European Trend Chart on Innovation

Methodology Report on European Innovation Scoreboard 2005

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European Commission
Enterprise Directorate-General

A discussion paper from the Innovation/SMEs Programme

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EXECUTIVE SUMMARY

The 2005 Methodology Report is a joint effort of MERIT – the contractor for the European Innovation Scoreboard – and the Unit of Econometrics and Statistical Support to Antifraud (ESAF) of the Institute for the Protection and Security of the Citizen (IPSC) from the Joint Research Centre.

The 2005 EIS Methodology Report studies two main topics. The first is the revision of the innovation indicators covered in the European Innovation Scoreboard. The second is a robustness analysis of the composite innovation index and the country rankings resulting from this index. This report is structured along 5 themes and 12 steps. A summary of these is shown in the overview table on page 6.

The first theme, the Identification of a conceptual framework, identifies in Step 1 five blocks of indicators describing the innovation process. Innovation drivers, Knowledge creation and Innovation & entrepreneurship describe innovation input. Application and Intellectual property describe innovation output. In Step 2 a first set of 52 indicators is identified as potential indicators in the 2005 EIS.

The second theme, the Selection of indicators, starts in Step 3 with a statistical analysis of interrelations between the five blocks and between indicators within each block. For each block two statistical exercises are carried out. First, a correlation matrix is computed for the indicators within each block to identify highly correlated indicators. Second, principal components analysis (PCA) is used to determine key phenomena and indicators within each of the blocks. The final result of both exercises has resulted in an intermediate list of 27 indicators. In Step 5 this intermediate list was send for comments to the Group of Senior Officials (GSO) resulting in a final list of 26 indicators.

The third theme, Pre-treatment of data, uses regression techniques in Step 6 to obtain a complete database by imputing missing values. As units of measurement differ between the various indicators, Step 7 explores two normalisation techniques – Standardisation or Z-scores and Re-scaling – to bring all indicators the same unit of measurement. Step 8 explores four different weighting schemes: budget allocation, using the weights supplied by the GSO members, equal weighting, factor analysis and benefit of the doubt.

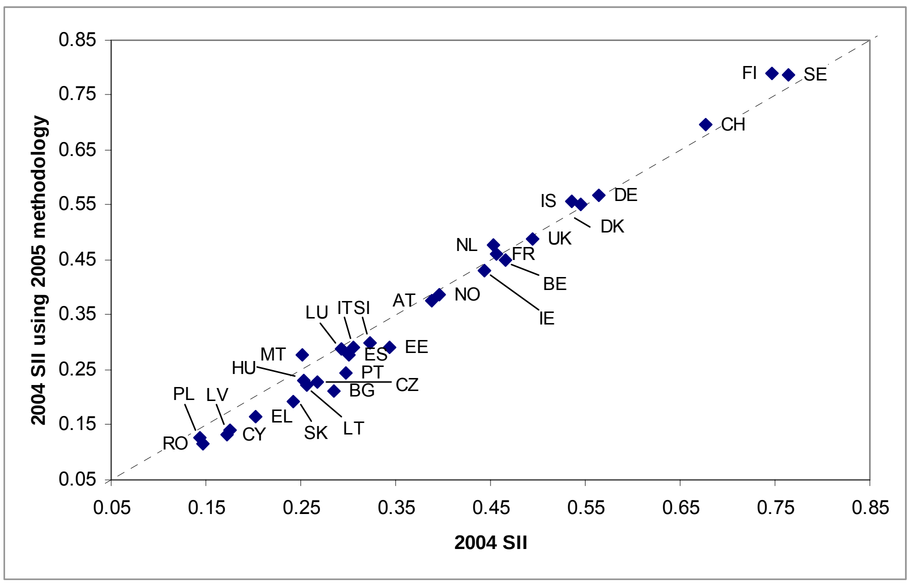
Theme 4, Evaluation of the innovation index and Robustness analysis, analyses in Step 9 the composite indicators for the 5 blocks and the composite indicators for Input and Output using four different weighting schemes and two normalisation techniques. Step 10 studies the analysis of trends in innovation indexes using single imputation.

The last theme, Conclusions, summarizes the main findings of the robustness analysis and presents conclusions for the 2005 EIS. The first conclusion is that the robustness analysis shows that country groupings appear to be stable using different weighting schemes. The second conclusion is that the robustness analysis shows the stability of country rankings when using different weighting schemes. Both conclusions point to the use of a simple weighting scheme.

For reasons of simplicity and continuity with previous scoreboard exercises, we adopt the following methodology:

- Equal weighting between all indicators;
- Normalisation based on relative to EU25 data (or EU15 data if data for the EU25 are not available) using rescaling with 0 as lower bound and 1 as upper bound;
- No imputation for missing data.

The results for the Summary Innovation Index based on the methodology used in 2004 and the improved methodology in 2005 are quite close. The figure below shows the values of the 2004 SII on the horizontal axis and the values of a hypothetical 2004 SII based on the 2005 methodology on the vertical axis. Although there is not a perfect match, the two series are highly correlated (0.995).



For the computation of the composite indicators all data are re-scaled using the MinMax-approach. For SII trends, we assume that the maximum and minimum scores are equal to the maximum and minimum scores over a 3-year period. Thus if the maximum score for an indicator is found in 2002 and we have data for 2001-2003 for this indicator, the 2002 score is used as the maximum score in all 3 years. Over a 3-year period the SII and the ranks based on the SII are quite stable for most countries. Exceptions are Slovakia experiencing a change of 5 ranks and Latvia, Poland, Romania and Iceland all experiencing a change of 2 ranks.

1. INTRODUCTION

In co-operation with the Joint Research Centre this Methodology Report[1] looks at several methodological issues involving the European Innovation Scoreboard (EIS). First, the list of innovation indicators has been revised to include 26 indicators of which 18 are identical to those used in the 2004 EIS and 8 are new. Secondly, the report provides a robustness analysis on composite indicators. Finally, the report explores possibilities of computing composite indicators time series. The Group of Senior Officials (GSO)[2] has been actively involved to support the analysis in the 2 first steps.

Composite indicators are increasingly recognized as a useful tool for policy making and public communications in conveying information on countries' performance in fields such as environment, economy, society, or technological development. Composite indicators are much easier to interpret than trying to find a common trend in many separate indicators. They have proven to be useful in ranking countries in benchmarking exercises.

However, the construction of a composite indicator is not straightforward and the methodological challenges raise a series of technical issues that, if not addressed adequately, can lead to composite indicators being misinterpreted or manipulated. Therefore, careful attention needs to be given to their construction and subsequent use.

The report provides additional information on the background of the quantitative analyses that have been conducted. According to a principle of transparent communication of scientific information, we would like to make our methodologies visible and clear to EIS users, in order to communicate the range of action of the index, together with its capacities and gaps. Our aim is to provide additional information on the choices made during the steps of the index building process, as a sort of history communicating the quality of the approach in a transparent and defensible way.

The graph on the following page shows the various steps taken in this report. The graph also provides a summary of the achieved results, the methodologies used and the rational followed in each of the steps. The last row provides a helpful link to the respective section in this report.

[1] The reader is informed that the EIS Methodology Reports are an ongoing process, with important results from previous years not being repeated. The reader is advised also to look at the reports from 2002, 2003 and 2004.
[2] The GSO is composed of representatives of the Member States and supports the Commission in developing innovation policy and initiatives.

EUROPEAN INNOVATION SCOREBOARD 2005: METHODOLOGICAL OVERVIEW

	IDENTIFICATION OF A CONCEPTUAL FRAMEWORK		SELECTION OF EIS INDICATORS			PRE-TREATMENT OF DATA			INDEX EVALUATION AND RESULTS		CONCLUSIONS	
STEPS OF THE PROCESS	1	2	3	4	5	6	7	8	9	10	11	12
APPROACH OF EACH STEP	IDENTIFICATION OF MAIN BLOCKS	IDENTIFICATION OF COMPONENT INDICATORS	STATISTICAL ANALYSIS WITHIN AND BETWEEN BLOCKS	INTERMEDIATE LIST OF INDICATORS	FINAL LIST OF INDICATORS	IMPUTATION OF MISSING VALUES	IDENTIFICATION OF NORMALISATION TECHNIQUES	IDENTIFICATION OF WEIGHTING SCHEMES	EVALUATION OF THE INNOVATION INDEX AND ROBUSTNESS ANALYSIS	ANALYSIS OF TRENDS (1)	CONCLUSIONS FOR EIS 2005 INNOVATION INDEX	ANALYSIS OF TRENDS (2)
MAIN ACTORS INVOLVED	MERIT - DG ENTR	MERIT - DG ENTR	JRC	MERIT - DG ENTR	MERIT - DG ENTR	JRC	JRC	JRC	JRC	JRC	MERIT – DG ENTR	MERIT
ACHIEVED RESULTS	INPUT: INNOVATION DRIVERS, KNOWLEDGE CREATION, INNOVATION & ENTREPRENEURSHIP. OUTPUT: APPLICATION, INTELLECTUAL PROPERTY	PROPOSAL OF A DRAFT SET OF INDICATORS FOR EACH BLOCKS (IN TOTAL 52 INDICATORS)	IDENTIFICATION OF THE DIMENSIONS OF THE PHENOMENON ACCORDING TO RELEVANCE OF INDICATORS	IDENTIFICATION OF REDUCED LIST OF 26 INDICATORS	IDENTIFICATION OF FINAL LIST OF 26 INDICATORS TO BE USED IN EIS 2005	TO OBTAIN A COMPLETE DATABASE BY IMPUTING MISSING VALUES	COMPARABILITY OF DATA	DETERMINATION OF MOST SUITABLE WEIGHT FOR AGGREGATION	EVALUATION OF THE INNOVATION INDEX AND COUNTRY RANKING	EVALUATION OF THE INNOVATION INDEX OVER THREE CONSECUTIVE YEARS	WEIGHTING SCHEME AND NORMALISATION TECHNIQUE FOR EIS 2005 INNOVATION INDEX	EVALUATION OF THE INNOVATION INDEX OVER THREE CONSECUTIVE YEARS
METHODOLOGIES ADOPTED	POLICY RELEVANCE	POLICY RELEVANCE, DATA AVAILABILITY	CORRELATION AND PRINCIPAL COMPONENTS ANALYSIS (PCA)	REDUNDANCY, POLITICAL IMPACT, AVAILABILITY, FIRST COMER PRIVILEGE	COMMENTS FROM GSO MEMBERS	REGRESSION AND CORRELATION ANALYSIS, MULTIPLE IMPUTATION	STANDARDISATION AND RESCALING (-0.5;.0.5)	BUDGET ALLOCATION, EQUAL WEIGHTING, FACTOR ANALYSIS AND BENEFIT OF THE DOUBT	ADDITIVE METHOD, ROBUSTNESS ANALYSIS	REGRESSION AND CORRELATION ANALYSIS, MULTIPLE IMPUTATION	EQUAL WEIGHTING, RE-SCALING (0,1)	RESCALING (0;1) USING BEST AND WORST PERFORMANCE OVER THREE YEAR PERIOD; IMPUTING FOR "MISSING" DATA BY ASSUMING EQUALITY WITH DATA AT FOLLOWING YEAR
RATIONAL	TO IDENTIFY KEY ASPECTS OF INNOVATION INTO INPUT AND OUTPUT	TO IDENTIFY KEY ASPECTS OF INNOVATION FOR DESCRIBING THE MAIN BLOCKS	ANALYSIS OF THE CORRELATION OF VARIABLES: IN PRESENCE OF REDUNDANT INFORMATION SOME INDICATORS CAN BE ELIMINATED	TO OBTAIN A REDUCED LIST OF INDICATORS FOR POLICY-MAKERS	TO OBTAIN A FINAL LIST OF INDICATORS FOR EIS 2005	MISSING VALUES HAVE TO BE IMPUTED	DATASET INCOMMENSURATE WITH EACH OTHER FOR HAVING DIFFERENT UNIT OF MEASUREMENT, HAVE TO BE BROUGHT TO THE SAME UNIT	BUDGET ALLOCATION IS A RECOGNISED METHODOLOGY. THE PARTICIPATION OF EXPERTS ALLOWS DETERMINATION OF WEIGHTS	TO ILLUSTRATE COUNTRY SCORES UNCERTAINTY DUE TO CHANGES IN WEIGHTING METHODS, NORMALISATION TECHNIQUES, ETC.	TO ILLUSTRATE THE DEVELOPMENT OF THE INNOVATION INDEX OVER A SHORT PERIOD OF TIME	TO IDENTIFY THE 2005 METHODOLOGY FOR COMPUTING THE INNOVATION INDEX	TO ILLUSTRATE THE DEVELOPMENT OF THE INNOVATION INDEX OVER A SHORT PERIOD OF TIME
PARTICIPATION OF EXTERNAL PANELS					COMMENTS FROM GSO (GROUP OF SENIOR OFFICIALS)			QUESTIONNAIRE FROM DG ENTR TO GSO FOR BUDGET ALLOCATION				
INTERMEDIATE RESULTS			JRC REPORT 1						JRC REPORT 2	JRC REPORT 2		
COMMENTS AND IMPROVEMENTS						SOME BIZARRE DATA WERE FOUND AND REPLACED AFTER FURTHER INVESTIGATION			POSSIBILITY TO DESIGN ECONOMETRIC MODEL LINKING INNOVATION TO ECONOMIC PERFORMANCE			
SECTION IN REPORT	2.1	2.2	3.1	3.2	3.2	4.1	4.2	4.3	5.1	5.2	6.1 & 6.2	6.2

2. IDENTIFICATION OF A CONCEPTUAL FRAMEWORK

The construction of a Summary Innovation Index requires the definition of a conceptual framework. This identifies Innovation as the process leading to the adoption and diffusion of new technologies, aimed at creating new processes, products and services. While the term adoption represents the final stage of an invention, diffusion focuses on the supply of new goods and services to the consumer.

In this context, Innovation is the mean to achieve competitiveness in the framework of the revised Lisbon agenda.

2.1 DEFINITION OF MAIN BLOCKS OF INDICATORS (STEP 1)

The Summary Innovation Index is composed of two main groups, Innovation Input and Innovation Output.

The relevant elements of innovation Input are captured by three sub-groups of indicators:

- **Innovation drivers**, to measure the structural conditions required for innovation potential
- **Knowledge creation**, to measure the investments on human factors and on R&D activities, considered as the key elements for a successful knowledge-based economy
- **Innovation & entrepreneurship**, to measure the efforts towards innovation at the microeconomic level

The relevant elements of innovation Output are captured by two sub-groups of indicators:

- **Application**, to measure the performance, expressed in terms of labour and business activities, and their value added in innovative sectors
- **Intellectual property**, to measure the achieved results in terms of successful know how, especially referred to high-tech sectors.

The choice of the indicators for the formalisation of the phenomenon of innovation into a single index is of particular importance as it represents the foundation of all the forthcoming analysis. It has been based on two main criteria:

- Policy relevance, with the aim of identifying indicators that are meaningful for decisional processes and reflective of the political orientations (i.e. Lisbon objectives);
- Conceptual resonance in respect to the phenomenon object of study; in other words ability of the formalised model to represent the issue.

2.2 IDENTIFICATION OF THE COMPONENT INDICATORS (STEP 2)

A first list of 52 indicators was constructed based on criteria of relevance and data availability. The indicators are identified in the second column in Table 1; 23 of these indicators corresponded to innovation indicators covered in the EIS 2004.

