29
- Population with tertiary education per 100 population aged 25-64

Only a few indicators can be quickly and directly influenced by policies, although the problem of efficient allocation of resources is not included in this discussion:

- Public R&D expenditures
- Shares of enterprises receiving public funding for innovation
- Early stage venture capital

Other indicators are the result of long term development structures which although can be affected by incentive systems, are still outside the reach of direct policy intervention.

It is not appropriate to use one composite indicator to assess innovative capacity of countries. Modern innovation theories emphasize the systemic character of the innovation process, pointing to the fact that several actors and actions affect the outcome of performance of the system. Consequently, different ways or different approaches may lead to success.

An overall index is not useful for innovation policy. It can not identify those fields where there is a need for innovation policy intervention. As a result, measures for improvement are dubious: what could be done to improve the indicator in the short term?

- Share of high-tech exports

Moreover, improving indicators that are represented by shares or rations can be misleading. Shares and ratios comprise of both numerators and denominators. A ratio is low if the nominator is low or the denominator is high. An indictor represented by a ratio can be improved, in theory, by either component. Consequently, using the EIS to improve indicators in the short term involves "measurement noise".

Neither the SII nor the single indicators are related to typical areas of policy intervention. In general, innovation policy has to take into account market environments, technology developments, and specific barriers to innovation at different types of enterprises (SMEs, start-ups, large companies, exports vs. home market orientation, etc) to design appropriate policy intervention. Innovation policy needs to take into account the specific institutional and economic environment of a country.

In summary, there is a need to link indicators and policy, distinguishing between performance and policy indicators.

Effects:

The use of an aggregate, single figure is weak for practical policy purposes as it is neither immediately transparent nor does it imply that a specific action can be taken.

Suggestions:

- Combine the publication of the EIS results with detailed background information on the features of the respective national innovation system that may affect the EIS results.

- Extend the intervals between years of publication

- Instead of forming a composite indicator, use differentiated analysis of innovation systems, with the help of several indicators representing several dimensions of innovative performance. The grouping of indicators (three input and two output ones) or any variation of it should have close connections with categories and subcategories of Trend Chart. This method would allow for differentiated political action and advice.

8. Other comments on EIS 2007 indicators

- S&E graduates per 1000 population aged 20-29

  The indicator could be too narrowly defined as not all relevant degrees are included (Schibany et al., 2007).

- Broadband penetration rate

  Not directly relevant for innovation as it is not measuring broadband activities in the business sector. Indicator also reaches saturation level in many countries.

- Innovative SMEs co-operating with others

  There is no clear evidence that more co-operation leads to more innovation (cf. Rammer, 2005). The indicator should distinguish between co-operation partners (private vs. universities and research institutes).

- Innovation expenditures

  The indicator partly overlaps with the indicator on business R&D expenditures and could be replaced with non-R&D innovation expenditures (CIS-4) due to overlap with business R&D indicator (cf. Peters et al., 2007).

- Early-stage venture capital

  Indicator too volatile, VC is not very important for financing innovation and it is not limited to national boundaries.

- ICT expenditures

  A possible problem could result from a catching-up effect where countries starting at low levels will show a more rapid growth. There is also a problem of quality-adjusted prices where ICT expenditures can fall as a result of declining IT prices.

- SMEs using organisational innovation

  The indicator does not capture marketing innovations.

- Employment in high-tech services

  Knowledge-intensive services might capture more relevant services sector than high-tech services. The indicator could be replaced by employment in knowledge-intensive services.

- Sales of new-to-market products

  Highly relevant indicator of market novelties or creative innovation; one of the few indicators linked to economic performance (cf. Peters et al., 2007).

- Sales of new-to-firm products

  Highly relevant indicator of imitation or absorption innovation activities; one of the few indicators linked to economic performance (cf. Peters et al., 2007).

- Employment in medium-high and high-tech manufacturing

  This indicator is falling over time and there is a possible overlap with indicator on exports of high tech products. The indicator could be merged with the indicator on high-tech services employment.

Annex 3: Non-selected indicators as suggested at the EIS workshop

Workshop participants recommended several other indicators to be included:

Human resources:

- o It was suggested to include additional indicators that would capture training activities, vocational training and investments in competence. However, the indicator "life-long learning" due to its broader nature, already captures these proposed concepts.
- o Human Resources in Science & Technology (HRST) aged 25-35 as a percentage of occupied population in the same age group.
    - ▪ Not included as this indicator clearly overlaps with the indicator on the share of population with tertiary education.
- o Growth in business researchers capturing "the diversified nature of researchers in businesses, regardless of their academic background".
    - ▪ Not included as the EIS indicators are all level indicators. Including a growth indicator would unnecessarily complicate the calculation of the SII. There is also a clear overlap with the indicator on business R&D expenditures.