Table 1: Innovation indicators: from first list to final list

	Included in First List (#52)	Included in Second List (#27)	Included in Final List (#26)	EIS 2004 Indicator
INPUT – Innovation drivers				
S&E graduates (‰ of population aged 20-29)	√ 1-1	√	√ 1.1	1.1
Population with tertiary education (% of population aged 25-64)	√ 1-2	√	√ 1.2	1.2
Broadband penetration rate (number of broadband lines per 100 population)			√ 1.3	
Participation in life-long learning (% of population aged 25-64)	√ 1-5	√	√ 1.4	1.3
Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	√ 1-6	√	√ 1.5	
Internet access - Level of Internet access of Enterprises	√ 1-3			(4.4)
Internet access - Level of Internet access of Households	√ 1-4	√		(4.4)
Job-to-job mobility of employed HRST in %	√ 1-7			
HRSTC as a percentage employed population aged 24-65, 2000	√ 1-8			
Employed HRST (Human Resources in Science and Technology) - as a % of total employment	√ 1-9			
INPUT – Knowledge creation				
Public R&D expenditures (% of GDP)	√ 2-1	√	√ 2.1	2.1
Business R&D expenditures (% of GDP)	√ 2-2	√	√ 2.2	2.2
Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	√ 3-11	√	√ 2.3	
Share of enterprises receiving public funding for innovation			√ 2.4	
University R&D expenditures financed by business sector	√ 2-6	√	√ 2.5	
High-tech venture capital (% of venture capital investment)	√ 2-3			
Business R&D expenditures financed by government sector	√ 2-5	√		
Foreign Direct Investment intensity - Average value of inward and outward FDI flows divided by GDP, multiplied by 100	√ 2-7			
Share of companies receiving public funding for innovation	√ 2-8			
R&D expenditures in high-tech manufacturing (% of total manufacturing R&D expenditures)	√ 2-9			
INPUT – Innovation & entrepreneurship				
SMEs innovating in-house (% of SMEs)	√ 3-1	√	√ 3.1	3.1
Innovative SMEs co-operating with others (% of SMEs)	√ 3-2	√	√ 3.2	3.2
Innovation expenditures (% of turnover)	√ 3-3	√	√ 3.3	3.3
Early-stage venture capital (% of GDP)	√ 2-4	√	√ 3.4	4.2
ICT expenditures (% of GDP)	√ 3-5	√	√ 3.5	4.5
SMEs using non-technological change (% of SMEs)	√ 3-4	√	√ 3.6	3.4
Share of strategic innovators	√ 3-6			
Share of innovating companies quoting Government or private non-profit research institutes as important source of innovation	√ 3-7			
Share of innovating companies quoting Universities or other higher education institutes as important source of innovation	√ 3-8			
Percent of firms involved in networking activities	√ 3-9			
Share of medium-high-tech and high-tech R&D (% of business R&D expenditures)	√ 3-10			
OUTPUT – Application				
Employment in high-tech services (% of total workforce)	√ 4-2	√	√ 4.1	1.5
High-tech exports - Exports of high technology products as a share of total exports	√ 4-6	√	√ 4.2	

	Included in First List (#52)	Included in Second List (#27)	Included in Final List (#26)	EIS 2004 Indicator
Sales of new-to-market products (% of turnover)	√ 4-3	√	√ 4.3	4.3.1
Sales of new-to-firm not new-to-market products (% of turnover)	√ 4-4	√	√ 4.4	4.3.2
Employment in medium-high and high-tech manufacturing (% of total workforce)	√ 4-1	√	√ 4.5	1.4
Value-added in high-tech manufacturing (% of manufacturing value-added)	√ 4-5			4.6
Share of high-growth innovators	√ 4-7			
Labour productivity in high-tech manufacturing relative to total manufacturing	√ 4-8			
Rate of volatility (sum of birth rate and death rate)	√ 4-9			
Royalties (payments + receipts) as a % of GDP	√ 4-10			
Value-added in high-tech industries (% of total value-added)	√ 4-11			
OUTPUT – Intellectual property				
(New) EPO patents per million population	√ 5-3	√	√ 5.1	2.4.1
(New) USPTO patents per million population	√ 5-4	√	√ 5.2	2.4.2
(New) Triadic patent families per million population	√ 5-7	√	√ 5.3	
Number of (new) domestic community trademarks per million population	√ 5-5	√	√ 5.4	
Number of (new) domestic community industrial designs per million population	√ 5-6	√	√ 5.5	
(New) EPO high-tech patents per million population	√ 5-1			2.3.1
(New) USPTO high-tech patents per million population	√ 5-2			2.3.2
(New) National patents per million population	√ 5-8	√		
Share of innovative companies protecting through copyright	√ 5-9			
Share of innovative companies protecting through registration of design patterns	√ 5-10			
Share of innovative companies protecting through secrecy	√ 5-11			
Share of innovative companies protecting through trademarks	√ 5-12			

3. SELECTION OF INDICATORS

3.1 STATISTICAL ANALYSIS WITHIN AND BETWEEN BLOCKS (STEP 3)[3]

Principal Components Analysis is a tool to identify patterns in multi-dimensional data and express the data as to highlight their similarities and differences. The variance of the observed data is explained through a few linear (orthogonal) combinations of the original data that measure different statistical dimensions in the data. The interpretation of the different dimensions helps to identify the main relevant aspects of the phenomenon. Subsequently, other criteria, such as policy relevance and data availability are used to identify a reduced list of indicators. The same analysis has been conducted after step 4 (cf. Table 1) on the reduced list of 27 indicators and, for verification of consistency, after step 5 (cf. Table 1).

"Innovation drivers" group (10 indicators)

	1-1	1-2	1-3	1-4	1-6	1-7	1-8	1-9	1-5
1-1	1.00								
1-2	0.60	1.00							
1-3	0.17	0.46	1.00						
1-4	0.19	0.61	0.64	1.00					
1-6	0.09	0.04	0.08	-0.17	1.00				
1-7	0.52	0.63	0.30	0.41	-0.42	1.00			
1-8	0.48	**0.86**	0.36	0.69	0.04	0.38	1.00		
1-9	0.43	**0.89**	0.55	0.64	0.24	0.42	**0.83**	1.00	
1-5	0.44	0.66	0.45	**0.78**	0.05	0.50	0.67	0.61	1.00

Indicator numbers correspond to indicators as identified in 2nd column in Table 1.

From the correlation matrix we conclude that:

- Indicator 1-2 (tertiary education) is correlated to indicators 1-8, 1-9 (HRST and HRSTC type of employment).

The principal components analysis tells that the phenomenon has 3 main dimensions.

- The first dimension can be interpreted as *human skills & mobility* and is explained by indicators 1-1, 1-2 and 1-7;
- The second dimension can be interpreted as *working in S&T sector* and is explained by indicators 1-3, 1-4, 1-3, 1-8 and 1-9. Internet Use (1-3 and 1-4) is inherently embedded in S&T activities;
- The third dimension is *youth education* being represented by indicator 1-6.

Comments: *Indicators 1-3 and 1-4 should be merged. Indicators 1-8 and 1-9 should be merged.*

[3] This section is an edited copy of "Statistical analysis of Innovation indicators". Draft report prepared by Debora Gatelli, Maurizio Sajeva and Stefano Tarantola (JRC). Ispra, February 4, 2005.

"Knowledge creation" group (9 indicators)

	2-1	2-2	2-3	2-4	2-5	2-6	2-7	2-8	2-9
2-1	1.00								
2-2	0.64	1.00							
2-3	0.14	0.42	1.00						
2-4	0.67	**0.87**	0.48	1.00					
2-5	-0.39	-0.47	-0.45	-0.44	1.00				
2-6	0.40	0.33	0.05	0.17	-0.20	1.00			
2-7	-0.36	0.16	-0.14	-0.02	-0.23	0.39	1.00		
2-8	0.27	0.13	-0.02	0.00	-0.37	-0.05	-0.10	1.00	
2-9	0.50	0.25	-0.16	0.47	-0.03	0.03	0.16	0.49	1.00

Indicator numbers correspond to indicators as identified in 2nd column in Table 1.

From the correlation matrix we conclude that:

- Business R&D expenditures (2-2) is correlated to early-stage venture capital (2-4);
- The other indicators are weakly correlated.

The principal components analysis tells that the phenomenon has 3 dimensions. However, it is not easy to give a clear interpretation to two dimensions:

- The first dimension can be interpreted as *R&D expenditures in general as incentives for innovation* and is explained by 2-1, 2-2, 2-4, 2-5 and 2-6;
- The second dimension is explained by indicators 2-3 and 2-8;
- The third dimension is explained by indicator 2-7.

Comments: *Indicators 2-2 and 2-4 are inter-related but one does not include the other. So keep both. No correlation between indicators 2-5 and 2-6 means no integration between R&D cross-financed by public and private sectors. Indicator 2-7: capacity to invest abroad and attract investments from abroad. It includes all sectors not only R&D, therefore we should choose a more focused indicator, if it exists.*

"Innovation & entrepreneurship" group (11 indicators)

	3-1	3-2	3-3	3-4	3-5	3-6	3-7	3-8	3-9	3-10	3-11
3-1	1.00										
3-2	0.42	1.00									
3-3	-0.18	-0.26	1.00								
3-4	0.62	-0.14	-0.41	1.00							
3-5	-0.18	-0.04	-0.14	0.02	1.00						
3-6	0.51	0.57	-0.06	0.19	-0.13	1.00					
3-7	-0.30	0.18	-0.19	-0.20	-0.01	-0.21	1.00				
3-8	-0.16	0.11	0.03	-0.03	-0.14	-0.09	0.65	1.00			
3-9	0.36	0.73	-0.15	0.16	-0.18	**0.86**	-0.10	-0.07	1.00		
3-10	0.39	0.12	0.22	0.45	-0.22	0.39	-0.42	0.37	0.17	1.00	
3-11	0.22	0.23	-0.03	-0.22	-0.22	0.66	-0.20	-0.11	0.52	0.67	1.00

Indicator numbers correspond to indicators as identified in 2nd column in Table 1.

From the correlation matrix we conclude that:

- Indicator 3-9 is correlated to both indicators 3-2 and 3-6;

- The other indicators are weakly correlated.

The principal components analysis tells that the phenomenon has 4 dimensions. However, it is not easy to give a clear interpretation to these dimensions:

- The first dimension is explained by indicators 3-1, 3-2, 3-3, 3-6 and 3-9;
- The second dimension is explained by indicators 3-10 and 3-11;
- The third dimension is explained by indicators 3-5 and 3-7;
- The fourth dimension is explained by indicators 3-4 and 3-8.

"Application" group (11 indicators)

	4-1	4-2	4-3	4-4	4-5	4-6	4-7	4-8	4-9	4-10	4-11
4-1	1.00										
4-2	0.27	1.00									
4-3	0.28	-0.11	1.00								
4-4	0.31	0.23	0.46	1.00							
4-5	0.41	**0.77**	0.15	0.32	1.00						
4-6	0.16	0.42	-0.07	0.26	0.47	1.00					
4-7	0.03	-0.43	0.10	0.15	-0.30	-0.03	1.00				
4-8	-0.02	-0.03	0.46	0.16	0.35	0.14	-0.51	1.00			
4-9	-0.55	0.04	**-0.79**	-0.70	-0.24	0.50	-0.06	-0.06	1.00		
4-10	0.20	0.48	-0.11	0.18	0.48	**0.78**	0.01	0.07	0.32	1.00	
4-11	**0.85**	0.57	0.18	0.24	0.70	0.26	0.32	-0.25	-0.39	0.23	1.00

Indicator numbers correspond to indicators as identified in 2nd column in Table 1.

From the correlation matrix we conclude that:

- Indicator 4-1 is correlated to indicator 4-11 (synergy between employment in medium-high and high-tech manufacturing and value added in high-tech industries);
- Indicator 4-2 is correlated to indicator 4-5 (synergy between employment in high-tech services and value added in high-tech manufacturing);
- Indicator 4-3 is negatively correlated to indicator 4-9 (synergy between stability of the company and creation of new products);
- Indicator 4-6 is correlated to indicator 4-10 (synergy between share of high tech exports and royalties).

The principal components analysis tells that the phenomenon has 3 dimensions:

- The first dimension is explained by 4-2, 4-5, 4-6 and 4-10 and can be interpreted as *cycle of high-tech enterprises*;
- The second dimension is explained by 4-3, 4-4, 4-8 and 4-9 and can be interpreted as *productivity and new high-tech products*;
- The third dimension is explained by 4-1, 4-7 and 4-11 and can be interpreted as *presence of innovation-oriented enterprises*.

"Intellectual property" group (12 indicators)

	5-1	5-2	5-3	5-4	5-5	5-6	5-7	5-8	5-9	5-10	5-11	5-12
5-1	1.00											
5-2	**0.92**	1.00										
5-3	**0.87**	**0.80**	1.00									
5-4	**0.84**	**0.85**	**0.97**	1.00								
5-5	0.14	0.14	0.21	0.18	1.00							
5-6	0.32	0.23	0.61	0.54	0.18	1.00						
5-7	**0.89**	**0.88**	**0.97**	**0.98**	0.12	0.53	1.00					
5-8	0.63	0.67	**0.77**	**0.76**	0.13	**0.76**	**0.77**	1.00				
5-9	0.28	0.35	0.33	0.41	-0.01	0.05	0.37	0.38	1.00			
5-10	0.16	0.20	0.26	0.29	-0.01	0.26	0.30	0.40	0.66	1.00		
5-11	0.34	0.41	0.41	0.44	0.04	0.25	0.44	0.55	0.53	0.62	1.00	
5-12	0.04	0.11	0.02	0.09	-0.19	-0.07	0.09	0.07	**0.70**	**0.79**	0.33	1.00

Indicator numbers correspond to indicators as identified in 2nd column in Table 1.

From the correlation matrix we conclude that:

- Indicator 5-1 is correlated with indicators 5-2, 5-3, 5-4 and 5-7;
- Indicator 5-2 is correlated with indicators 5-3, 5-4 and 5-7;
- Indicator 5-3 is correlated with indicators 5-4, 5-7 and 5-8;
- Indicator 5-4 is correlated with indicators 5-7 and 5-8;
- Indicator 5-8 is correlated with indicators 5-6 and 5-7.

The principal components analysis tells that the phenomenon has 3 dimensions:

- The first dimension is explained by indicators 5-1, 5-2, 5-3, 5-4 and 5-7 and can be interpreted as *patenting*;
- The second dimension is explained by indicators 5-9, 5-10, 5-11 and 5-12 and can be interpreted as *copyrights and trademarks*;
- The third dimension is explained by 5-5 and 5-6 and can be interpreted as *domestic trademarks and designs*.

Comments: *Indicator 5-8 would fall in both dimensions 1 and 3. Remove it.*

Correlation between groups

The correlation coefficients between groups have also been estimated. The table shows that Innovation drivers push Intellectual property. Innovation & entrepreneurship steers Application.

	Innovation drivers	Knowledge creation	Innovation & entrepreneurship	Application	Intellectual property
Innovation drivers	1.00				
Knowledge creation	-0.05	1.00			
Innovation & entrepreneurship	0.24	-0.17	1.00		
Application	0.45	0.08	**0.72**	1.00	
Intellectual property	**0.76**	-0.14	0.47	0.46	1.00

3.2 FINAL LIST OF INDICATORS (STEPS 4 AND 5)

The selection of the reduced list of 26 indicators identified in the third column in Table 1 has been done according to the following criteria:

1. Redundancy: when 2 indicators are found to be redundant, which means that they give the same information, it is recommended to select only one.
2. Political impact: when 2 indicators are highly correlated and convey strong political messages, they can be both included in the final list.
3. Availability: indicators which prove to be available for a large number of countries, and which can be extracted from regularly updated databases are recommended.
4. First comer privilege: when two indicators are redundant, it is recommended to select the one that was already included in the EIS 2004.

Principal components analysis and considerations regarding redundancy, political impact, availability and first comer privilege resulted in the list of 26 indicators identified in the third column in Table 1. This list of indicators was distributed among the GSO members for comments.

Based on the comments received from the GSO members from the Czech Republic, Finland, Portugal, Austria, Ireland, the UK, Estonia and Germany, the proposed list of indicators was slightly revised by replacing Internet access by the Broadband penetration rate, Business R&D expenditures financed by government sector by Share of enterprises receiving public funding for innovation and by removing National patents per million population. The final list of 26 indicators that will be used in the EIS 2005 is identified in the fourth column of Table 1. The last column in Table 1 shows similarities with the indicators of the 2004 European Innovation Scoreboard. Definitions and interpretations of the EIS 2005 indicators are given in Annex XVII.

4. PRE-TREATMENT OF DATA

4.1 IMPUTATION OF MISSING VALUES (STEP 6)

The set of indicators is not complete for all countries. Therefore, missing values have to be imputed. Missing values are substituted by the predicted values obtained from a regression analysis. The dependent variable of the regression is the indicator hosting the missing value and the regressor is the indicator showing the highest degree of correlation with the dependent variable.

Let us assume to have an indicator X_j only observed for *r* countries but missing for the remaining *M-r* countries. Let us identify a fully observed indicator X_i with the highest correlation with X_j. We compute the regression of X_j on X_i using *r* complete observations,

$$\hat{x}_{jk} = \hat{\alpha}_j + \hat{\beta}_j x_{ik} \qquad k = 1,..,M-r$$

and we impute the M-r missing values using the predicted parameters from the regression. The parameters α and β are estimated with the ordinary least squares method. Annex Table XVI shows all imputed data (highlighted in grey).

4.2 IDENTIFICATION OF NORMALISATION TECHNIQUES (STEP 7)

The construction of a synthetic index requires comparability of data[4]. The innovations indicators are incommensurate with each other as several of them have different units of measurement. Both R&D expenditure indicators e.g. are expressed as a percentage of GDP whereas all intellectual property indicators are expressed per million population. The R&D indicators are thus faced with a maximum value of 100 whereas the intellectual property indicators have no maximum.

Whenever indicators in a dataset are incommensurate with each other, and/or have different measurement units, it is necessary to bring these indicators to the same unit, to avoid adding up apples and pears. Normalization serves primarily to this purpose. There are a number of normalization methods available. In this exercise we foresee the use of the two most common methods: *standardisation (or z-scores)* and *re-scaling*. We then assess the robustness of the country scores that result from the use of both methods in section 5.

Standardisation: each component indicator x_{ic}^t is transformed into $y^t = \dfrac{x_{ic}{}^t - \bar{x}_i{}^o}{\sigma_i{}^o}$, where $\bar{x}_i{}^o$ is the mean over the countries *c*, and $\sigma_i{}^o$ is the standard deviation. The superscript 'o'

[4] There are three main challenges for constructing a composite index: determining the weights given to each sub-indicator, converting different units of measurement into the same unit, and developing rules for treating interval level data when there are outliers. The 2002 EIS Methodology Report already provided an extensive evaluation for each of these three issues and evaluated five methods for calculating a composite innovation index: Number of indicators above the mean minus the number below the mean; Summing percentage differences from the mean;

refers to the initial year and the *t* refers to the year under study. This normalisation method allows comparisons of country performance over different years. Z-scores convert the indicators to a common scale with a mean of zero and standard deviation of one. *Re-scaling*: Each indicator x_{ic}^{t} for a generic country c and time t is transformed in $I_{ic}^{t} = \frac{x_{ic}^{t} - min_c(x_i^t)}{max_c(x_i^t) - min_c(x_i^t)}$ where $min_c(x_i^t)$ and $max_c(x_i^t)$ are the minimum and the maximum value of x_{ic}^{t} across all the countries *c* at time t. In this way, the normalized indicators I_{ic} have values laying between 0 (laggard, $x_{ic}^{t} = min_c(x_i^t)$) and 1 (leader, $x_{ic}^{t} = max_c(x_i^t)$. The re-scaling normalizes indicators to have an identical range, in this case (-0.5;0.5). This range has been selected to maintain the symmetry around zero as in the z-scores method.

For the calculation of the index in section 6.2 the transformation used is the re-scaling, which normalizes indicators in the range (0; 1). For a different year, a new normalization should be calculated as the range is supposed to change. There are alternative formulations of re-scaling that allow time-dependency to be accounted for appropriately.

4.3 IDENTIFICATION OF WEIGHTING SCHEMES (STEP 8)

The indicators have been weighted using four different methods:

- Budget allocation method through the consultation of 11 external experts (Group of Senior Officials);
- Equal weighting where all indicators receive the same weight;
- Factor analysis method where weights are obtained correcting for the overlap of information among correlated indicators;
- Benefit of the doubt method where for each country the *best* set of weights is maximizing the innovation index for that country.

Standardized values (z scores) for each indicator; Re-scaled values. The re-scaled scores vary within the identical range for each indicator (0 to 1); and Best performance.

5. INDEX EVALUATION AND RESULTS

The Innovation Index in all analyses in this section is computed as a weighted sum of its normalised component indicators:

$$CI_c = \sum_{q=1}^{Q} w_q I_{qc}$$

with $\sum_q w_q = 1$ and $0 \le w_q \le 1$, for all $q=1,..,Q$ and $c=1,\ldots,M$. Q is the number of component indicators and M is the number of countries. The Innovation Index will be available for each of the five categories, as well as for the more aggregated level of input and output.

5.1 EVALUATION OF THE INNOVATION INDEX AND ROBUSTNESS ANALYSIS (STEP 9)

Budget allocation method

The innovation index is firstly evaluated using the weights provided by 11 external experts (Group of Senior Officials) via budget allocation, in order to elicit their opinions. Each of the GSO's of in total 31 countries[5], was asked in a small survey to first distribute 100 points over each of the 5 blocks and then to distribute 100 points per block over each of the indicators in that block. In total 12 GSO's responded to the survey of which 1 response came too late to be included in the analyses in this section.

The budget allocation exercise has to be executed within each category and then between the categories of the Innovation Index. In other words, the experts were not required to allocate the 100 points directly to the 26 indicators. There is an important reason for that. Experience shows that allocating points to more than 10 indicators altogether is practically impossible, because the more indicators the more likely it is to loose consistency in the judgment[6]. This is called "circular thinking" and can cause serious cognitive stress to the expert, which sometimes refuses to complete the survey.

Figure 1 shows the index values via boxplots[7], which include all the possible weights. Annex I provides graphs for all blocks of indicators using the rescaling method. Annex II provides graphs for all blocks of indicators using the standardization or z-scores method.

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[5] These included all EU25 countries plus Iceland, Norway, Switzerland, Bulgaria, Romania and Turkey.

[6] It is often the case that people's thinking is not always consistent. For example, if one claims that A is much more important than B, B slightly more important than C, and C slightly more important than A, judgment is inconsistent and decisions made are less trustworthy. Inconsistency, however, is part of the human nature and therefore in reality it is enough just to measure somehow the degree of inconsistency. This appears to be the only way so results could be defended and justified in front of public. [JRC state-of-the-art report on composite indicators, 2002]

[7] A boxplot is a plot with a box, whiskers and symbols for extreme values. The box has lines at the lower quartile, median, and upper quartile values. The whiskers are lines extending from each end of the box to show the extent of the rest of the data. The length of the whiskers is by default 1.5 times the length of the box. Extreme values are data with values beyond the ends of the whiskers. The symbol for these data is ' + '.

Figure 1 Innovation Input: Normalization with the *Rescaling* method; weights provided by GSO via budget allocation

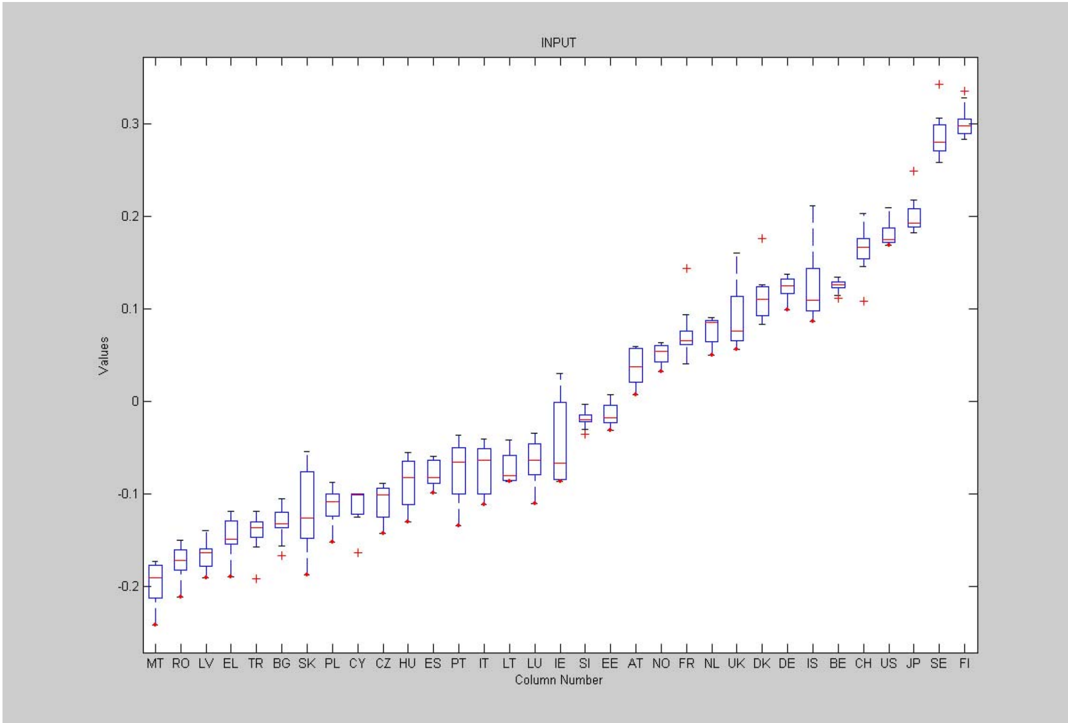
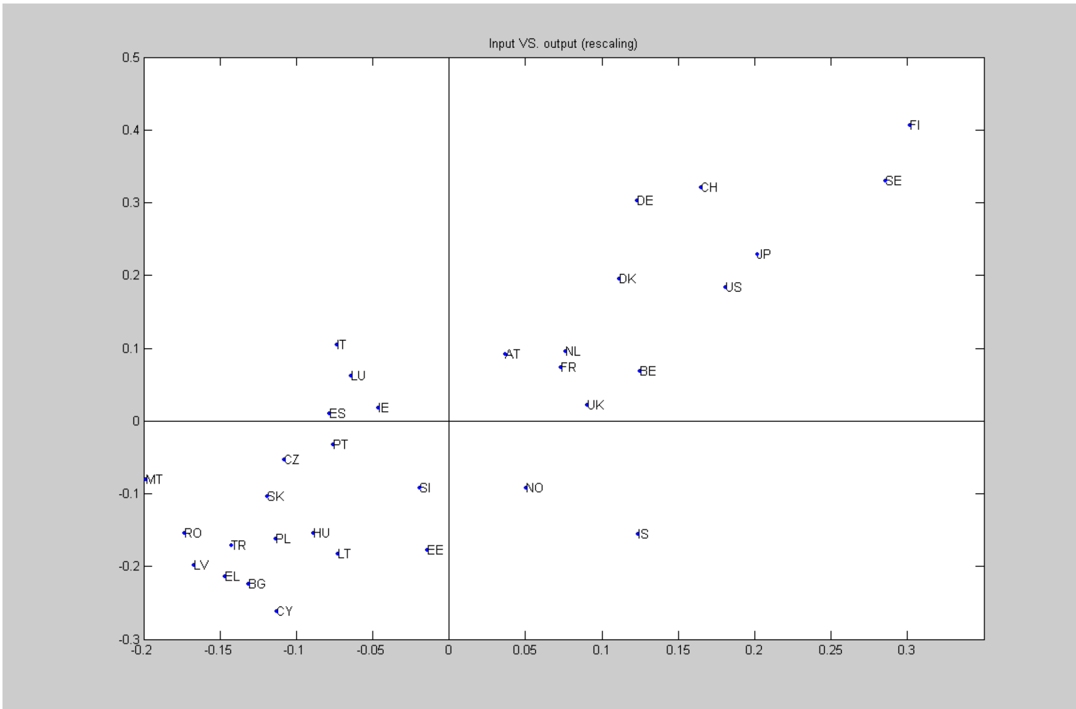


Figure 2 shows innovation input versus innovation output for all countries. In this way we capture the overall situation of innovation whilst keeping input and output visible. Annex III provides a similar graph using the Z-scores method. The weights used in Figure 2 and Annex III are the average weights provided by the GSO's. The hypothetical average performing country has zero score for both input and output. Those with positive score are better than the average.

Note that high investments in innovation have generally a high return in performance (correlation coefficient 0.78). We can also see countries that make an efficient use of innovation investments in the upper-left quadrant (Italy, Luxembourg, Spain and Ireland). On the contrary, it seems that there is low efficiency of innovation investments by the countries in the lower-right quadrant (Iceland and Norway). For these latter countries, investments in innovation are addressed to different sectors of the economy other than those captured by the output innovation indicators that partly focus on high-tech. In the case of Norway, R&D investments, less developed than in other Scandinavian countries, are mostly focused on its main national economic activities, such as the exploitation of oil and natural gas, shipyard industry, fishery and metal industry. In Iceland, investments are mainly addressed to geology for the exploitation of geothermic sources and to genetics, as the existence of a small number of family strains facilitates this kind of studies.

The numerical results of the aggregated indices (input & output) are shown in Annex IV. For each of the 11 experts, we calculated the indices for the 33 countries and sorted the results in increasing order. The correlations among the weights given by the different country experts are given in Annex V: they are all reasonably high, independently of the level of performance of the given country. This means that the weights selected by the experts are not driven by the performance of their respective country.

Figure 2 Input versus Output with *Rescaling* normalization



Factor Analysis method

Using factor analysis we obtain weights that correct for the overlapping of the information among correlated indicators. We have employed the approach proposed by Nicoletti et al. (2000)[8]. In Annex VI the innovation scores and rankings are given with three alternative weighting methods: equal weights, budget allocation and factor analysis.

Closer inspection shows that the results for the different weighting methods are similar. The values of the input and output indexes are highly correlated as shown in the following table.

	BDG Input	BDG Output	EQW Input	EQW Output	FAC Input	FAC Output	BOD Input	BOD Output
Budget allocation (BDG) - Input	1.000							
Budget allocation (BDG) - Output	.787**	1.000						
Equal weighting (EQW) - Input	**.989****	.771**	1.000					
Equal weighting (EQW) - Output	.805**	**.977****	.795**	1.000				
Factor Analysis (FAC) - Input	**.979****	.741**	**.993****	.771**	1.000			
Factor Analysis (FAC) – Output	.787**	**.984****	.771**	**.991****	.739**	1.000		
Budget of the doubt (BOD) – Input	.965**	.748**	**.980****	.783**	**.975****	.752**	1.000	
Budget of the doubt (BOD) – Output	.762**	**.954****	.749**	**.990****	.723**	**.981****	.742**	1.000

**. Correlation is significant at the 1%-level (2-tailed).

Benefit of the doubt[9]

This procedure (Melyn and Moesen, 1991, Cherchye et al., 2004[10]) can be seen as a particular case of *data envelopment analysis* (DEA). It calculates the innovation index for a given country by using the *best* set of weights, which maximizes the index for that country with respect to the best performing country using the same set of weights. The same procedure is followed for each country. Weights are therefore country-dependent. In general, even using the best combination of weights for a given country, other countries may show better performance. The optimization process could easily lead to an innovation index made by the indicator where the country performs at its best if no restrictions on the weights were imposed. In such case many countries would have the value of the index equal to one. Bounding restrictions on weights are hence necessary for this method to be of practical use. The formula used is: $bounds = \frac{1}{n}(1 \pm 0.4)$ where n is the number of component indicators. For example, for the first group, the lower bound is set to 12% and the upper bound to 28%, and for the innovation input (output) the lower bound is 20% (30%) and the upper bound is 46% (70%). Figure 3 shows the results for Innovation input. Annex VII provides graphs for

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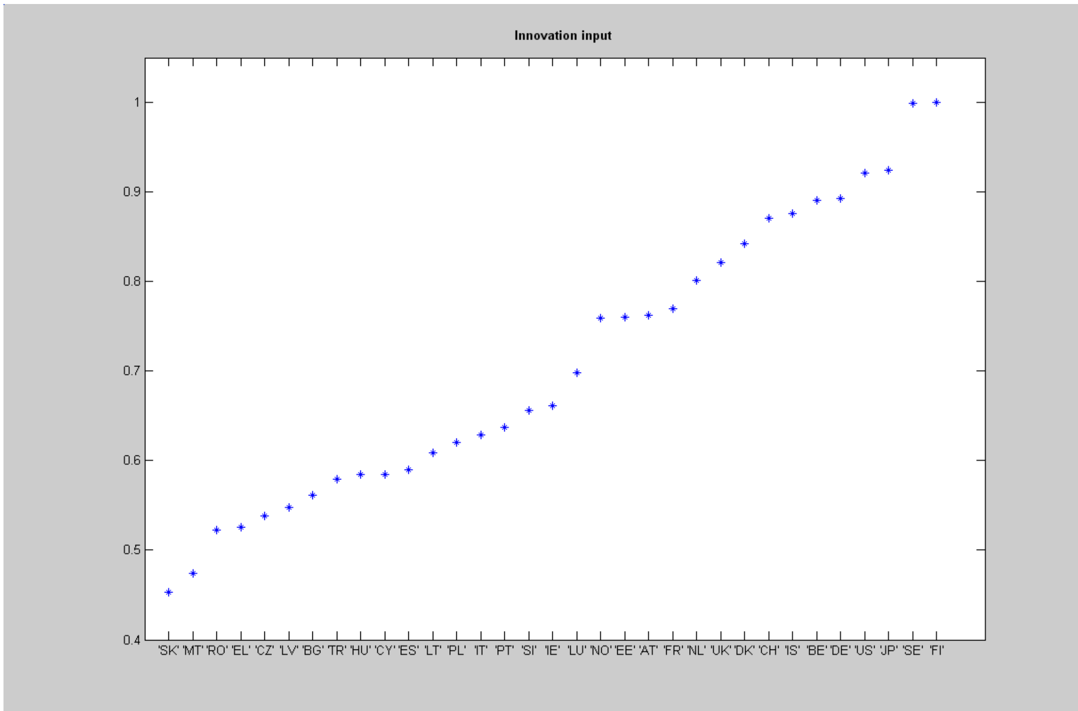
[8] Nicoletti, Scarpetta and Boylaud (2000) "Summary Indicators of product market regulation with an extension to employment protection legislation", OECD, Economics department working papers No. 226, ECO/WKP(99)18.
[9] One of the GSO members has suggested the use of this weighting approach.
[10] Melyn, W. and W. Moesen (1991), "Towards a Synthetic Indicator of Macroeconomic Performance: Unequal Weighting when Limited Information is Available", Public Economics Research Paper 17, Center for Economic Studies, Leuven. Cherchye, L., W. Moesen and T. Van Puyenbroeck (2004), "Social Inclusion in the EU: Towards a Synthetic Indicator with Endogenous Weights", in: The Open Method of Coordination and Minimum Income Protection in Europe, ed. B. Cantillon and J. Vandamme, Leuven, pp. 69-81.

all blocks of indicators using the benefit of the doubt method. Annex VIII shows the scores of the innovation index calculated with the BOD method.