Finance and support:

- o Tax treatment of R&D both taking "into account the widening of innovation-targeted investments and the growing openness of innovation to wider forms of cooperation" and allowing "to capture a system's reaction to diversified innovation-targeted investments".
    - ▪ The indicator is not included as it would increase the acclaimed bias towards R&D-based innovation.

Linkages and entrepreneurship:

- o Relative prominence of cited scientific literature capturing "the relevance of IP and scientific advanced for innovation".
- o Percent of international collaboration on S&E articles as a share of a country's total article output reflecting "the international dimension in a country's knowledge base".
    - ▪ Both indicators will not be included in the EIS as they are measures of research performance. In addition, an indicator using publications data is already to be included (i.e. public-private co-publications).
- o The Global Entrepreneurship Monitor[20] was recommended as a source of data on early-stage entrepreneurial activity instead of using entry-exit rates. However, there were concerns about the use of this data as it measures aspirations and further exploration is needed before such an indicator could be included in the EIS.
- o The World Bank Doing Business indicators were suggested. However this set of indicators appear more relevant for the environment for starting business rather than the level of entrepreneurial innovation.

There were strong differences in opinion among workshop participants about the use of Community Innovation Survey (CIS) data. Some workshop participants considered these data as unreliable as they are perception based and thus difficult to compare across countries (and over time). Others, including participants involved in the collection of CIS data in their countries, were in favour of using CIS data. As the CIS was specifically designed to measure innovation activities and their effects, this survey will be used for benchmarking innovation performance in the EIS.

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[20] http://www.gemconsortium.org/

Annex 4: Correspondence table between NACE, ISIC and EBOPS (Extended Balance of Payments Services Classification)

NACE Rev.1.1	ISIC Rev.3.1	EBOPS
Knowledge-intensive services: 61-62, 64-74	Knowledge-intensive services: 61-62, 64-74	207, 208, 211, 212, 218, 228, 229, 245 (=246+247), 253 (=254+255+256+257+258), 254, 260, 263, 272, 274 (=275+ 276+277), 278, 279, 280, 284 (partly also included in ISIC 90 Sewage and refuse disposal, sanitation and similar activities)
61	61 Water transport	
61.1	*611 Sea and coastal water transport*	207 Sea transport – passenger 208 Sea transport - freight
61.2	*612 Inland water transport*	228 Inland waterway transport – passenger 229 Inland waterway transport – freight
62	62 Air transport	
62.1	*621 Scheduled air transport*	211* Air transport – passenger 212* Air transport – freight
62.2, 62.3	*622 Non scheduled air transport*	211* Air transport – passenger 212* Air transport – freight 218 Space transport
64	64 Post and telecommunications	
64.1	*641 Post and courier activities*	246 Postal and courier services
64.2	*642 Telecommunications*	247 Telecommunication services
65	65 Financial intermediation, except insurance and pension funding	260* Financial services
66	66 Insurance and pension funding, except compulsory social security	
66.01	*6601 Life insurance*	254* Life insurance and pension funding
66.02	*6602 Pension funds*	254* Life insurance and pension funding
66.03	*6603 Non-life insurance*	255 Freight insurance 256 Other direct insurance 257 Reinsurance
67	67 Activities auxiliary to financial intermediation	
67.1	*671 Activities auxiliary to financial intermediation, except insurance and pension funding*	260* Financial services
67.2	*672 Activities auxiliary to insurance and pension funding*	253* Insurance services 258 Auxiliary (insurance) services
70	70 Real estate activities	284* Miscellaneous business, professional and technical services – other business services
71	71 Renting of machinery and equipment without operator and of personal and household goods	272 Operational leasing services
72	72 Computer and related activities	263 Computer services
73	73 Research and development	279 Research and development
74	74 Other business activities	
74.11	*7411 Legal activities*	275 Legal services
74.12	*7412 Accounting; book-keeping and auditing activities; tax consultancy*	276 Accounting, auditing, bookkeeping and tax consulting services
74.13	*7413 Market research and public opinion polling*	278* Advertising, market research and public opinion polling
74.14, 74.15	*7414 Business and management consultancy activities*	277 Business and management consulting and public relations services
74.2, 74.3	*742 Architectural and engineering activities and related technical consultancy*	280 Architectural, engineering and other technical services
74.4	*743 Advertising*	278* Advertising, market research and public opinion polling
74.5, 74.6, 74.7, 74.8	*749 Business activities n.e.c.*	284* Miscellaneous business, professional and technical services – other business services

Source: Table A.IV.1 in United Nations, Manual on Statistics of International Trade in Services, Statistical Papers Series M. No. 86, 2002.