Figure 3 Innovation Index scores sorted in increasing order of country performance based on "benefit of the doubt weights"



Robustness analysis

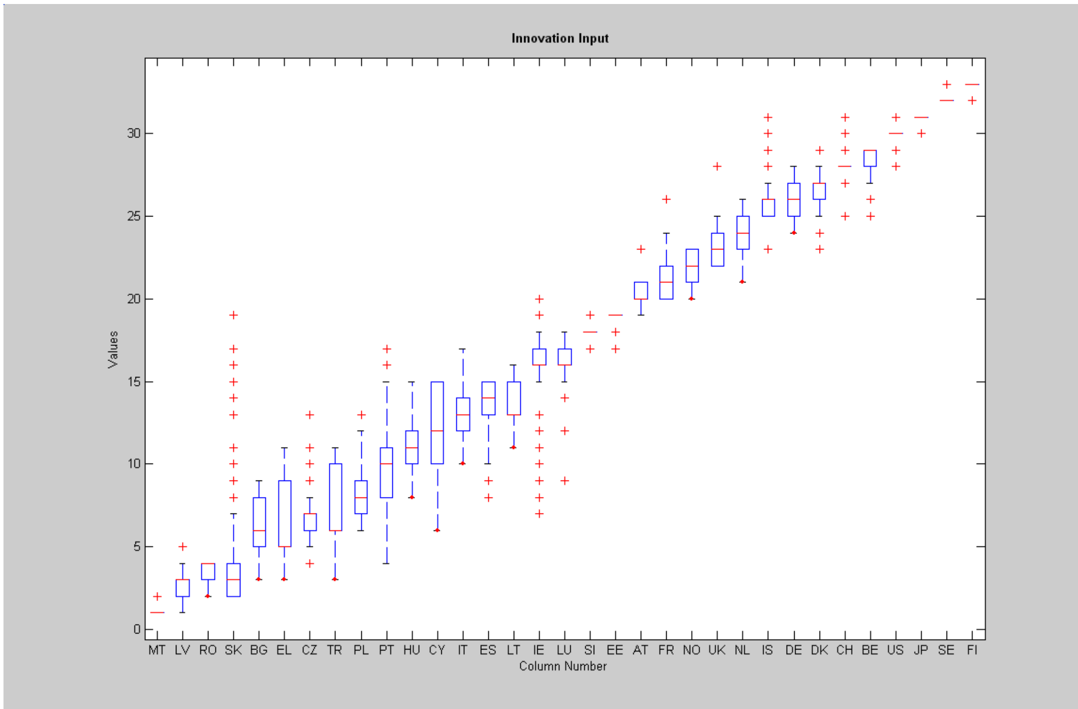
At the basis of the robustness analysis there is a Monte Carlo experiment, which consists in a set of simulations (300 in this case) of evaluation of the index. In each simulation a normalization method for the indicators is selected at random with equal probability between two alternative normalization methods. These are standardization (or z-scores) and re-scaling. Z-scores convert the indicators to a common scale with a mean of zero and standard deviation of one. The re-scaling normalizes indicators to have an identical range, in this case (-0.5;0.5). This range has been selected to maintain the symmetry around zero as in the z-scores method.

In each simulation, a weighting method is also selected at random with equal probability (33% each) between equal weights, budget allocation and factor analysis.

In addition, in the simulations where the budget allocation is used, the experts are selected at random with equal probability (1/11). The index has been calculated with linear aggregation. At the end of the procedure, we have 300 evaluations of the index for each country and for each of the five groups. The uncertainty bounds of the index for each country take simultaneously into account the different types of normalization and weighting. These bounds are calculated using the country rankings instead of the index values. In this latter case, index values would span different scales depending on the normalization method used and the uncertainty bounds would be overestimated.

Figure 4 represents with boxplots the uncertainty bounds of the countries ranking for Innovation input. Annex IX provides graphs for all blocks of indicators.

Figure 4 Robustness analysis for Innovation input



5.2 TREND ANALYSIS (STEP 10)

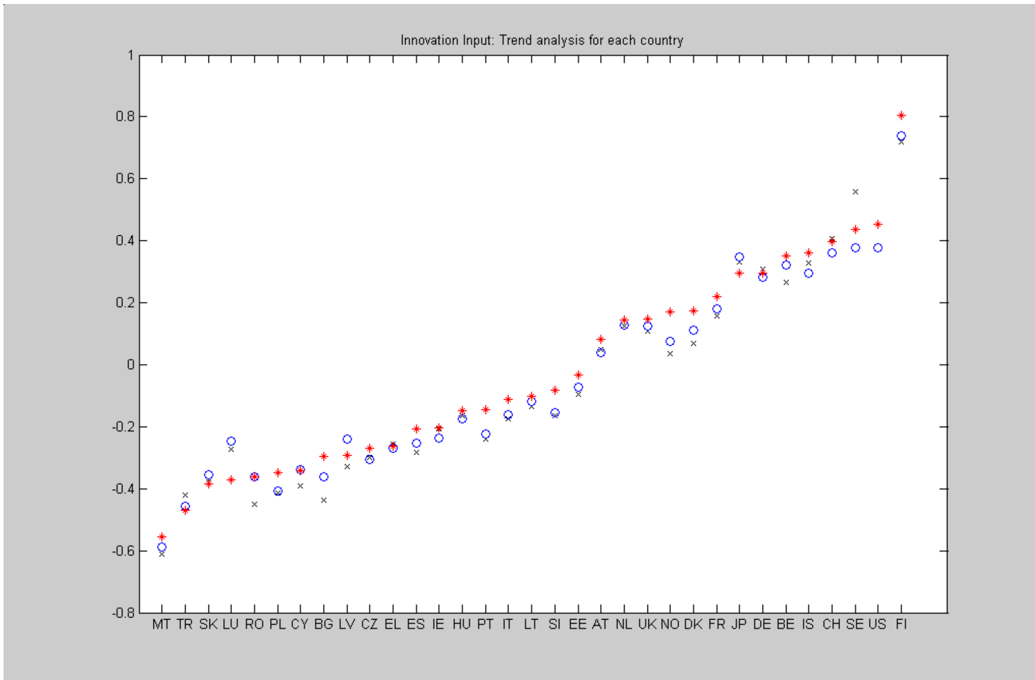
We consider a time span of three consecutive years. Unfortunately those years do not correspond in all indicators, so we consider the three most recent years available in the trend analysis. Missing data have been imputed with regression/correlation techniques over all the three years.

In Annex X we show the results of the robustness analysis for Innovation input and in Annex XI for output. Each year is plotted separately. Note that Annex X for the most recent year does not coincide with Figure 4 and Annex IX because i) the normalizations refer to different years and ii) the imputation procedure used across the three years provides slightly different results than those obtained in the one-year analysis.

Annex XII contains the average index values for Innovation Input and Output in the three years considered. The average is obtained over the Monte Carlo repetitions of the index calculation. In other words, we calculated the index N times (N=300 in this case, the higher N the higher the precision of the results) and then considered the average over N in order to have one value for each year, which allows comparison across different years.

Figure 5 represents the trend of the Innovation Input index values in the three years for each country. Annex XIII shows a similar graph for Innovation Output.

Figure 5 Trend analysis for Innovation Input



Innovation index for first year by black x, for second year by blue o and third year by red *.

6. CONCLUSIONS FOR EIS 2005 SUMMARY INNOVATION INDEX

6.1 INTERPRETATION OF ROBUSTNESS ANALYSIS (STEP 11)

In section 5 composite innovation indexes have been calculated for each of the 5 main blocks and for input and output. Regression and correlation techniques have been used to impute all missing data over a three-year period. A robustness analysis of the composite indicators was carried out based on 300 simulations using different combinations of two different normalization methods and different weighting schemes of the indicators. Weights have been derived using the budget allocation method (BDG) using indicator weights as received from 11 GSO members, the factor analysis method (FAC), benefit of the doubt approach (BOD) and equal weighting (EQW).

Country groupings (based on hierarchical clustering) are identical for equal weighting and factor analysis. For budget allocation the top 3 groups are identical to those of the other weighting schemes. In total 23 countries never switch between groups, 8 countries switch only once between groups. The table below shows that the country grouping using the budget allocation weights differs most.

INPUT	OUTPUT	Budget allocation (BDG)	Equal weights (EQW)	Factor Analysis (FAC)	Benefit of the Doubt (BOD)
+++	+++	FI SE	FI SE	FI SE	FI SE
++	++	CH DE DK JP US	CH DE DK JP US	CH DE DK JP US	CH DE DK JP US
+	+	AT BE FR NL UK	AT BE FR NL UK	AT BE FR NL UK	AT BE FR LU NL UK
-	+	CZ ES IE IT LU PT	IE IT LU	IE IT LU	IE IT MT
--	-	MT	CZ ES HU MT PT SK	CZ ES HU MT PT SK	CZ ES HU PT SI SK
+/-	-/--	EE IS NO SI SK	EE IS NO SI	EE IS NO SI	IS NO
--	--	BG CY EL HU LT LV PL RO TR	BG CY EL LT LV PL RO TR	BG CY EL LT LV PL RO TR	BG CY EE EL LT LV PL RO TR

Groups are ordered top-down according to their average output performance. +++: Top performance; ++: Above average performance; +: Average performance; -: Below average performance ‘ --: Bottom performance.

If we compare changes between groups based on Input and Output ranks only, we only observe countries switching between the less performing groups. For Input we observe only 6 between group changes: CZ and SK moving from group 7 to 6 for BDG, EL and TR moving from group 7 to 6 using FAC and EE moving from group 5 to group 4 and SI dropping from group 5 to group 6 using BOD.

For Output we observe only 5 between group changes: ES moving from group 4 to group 3 and HU and IS dropping from group 5 to group using BDG and PT dropping from group 4 to group 5 using both EQW and BOD.

Conclusion 1:

Country groupings appear to be stable using different weighting schemes.

INPUT								OUTPUT							
BDG		EQW		FAC		BOD		BDG		EQW		FAC		BOD	
FI	1	FI	1	FI	1	FI	1	FI	1	FI	1	FI	1	DE	1
SE	2	SE	2	SE	2	SE	2	SE	2	CH	2	SE	2	SE	2
JP	3	JP	3	JP	3	JP	3	CH	3	SE	3	CH	3	FI	3
US	4	US	4	US	4	US	4	DE	4	DE	4	DE	4	CH	4
CH	5	BE	5	BE	5	DE	5	JP	5	JP	5	JP	5	JP	5
IS	6	CH	6	CH	6	BE	6	DK	6	DK	6	US	6	DK	6
DE	7	DE	7	DK	7	IS	7	US	7	US	7	DK	7	US	7
BE	8	DK	8	IS	8	CH	8	IT	8	LU	8	FR	8	LU	8
DK	9	IS	9	DE	9	DK	9	AT	9	NL	9	LU	9	NL	9
UK	10	UK	10	NL	10	UK	10	LU	10	AT	10	IT	10	AT	10
FR	11	NL	11	NO	11	NL	11	NL	11	FR	11	NL	11	UK	11
NL	12	FR	12	UK	12	FR	12	FR	11	UK	12	AT	11	IT	12
NO	13	NO	12	AT	13	AT	13	BE	13	BE	13	IE	13	IE	13
AT	14	AT	14	FR	14	EE	14	ES	14	IT	13	UK	14	FR	14
EE	15	EE	15	EE	15	NO	15	IE	15	IE	15	BE	15	BE	15
SI	16	SI	16	SI	16	LU	16	UK	16	MT	16	MT	16	MT	16
IE	17	IE	17	LU	17	IE	17	PT	17	ES	17	ES	17	ES	17
LU	18	LU	18	IE	18	SI	18	CZ	18	CZ	18	CZ	18	CZ	18
LT	19	LT	19	CY	19	PT	19	MT	19	NO	19	PT	19	HU	19
PT	20	ES	20	LT	20	IT	20	SI	20	SI	20	SI	20	NO	20
IT	21	IT	21	ES	21	PL	21	SK	21	PT	21	NO	21	SI	21
SK	21	CY	22	IT	22	LT	22	NO	22	HU	22	HU	22	PT	22
ES	23	HU	22	TR	23	ES	23	RO	23	IS	23	SK	23	IS	23
HU	24	PT	24	HU	24	CY	24	HU	24	SK	23	IS	24	SK	24
PL	25	PL	25	EL	25	HU	25	PL	25	PL	25	PL	25	PL	25
CZ	26	BG	26	PL	26	TR	26	TR	26	TR	26	EE	26	TR	26
CY	27	CZ	27	PT	27	BG	27	EE	27	EE	27	TR	27	RO	27
BG	28	TR	28	CZ	28	LV	28	IS	28	RO	28	RO	28	EE	28
TR	28	EL	29	BG	29	CZ	29	LT	28	LT	29	LT	29	BG	29
EL	30	RO	30	RO	30	EL	30	LV	30	BG	30	LV	30	LT	30
LV	31	SK	31	SK	31	RO	31	EL	31	LV	31	EL	31	EL	31
RO	32	LV	32	LV	32	MT	32	BG	32	EL	32	BG	32	LV	32
MT	33	MT	33	MT	33	SK	33	CY	33	CY	33	CY	33	CY	33

In Section 5.1 we have shown that Input and Output innovation indexes using different weighting schemes are highly correlated. A similar correlation matrix would show the same high correlations for the rankings of countries on their input and output performance[11].

Conclusion 2:

Country Input and Output rankings appear to be stable using different weighting schemes.

[11] All ranks are significantly correlated at the 1%-level and all correlation coefficients are at least 0.960 between the input based ranks and at least 0.963 between the output based ranks.

6.2 SUMMARY INNOVATION INDEX (STEP 11 CONTINUED)[12]

For the computation of the Summary Innovation Index (SII) the robustness analysis in the previous section has shown that country rankings are relatively stable. Variations in indicator weights and/or normalization methods only have a minor influence on the rankings of countries.

Table 4: EIS 2005 weighting schemes

	Description
Alternative 1: Equal weighting	• Equal weights for all indicators (=100/N where N is the number of indicators for which data are available)
Alternative 2: Equal weighting within and between blocks	• Equal weights for all blocks • Equal weights for all indicators within each block
Alternative 3: Unequal weighting between and equal weighing within blocks	• Innovation drivers: 20%; Knowledge creation: 20%; Innovation & entrepreneurship: 25%; Application: 20%; Intellectual property: 15% • Equal weights for all indicators within each block

For the 2005 EIS it thus seems best to *keep the weighting scheme as simple as possible*. Table 4 shows three alternatives that have been explored.

- Alternative 1 is the simplest one using equal weights for all indicators. If data are available for all 26 indicators, the weight for each indicator is thus 3.85%.
- Alternative 2 reflects the fact that 5 main blocks of indicators have been identified to describe the innovation process. This alternative uses equal weighting between the five blocks of indicators and equal weighting between the indicators in each block of indicators. Furthermore, the following rules are used for computing composite indicators:
  - For each of the five blocks, a composite indicator is only computed if data are available for at least 3 of the respective indicators;
  - For Input a composite indicator is only computed if composite indicators are available for Innovation drivers, Knowledge creation and Innovation & entrepreneurship.
  - For Output a composite indicator is only computed if composite indicators are available for Application and Intellectual Property.
  - A Summary Innovation Index is only computed if composite indicators are available for at least 4 of the 5 blocks of indicators.
- Alternative 3 is inspired by the average weights provided by the GSO members where an above average weight is given to Innovation & entrepreneurship and a below average weight to Intellectual property[13].

[12] Results in this section will differ from those in section 5 for several reasons. Some are purely due to differences in methodologies. Others are due to the use of updated data in this section compared to the dataset used in section 5. In particular for Switzerland many of the missing data in the section 5 dataset could be updated due to the kind assistance of Swiss Statistics.

Alternatives 2 and 3 explicitly take into account the conceptual framework where 5 main blocks of indicators have been identified to describe the innovation process. As not all GSO members have replied to the GSO survey, the average GSO weights do not necessarily reflect the true average weights of all 31 GSO members. Therefore, *alternative 2 seems to be the best option from a conceptual point of view*.

However, based on the fact that the results generated by these three alternative weighting schemes do not differ significantly[14], *the final choice has been to keep the weighting scheme as simple as possible*, thus to opt for alternative 1.

Conclusion 3:

For reasons of simplicity and continuity with previous scoreboard exercises, we adopt the following methodology:

- ***Equal weighting between all indicators;***
- ***Normalisation based on relative to EU25 data (or EU15 data if data for the EU25 are not available) using rescaling with 0 as lower bound and 1 as upper bound;***
- ***Relative to EU25 data are calculated as the ratio between the most recent data for a country and the value of the EU25 in that same year[15];***
- ***No imputation for missing data[16].***

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[13] The average weights for the 5 blocks of the GSO members from CZ, DE, IE, NL, AT, PT, SI, SE, UK, RO, CH and IS are as follow (standard deviation in brackets): Innovation drivers – 17.3 (4.7); Knowledge creation – 23.7 (3.6); Innovation & entrepreneurship – 26.6 (5.4); Application – 18.5 (6.7); Intellectual property – 14.0 (3.8). Differences between ranks using the equal weighting and the GSO-based weighting schemes are minor. For 18 countries rank numbers are identical, for 8 countries rank numbers differ by 1 rank and for 3 countries rank numbers differ by 2 ranks.

[14] The values of the Summary Innovation Index using equal weighting between and within groups and using equal weighting for all indicators are almost perfectly correlated with a correlation coefficient of 0.999.

[15] If for most countries data are available for 2003 the relative to EU25 values are calculated relative to the 2003 EU25 data. If for country *i* the most recent data is available for 2002 the relative to EU25 value is calculated relative to the 2002 EU25 data.

[16] The analyses in the previous sections used imputed data for all missing data. For the EIS 2005 we strive for continuity with previous scoreboard exercises and thus do not replace missing data by imputed data.

Preliminary results

Figure 6 2005 Summary Innovation Index (preliminary results)

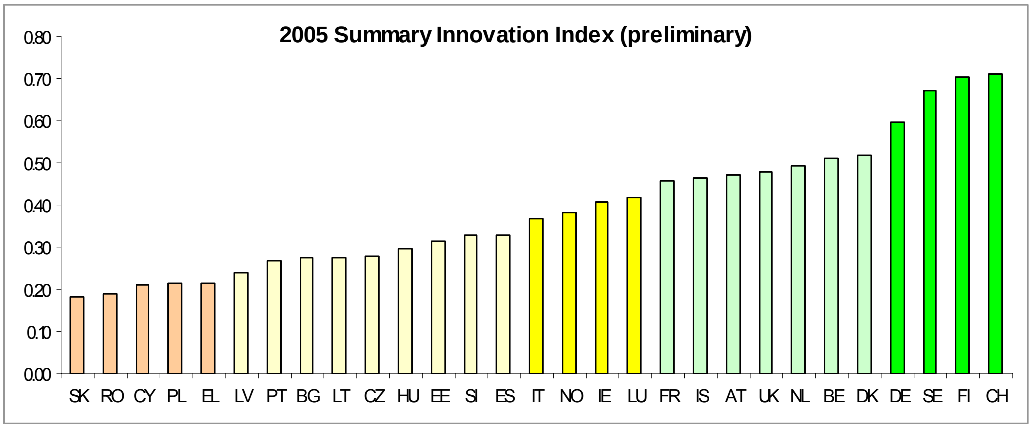

Figure 6 plots the SII based on April 2005 data availability. The countries can be divided using hierarchical clustering in the following 5 groups[17]:

1. Group-1: CH, DE[18], FI, SE
2. Group-2: AT, BE, DK, FR, NL, AT, UK
3. Group-3: IE, IT, LU, NO
4. Group-4: BG, CZ, EE, ES, HU, LT, LV, PT, SI
5. Group-5: CY, EL, PL, RO, SK

Figure 7 shows the values of the 2004 Summary Innovation Index on the horizontal axis and the values of a hypothetical 2004 SII based on the 2005 methodology on the vertical axis. Although there is not a perfect match, the two series are highly correlated (0.995).

As shown in Figure 8, Group-1 countries appear to give below average importance to Intellectual property and above average importance to Innovation drivers. Group-2 countries have a preference scheme close to the average of all 12 countries for which GSO weights are available. Group-4 countries give below average importance to Innovation drivers and above average importance to Innovation & entrepreneurship. For both Group-3 and Group-5 countries we only have one GSO expert who answered the survey and for reasons of confidentiality these weights are not shown in Figure 8.

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[17] This country grouping does not reflect the country grouping in the forthcoming EIS report on Strengths and Weaknesses (S&W report) and is here only used for illustrative purposes. Changes in the database between April and August 2005 and different analytic tools used in the S&W report are expected to yield different groups from those presented above.

[18] Germany is in fact in between the first and second group. However, as the average distance (as measured by the squared Euclidean distance) is lowest to the countries in the first group, Germany has been classified in the first group.

Figure 7 A comparison of the 2004 and 2005 EIS methodologies using EIS 2004 data

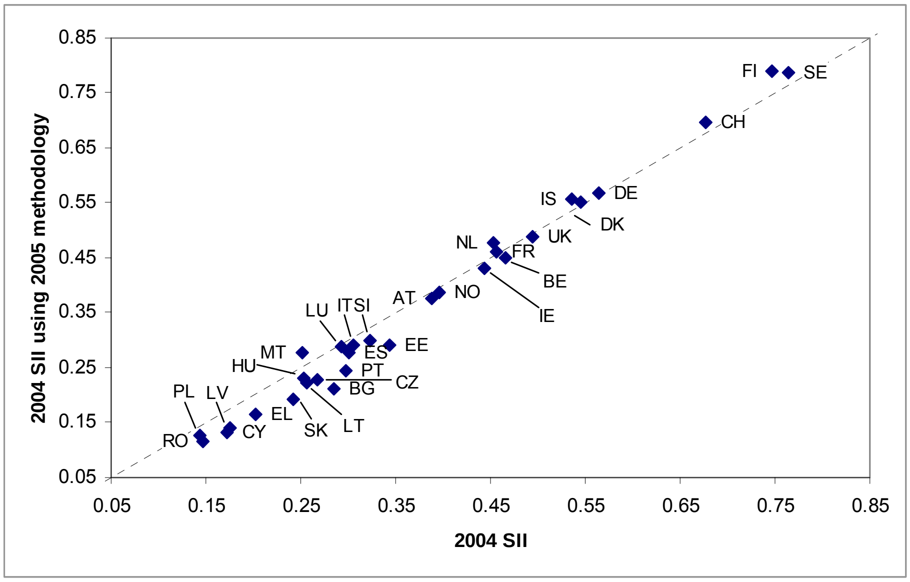
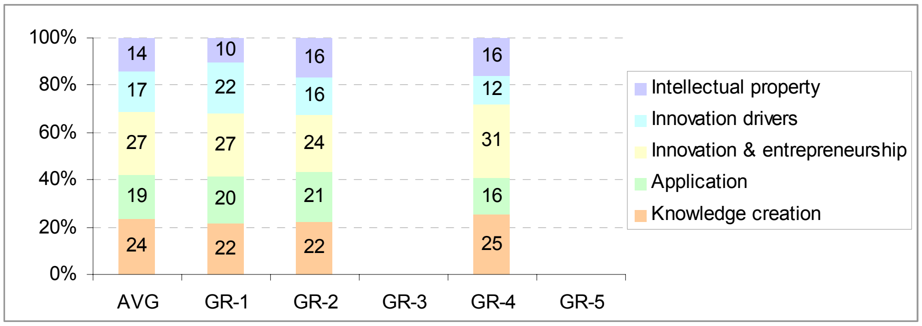


Figure 8 Differences in average “GSO weights” between groups of countries



Average weights derived from budget allocations from *12* GSO experts.

6.3 ANALYSIS OF TRENDS (STEP 12)[19,20]

In previous Innovation Scoreboards trends were only calculated for individual indicators. Trends were in fact calculated as the percentage change between the last year for which data are available and the average over the preceding three years, after a one-year lag. The three-year average was used to reduce year-to-year variability; while the one-year lag was used to increase the difference between the average for the three base years and the final year and to minimize the problem of statistical/sampling variability. Average country trends were then calculated as the unweighted average of the available indicator trends.

In EIS 2005 for the first time trends will be calculated for the Summary Innovation Index. This section will both analyse these trends in more detail and will briefly sketch available time series data.

For the 7 indicators based on CIS-3 there is only one observation. For these indicators trend data are not available. It will be assumed that data are identical for a 3-year period. These indicators are Share of enterprises receiving public funding for innovation (2.4), SMEs innovating in-house (3.1), Innovative SMEs co-operating with others (3.2), Innovation expenditures (3.3), SMEs using non-technological change (3.6), Sales of new-to-market products (4.3) and Sales of new-to-firm not new-to-market products (4.4).

In computing re-scaled data for the EIS Summary Innovation Index not the latest actual values of the indicators are used but the latest relative to EU15 or EU25 values. The idea is that by taking relative to EU15 or EU25 values, for those indicators for which years of reference differ these values will become more comparable, in particular if the indicator in general shows an increasing (or decreasing) trend. As an example, for the share of population with tertiary education we have the following data:

	Real data						Relative to EU25 data				
	1999	2000	2001	2002	2003		1999	2000	2001	2002	2003
EU25	19.4	20.0	20.1	20.4	21.2		100	100	100	100	100
FR	20.9	21.6	22.6	23.5	23.1		107.5	107.8	112.3	115.2	109.3
NL	22.6	24.1	24.0	24.9	--		116.4	120.4	119.1	121.8	--

Instead of directly comparing the 23.1 for FR in 2003 with the 24.9 for NL in 2002, one compares the latest relative value of 109.3 for FR with that of 121.8 for NL. These values thus enter into the summary innovation index for year T. For T-1 there are two options:

(1) Take the relative value for both FR and NL with a lag of one year, so 115.2 for FR and 119.1 for NL, or

[19] Results in this section will differ from those in section 5 for several reasons. Some are purely due to differences in methodologies. Others are due to the use of updated data in this section compared to the dataset used in section 5. In particular for Switzerland many of the missing data in the section 5 dataset could be updated due to the co-operation of Swiss Statistics.

[20] The analysis in the section is based on the equal weighting within and between blocks methodology.

(2) Do this for FR (thus 115.2) and to take the 2002 value for NL (121.8) so one would have data for the same year.

As trends are assumed to capture changes in the SII over time, the first option will be used in the EIS 2005.

Time series data availability for most of the non-CIS indicators is good with the exception of the following indicators: Broadband penetration rate (1.3), Share of medium-high-tech and high-tech R&D (2.3) and New community industrial designs (5.5).

Given the constraint by the 3-year period for which one can assume identical data for the CIS indicators, Summary Innovation Indexes will be calculated for 3 years only. Trends will thus only be based on real data for a 3-year period.

For the composite indicators at T-1 and T-2 data are identical to those at T for the following indicators: Share of medium-high-tech and high-tech R&D (2.3), Share of enterprises receiving public funding for innovation (2.4), SMEs innovating in-house (3.1), Innovative SMEs co-operating with others (3.2), Innovation expenditures (3.3), SMEs using non-technological change (3.6), Sales of new-to-market products (4.3) and Sales of new-to-firm not new-to-market products (4.4). For the composite indicators at T-2 data are also identical to those at T-1 for the following indicators: Participation in life-long learning (1.4) and New community industrial designs (5.5). As for 8 out of 26 indicators data are identical at T-1 and T and for 10 out of 26 indicators data are identical at T-2 and T, changes in the composite indicators for some of the groups are based on only a small number of indicators.

For the computation of the composite indicators all data are re-scaled using the MinMax-approach:

$$, \text{where } y_{ij}^{t} = \frac{x_{ij}^{t} - Min(x_{j}^{t})}{Max(x_{j}^{t}) - Min(x_{j}^{t})}$$

The re-scaled scores vary within the identical range for each indicator (0 to 1).

As we want to capture improvements over time, the maximum and minimum scores that are used in the above formula are equal to the maximum and minimum scores over the 3-year period. Thus if the maximum score for an indicator is found in 2002 and we have data for 2001-2003 for this indicator, the 2002 score is used as the maximum score in all 3 years. Because of this assumption the values for the composite indicators in year T may deviate slightly from those presented in the 2005 SII where the maximum and minimum scores of the most recent year are used.

Annex XIV shows scatter plots for the various composite indicators and their trends. Due to limited time series availability, not for all countries trends could be calculated for each of the composite indicators.

Figure 9 shows that the SII is quite stable over this 3-year period. Only for Poland and Bulgaria we see large(r) fluctuations. However, comparing increases or decreases in the value of the SII has no direct value. <u>The main purpose of the SII is to rank countries</u> on their innovative performance. Figure 10 shows that the ranks have been stable over the 3-year period for most countries. Exceptions are Slovakia experiencing a change of 5 ranks and Latvia, Poland, Romania and Iceland all experiencing a change of 2 ranks.

Figure 9 Three years of Summary Innovation Index

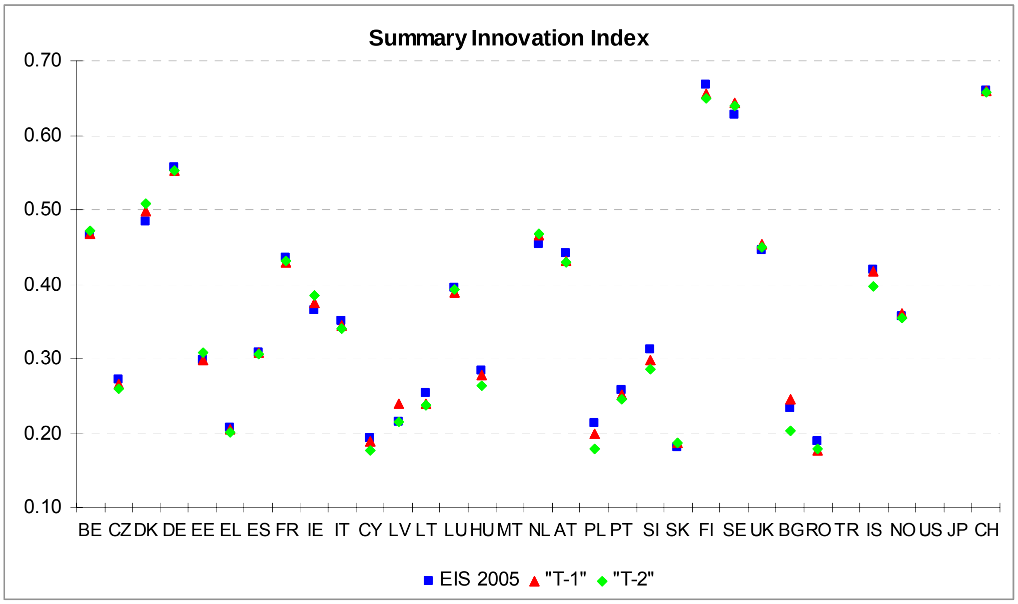
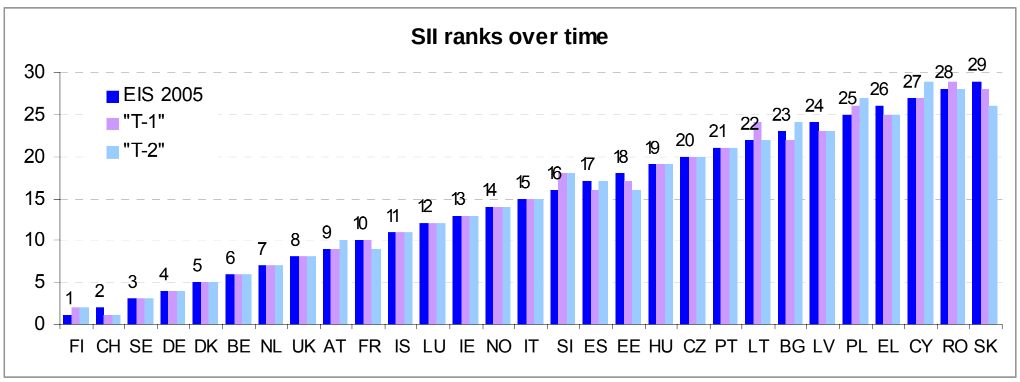


Figure 10 Three years of Summary Innovation Index Ranks



Given the fact the analysed time period is only 3 years, major rank changes are not expected. For this one would need a time period of around 10 years. Limited data availability prevents the re-construction of time series of 10 or more years for many of the indicators.

Annex XV shows various rank differences. Rank differences between the EIS 2005 and the one-year lagged EIS 2005 are minor and are the result of the change in indicators. Rank differences between the EIS 2004 and the EIS 2005 are also minor and changes in rank can be partly explained to the removal of some of the EIS 2004 indicators and the adding of 8 new indicators to the EIS 2005. As the last of the 3 graphs in Annex XV shows, there have been almost no “real” rank changes between 2004 and 2005.

Conclusion 4:

For calculating SII trends we adopt the following methodology:

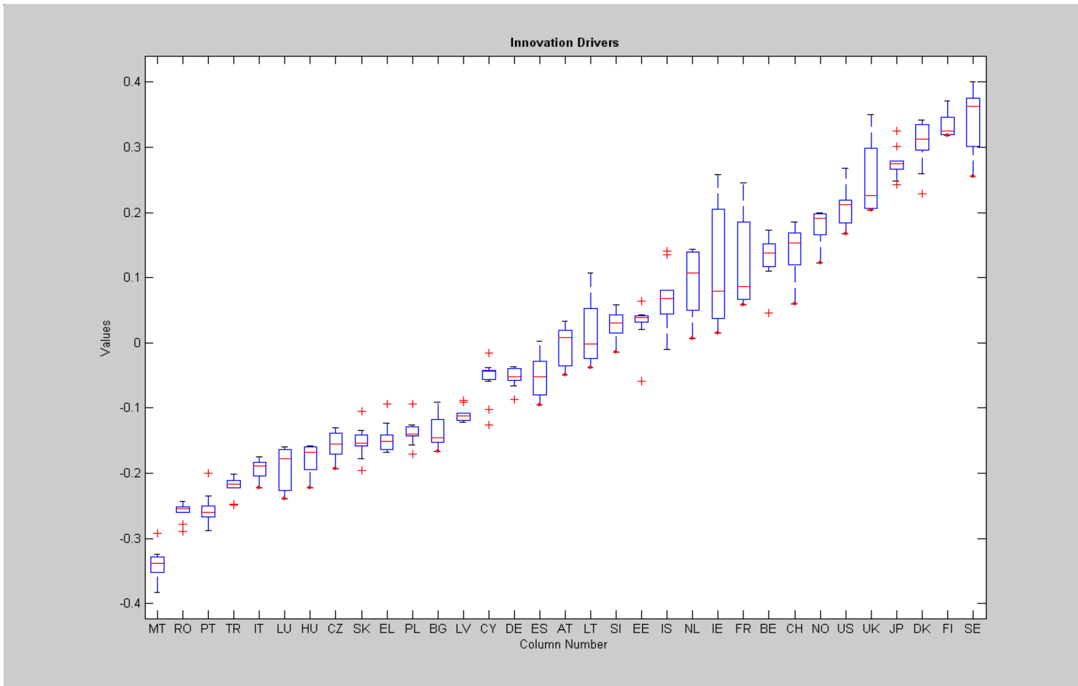
- ***Equal weighting between all indicators;***
- ***Normalisation based on relative to EU25 data (or EU15 data if data for the EU25 are not available) using rescaling with 0 as lower bound and 1 as upper bound;***
- ***Relative to EU25 data are calculated as the ratio between the most recent data for a country and the value of the EU25 in that same year[21];***
- ***For years T, T-1 and T-2 a summary innovation index is calculated using the MinMax-approach but <u>using maximum and minimum values over the 3-year period</u>;***
- ***No imputation for missing data in T;***
- ***For the 7 indicators based on CIS-3 data in T-1 and T-2 are assumed to be identical to the values in year T;***
- ***"Imputation" for missing data at T-1 and T-2 by assuming identical values to those in T respectively T-1.***

[21] If for most countries data are available for 2003 the relative to EU25 values are calculated relative to the 2003 EU25 data. If for country *i* the most recent data is available for 2002 the relative to EU25 value is calculated relative to the 2002 EU25 data.

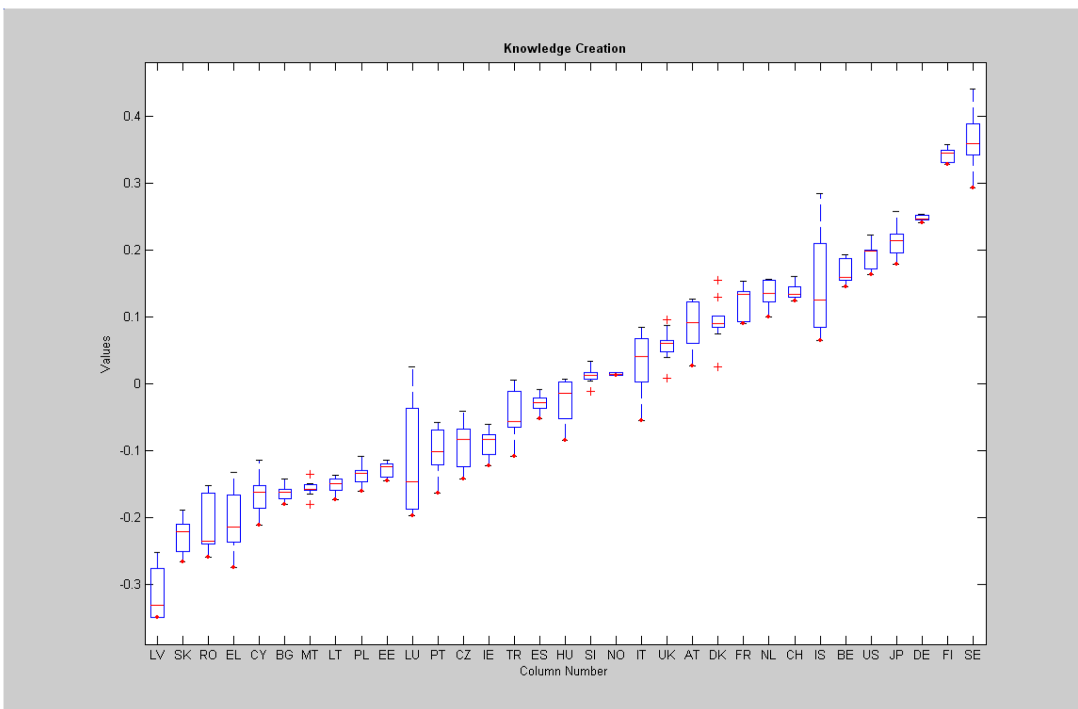
ANNEXES

Annex I – Normalization with the *Rescaling* method; weights provided by GSO via budget allocation

Innovation Drivers

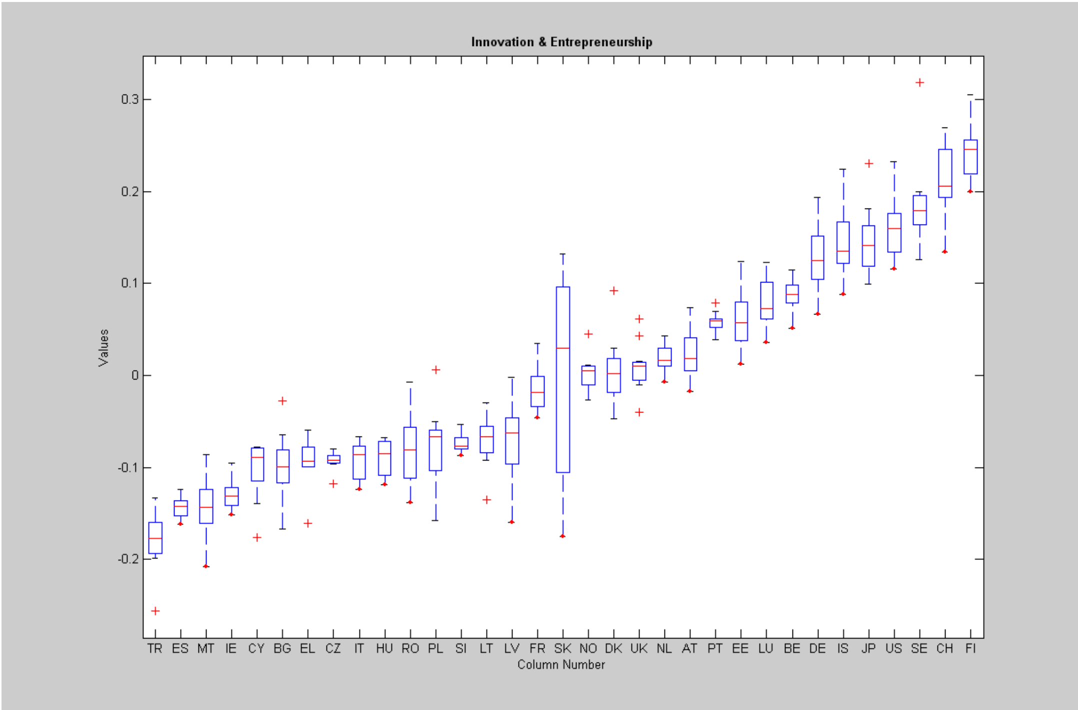


Knowledge Creation

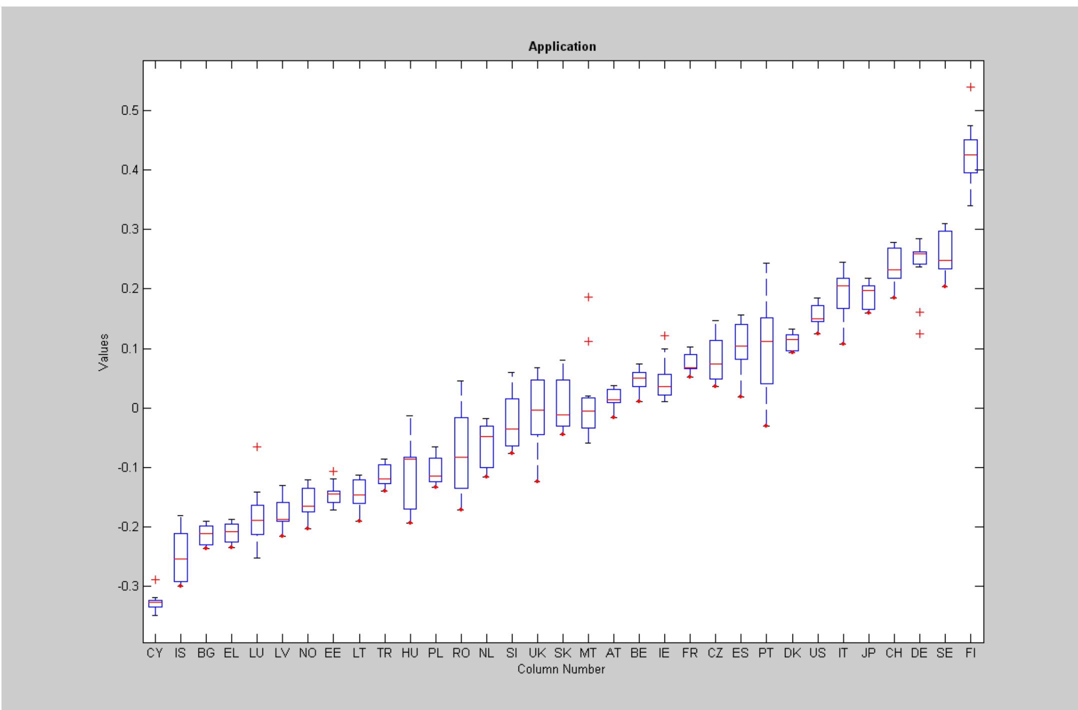


Annex I – continued

Innovation & Entrepreneurship

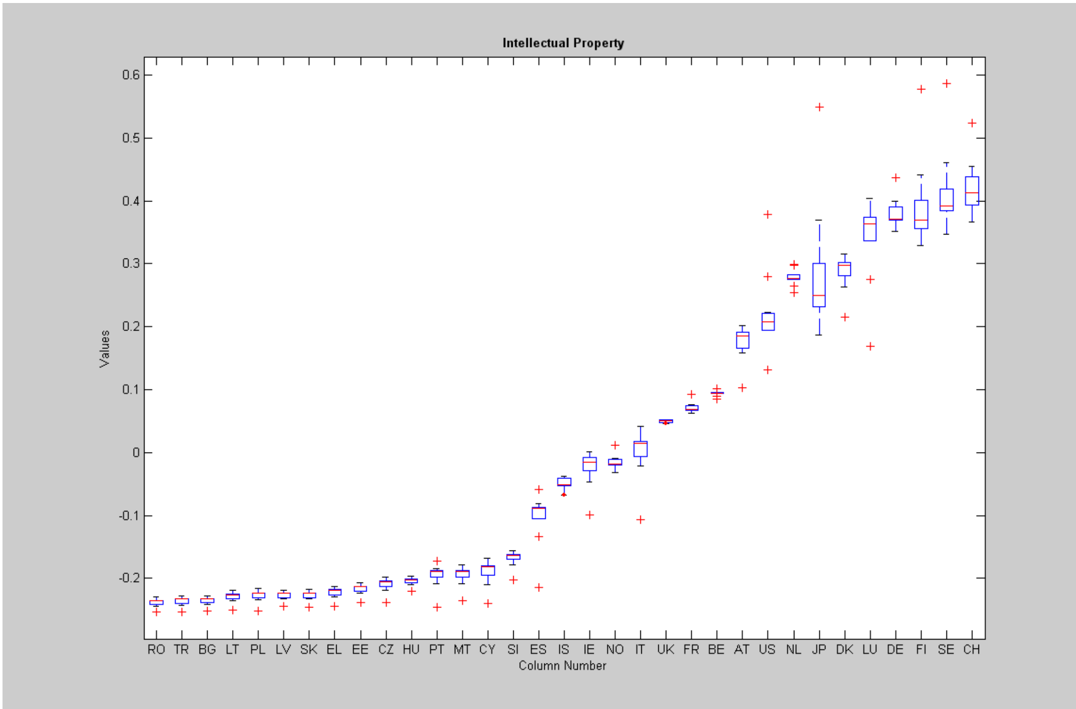


Application

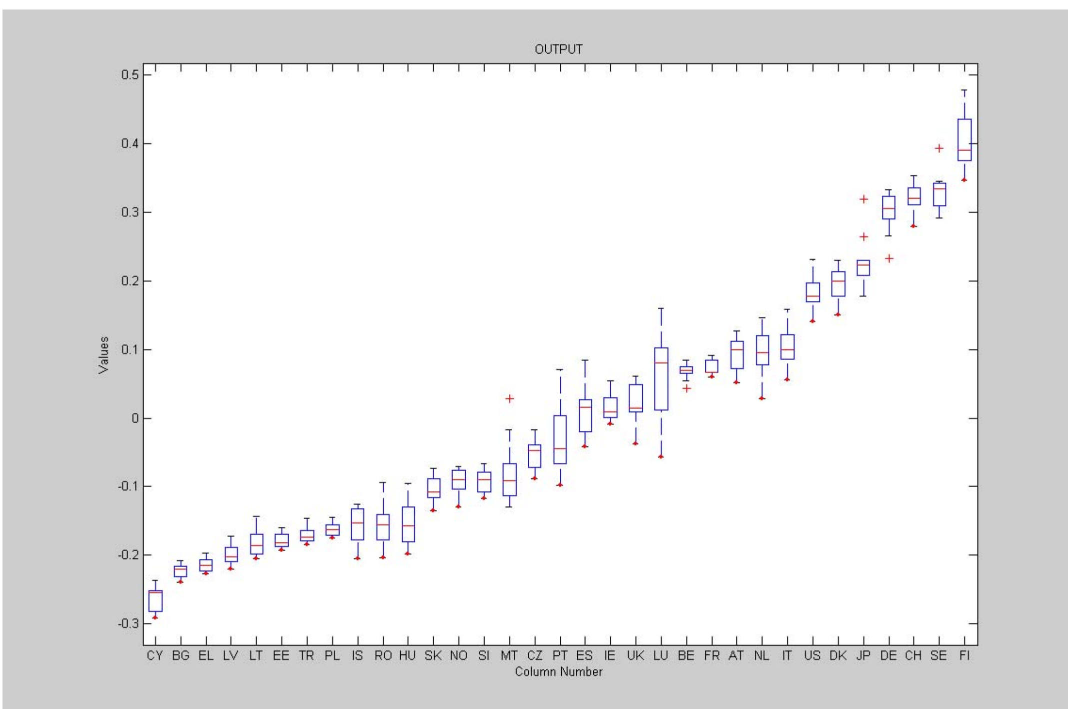


Annex I – continued

Intellectual Property

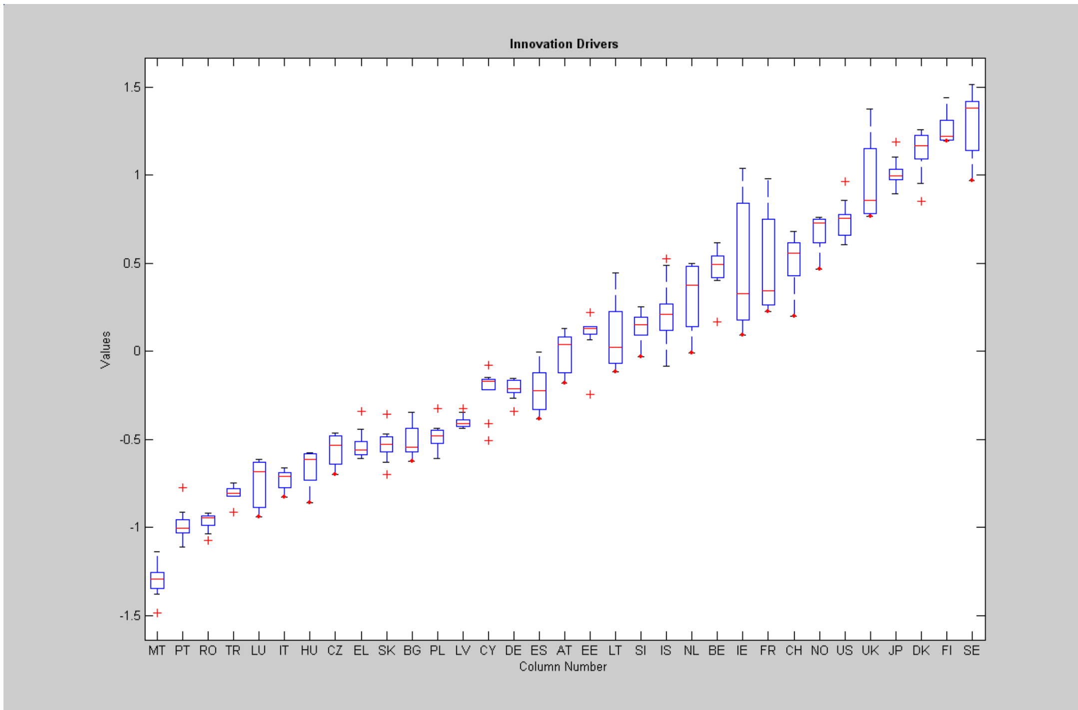


Innovation Output

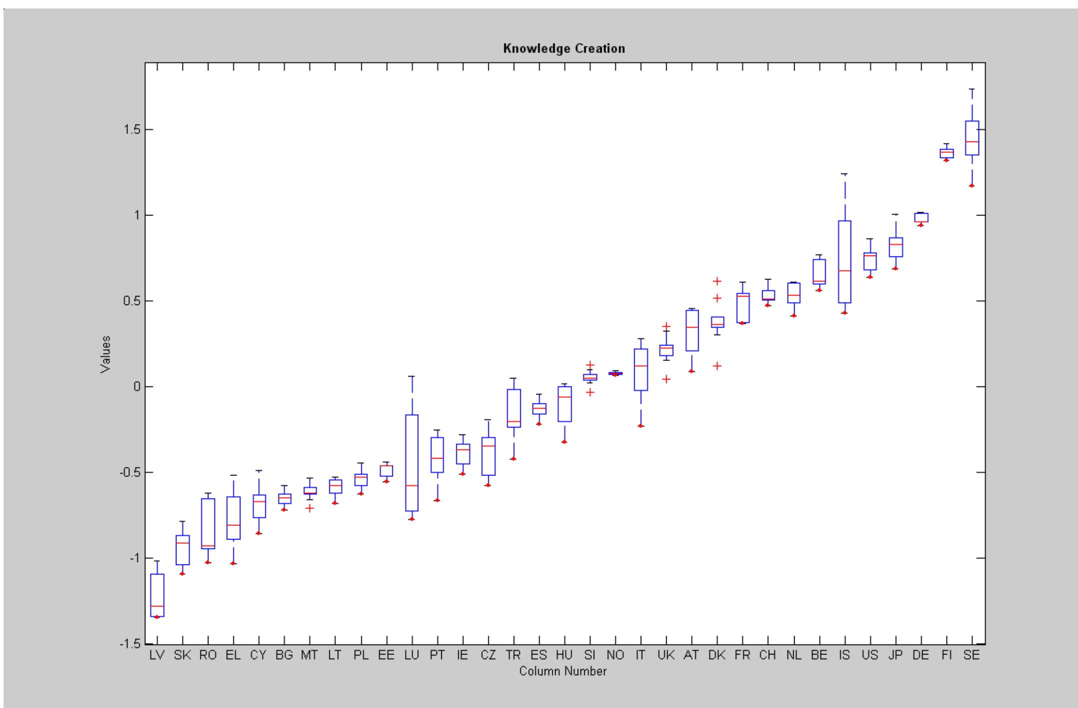


Annex II – Normalization with the *Z-scores* method; weights provided by GSO via budget allocation

Innovation Drivers

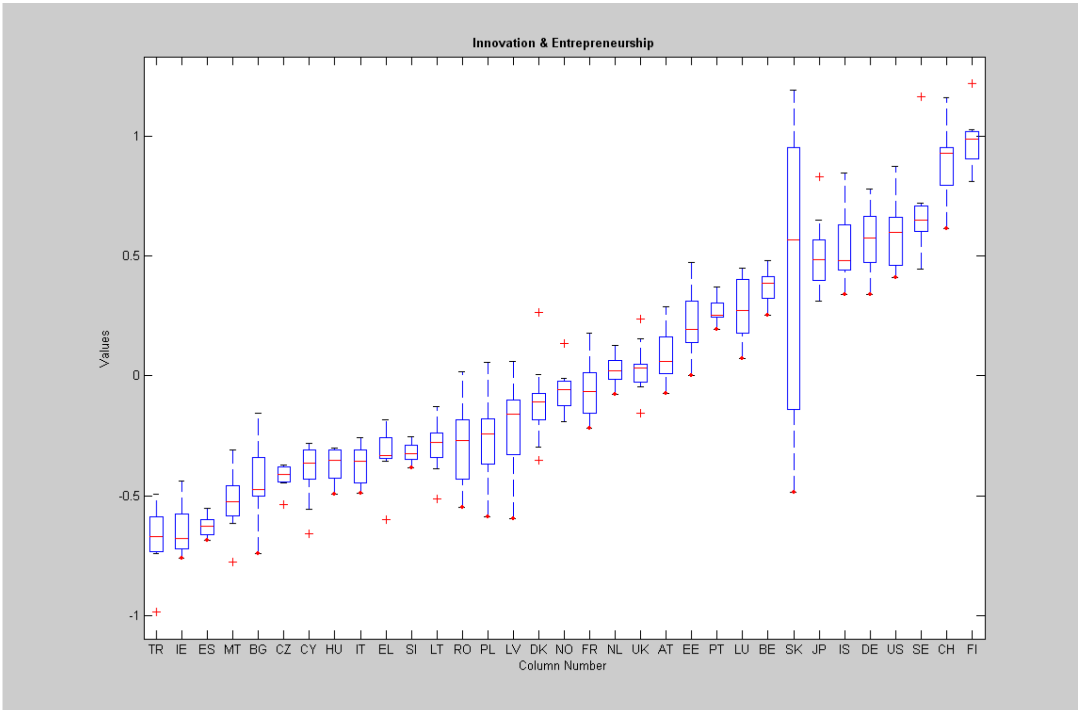


Knowledge Creation

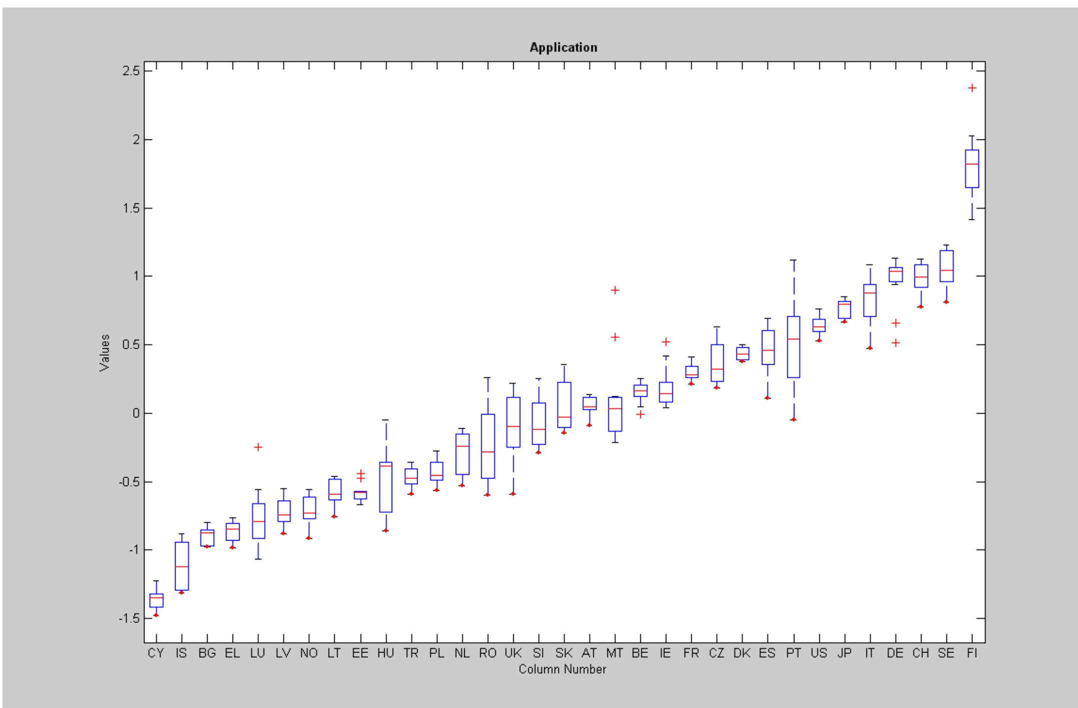


Annex II – continued

Innovation & Entrepreneurship

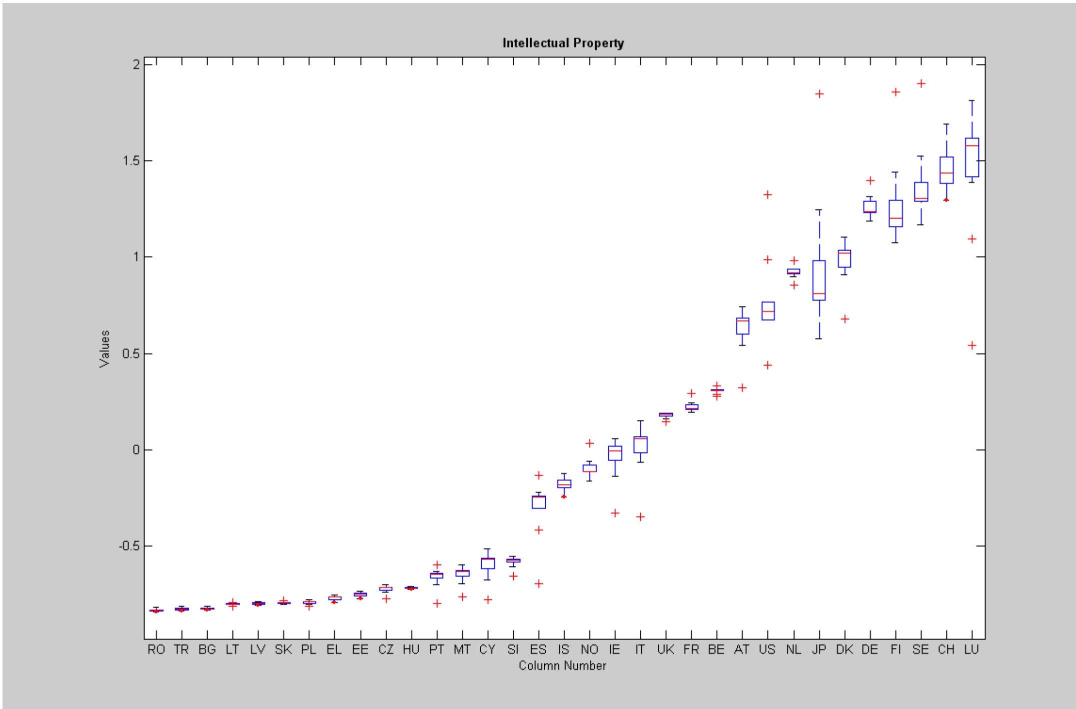


Application

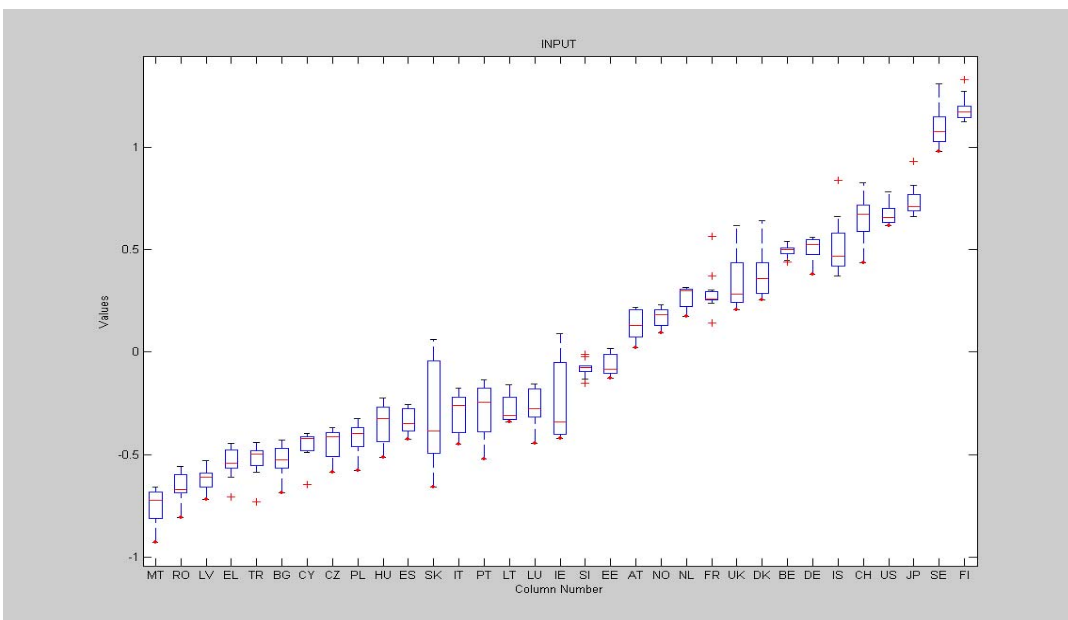


Annex II – continued

Intellectual Property

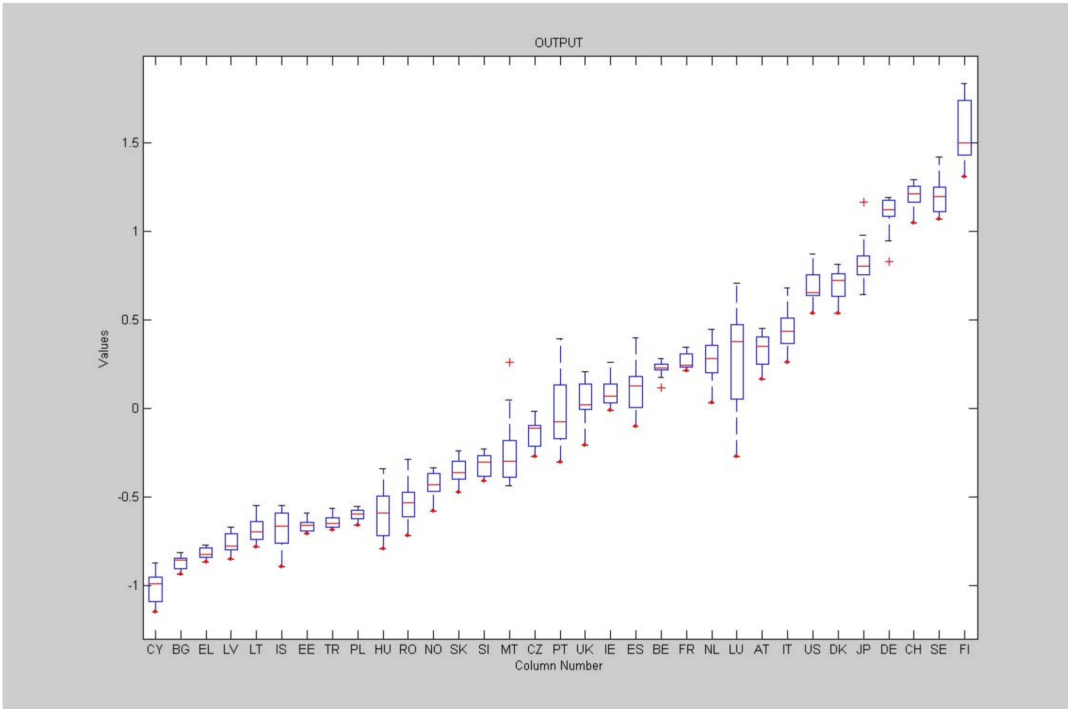


Innovation Input

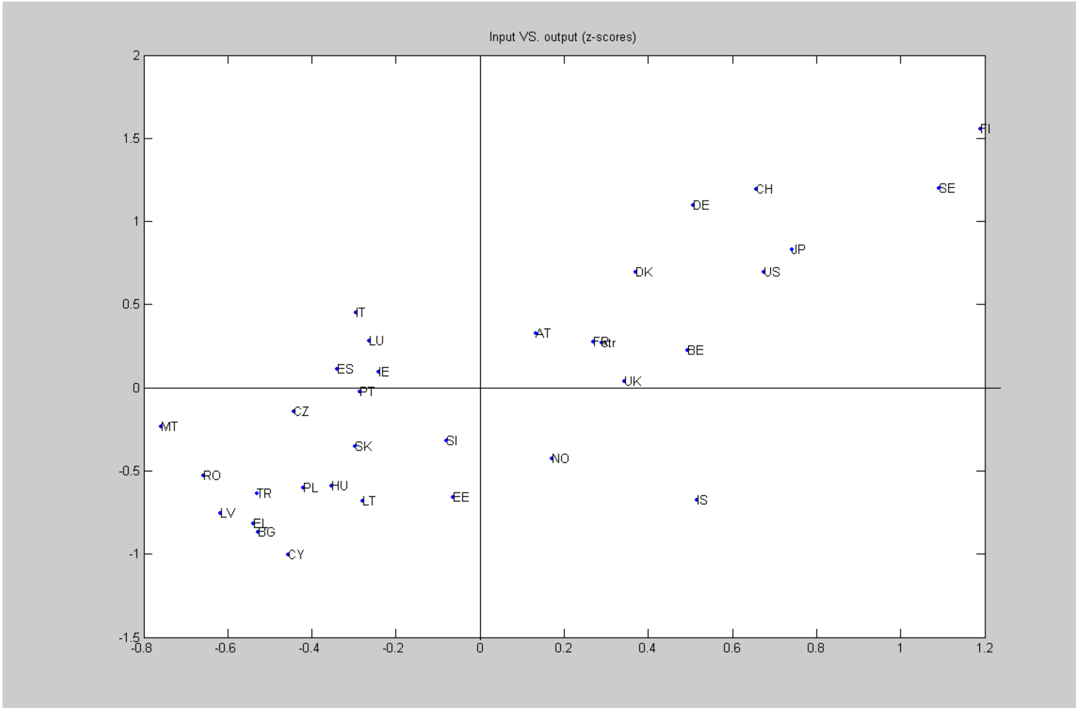


Annex II – continued

Innovation Output



Annex III – Input versus Output with *Z-scores* normalization



Annex IV – Results of the innovation index scores calculated with the budget allocation method

1st EXPERT				2nd EXPERT				3rd EXPERT				4th EXPERT			
INPUT		OUTPUT		INPUT		OUTPUT		INPUT		OUTPUT		INPUT		OUTPUT	
MT	-0.7249	CY	-0.9874	MT	-0.7947	CY	-1.1144	MT	-0.9303	CY	-1.1374	MT	-0.8123	CY	-1.0048
RO	-0.7204	BG	-0.9033	LV	-0.7177	BG	-0.8554	RO	-0.8089	BG	-0.9187	RO	-0.5707	BG	-0.8496
BG	-0.687	EL	-0.8049	RO	-0.6918	EL	-0.8524	TR	-0.7316	IS	-0.7733	LV	-0.5281	EL	-0.8229
CZ	-0.5863	HU	-0.7922	EL	-0.6125	LV	-0.798	EL	-0.7063	EL	-0.772	PT	-0.5218	LT	-0.7638
LV	-0.5401	IS	-0.751	TR	-0.5322	EE	-0.6986	LV	-0.6805	LV	-0.704	CZ	-0.464	LV	-0.7554
PL	-0.5214	LV	-0.6748	BG	-0.5258	IS	-0.6971	CY	-0.6463	HU	-0.6681	EL	-0.4444	TR	-0.6882
TR	-0.4785	LT	-0.637	CY	-0.4912	LT	-0.696	SK	-0.4958	EE	-0.6609	TR	-0.4426	PL	-0.6574
EL	-0.446	TR	-0.617	SK	-0.4838	RO	-0.6293	BG	-0.4653	TR	-0.6139	BG	-0.4287	IS	-0.5998
HU	-0.4445	EE	-0.5959	PL	-0.4137	TR	-0.6103	LU	-0.4446	PL	-0.6059	CY	-0.42	EE	-0.5913
CY	-0.4172	PL	-0.593	CZ	-0.3695	PL	-0.5683	HU	-0.4131	LT	-0.5986	IT	-0.4095	RO	-0.5015
IE	-0.3816	NO	-0.5142	ES	-0.3502	HU	-0.4754	PT	-0.4087	RO	-0.5574	SK	-0.3833	HU	-0.4319
LT	-0.3327	MT	-0.3977	PT	-0.3265	NO	-0.4111	PL	-0.3961	NO	-0.4669	HU	-0.3826	NO	-0.4309
ES	-0.3082	SI	-0.3029	HU	-0.3236	SK	-0.3014	CZ	-0.3926	SI	-0.4105	PL	-0.3246	SK	-0.3923
IT	-0.2824	RO	-0.2865	LT	-0.3094	SI	-0.273	IT	-0.3512	SK	-0.3452	LU	-0.2842	SI	-0.3538
PT	-0.1848	SK	-0.2815	LU	-0.303	MT	-0.1648	ES	-0.2631	LU	-0.2705	ES	-0.2641	PT	-0.1317
LU	-0.1731	UK	-0.2064	IT	-0.26	PT	-0.0752	LT	-0.2162	MT	-0.257	LT	-0.2098	CZ	-0.1031
SI	-0.1512	CZ	-0.113	IE	-0.2355	CZ	-0.0506	EE	-0.1277	CZ	-0.1316	EE	-0.0941	ES	-0.0997
EE	-0.1161	IE	0.0166	EE	-0.029	LU	-0.0244	SI	-0.0706	IE	-0.01	IE	-0.0468	UK	0.0643
SK	0.0122	BE	0.1761	SI	-0.0115	ES	0.1274	AT	0.0689	UK	0.0415	SI	-0.0227	BE	0.1183
AT	0.1034	NL	0.1953	AT	0.1733	IE	0.1434	IE	0.092	ES	0.1399	AT	0.0233	AT	0.2333
NO	0.1818	FR	0.2121	NO	0.2285	UK	0.1649	NO	0.1949	PT	0.1529	NL	0.1739	IT	0.2577
FR	0.2631	ES	0.2252	FR	0.2522	NL	0.2125	NL	0.2567	AT	0.165	NO	0.1975	IE	0.2586
UK	0.2765	PT	0.2378	NL	0.3139	BE	0.2731	IS	0.37	NL	0.1878	FR	0.3711	MT	0.2609
DK	0.281	AT	0.29	UK	0.344	AT	0.3034	DE	0.3811	BE	0.2225	DK	0.3765	NL	0.2797
NL	0.3009	LU	0.3267	DK	0.4402	FR	0.3117	BE	0.486	FR	0.287	CH	0.4347	LU	0.2904
DE	0.523	IT	0.5706	BE	0.4804	IT	0.4877	FR	0.5656	IT	0.4377	DE	0.4369	FR	0.3456
BE	0.5403	US	0.6019	DE	0.5259	DK	0.671	CH	0.5742	DK	0.5341	IS	0.4662	DK	0.6165
IS	0.5948	DK	0.7227	IS	0.5348	US	0.6992	UK	0.6174	US	0.8716	UK	0.4798	DE	0.8309
US	0.6342	JP	0.7498	CH	0.6739	JP	0.8436	DK	0.6411	DE	1.1538	BE	0.4998	US	0.8528
JP	0.7338	DE	0.9478	US	0.7004	CH	1.1541	US	0.782	JP	1.1625	US	0.6396	JP	0.978
CH	0.8265	SE	1.177	JP	0.7712	DE	1.1915	JP	0.9319	CH	1.2905	JP	0.6894	CH	1.0791
SE	1.0289	CH	1.2162	FI	1.1661	SE	1.2169	FI	1.2754	SE	1.4205	SE	1.0843	SE	1.097
FI	1.196	FI	1.7929	SE	1.1767	FI	1.4954	SE	1.3116	FI	1.8349	FI	1.1814	FI	1.6153

Annex IV - continued

5th EXPERT				6th EXPERT				7th EXPERT				8th EXPERT			
INPUT		OUTPUT		INPUT		OUTPUT		INPUT		OUTPUT		INPUT		OUTPUT	
MT	-0.6638	CY	-1.0035	MT	-0.7002	CY	-0.9685	MT	-0.6757	CY	-0.8723	MT	-0.8653	CY	-1.1502
RO	-0.6187	EL	-0.8654	RO	-0.6717	BG	-0.8518	RO	-0.6709	EL	-0.8384	RO	-0.6744	BG	-0.9377
LV	-0.595	LV	-0.8496	LV	-0.5881	EL	-0.8338	LV	-0.6108	BG	-0.8331	SK	-0.6598	IS	-0.8916
TR	-0.5537	BG	-0.8125	BG	-0.5693	LV	-0.7859	BG	-0.5584	LV	-0.7981	LV	-0.619	EL	-0.7713
EL	-0.5512	LT	-0.7804	EL	-0.5618	IS	-0.7615	EL	-0.543	LT	-0.7413	BG	-0.6133	HU	-0.7375
BG	-0.4919	EE	-0.6871	TR	-0.4828	LT	-0.6935	TR	-0.4897	EE	-0.6914	TR	-0.5874	LV	-0.6702
CY	-0.4455	TR	-0.6578	CY	-0.4659	EE	-0.6579	IE	-0.4215	TR	-0.6746	PL	-0.5785	EE	-0.6363
IE	-0.4207	RO	-0.6432	CZ	-0.4239	TR	-0.6215	CY	-0.4148	PL	-0.6199	CZ	-0.5261	NO	-0.577
CZ	-0.3922	PL	-0.596	IE	-0.4037	PL	-0.5627	CZ	-0.4069	HU	-0.6076	HU	-0.5135	TR	-0.563
ES	-0.3902	IS	-0.5899	ES	-0.3897	HU	-0.5509	PL	-0.3821	IS	-0.5649	CY	-0.4889	PL	-0.5518
PL	-0.3649	SK	-0.3604	PL	-0.3879	NO	-0.4677	ES	-0.3752	RO	-0.5339	EL	-0.4829	LT	-0.5472
LT	-0.3367	NO	-0.3602	LT	-0.3238	RO	-0.4563	LU	-0.3452	MT	-0.4352	IT	-0.4476	RO	-0.4627
HU	-0.2533	HU	-0.3414	HU	-0.2823	SK	-0.2956	LT	-0.3075	SK	-0.4169	ES	-0.3659	SI	-0.3383
LU	-0.227	PT	-0.305	LU	-0.2773	MT	-0.2383	HU	-0.2624	NO	-0.333	PT	-0.3202	MT	-0.3171
IT	-0.2162	SI	-0.2502	IT	-0.2567	SI	-0.2267	IT	-0.1757	SI	-0.301	LT	-0.16	SK	-0.2409
SK	-0.1566	CZ	-0.0949	PT	-0.2453	CZ	-0.0995	PT	-0.1742	CZ	-0.2719	LU	-0.1544	LU	-0.2195
PT	-0.1519	ES	-0.0406	EE	-0.1041	PT	-0.0337	SI	-0.0941	PT	-0.2464	SI	-0.0768	UK	-0.032
SI	-0.1311	MT	0.0453	SI	-0.0727	UK	-0.0037	EE	-0.0849	ES	-0.011	IE	-0.0195	CZ	-0.014
EE	-0.0678	UK	0.2061	SK	-0.0219	IE	0.1174	SK	0.0607	UK	0.0199	EE	0.0023	NL	0.0313
NO	0.0942	BE	0.2262	AT	0.1283	ES	0.1574	NO	0.1259	IE	0.0361	AT	0.0961	IE	0.0361
AT	0.1896	IE	0.2455	NO	0.1566	BE	0.216	AT	0.2105	FR	0.2307	NL	0.182	AT	0.1949
UK	0.2189	NL	0.3197	FR	0.2559	FR	0.2379	UK	0.2354	BE	0.2497	NO	0.2304	BE	0.2293
FR	0.2403	FR	0.3237	UK	0.2591	NL	0.2514	DK	0.2538	IT	0.3564	FR	0.3032	FR	0.2461
DK	0.2555	IT	0.3308	NL	0.3085	AT	0.394	FR	0.257	NL	0.4465	UK	0.4332	PT	0.3905
NL	0.2933	AT	0.3663	DK	0.3599	LU	0.464	NL	0.3127	AT	0.4522	BE	0.4391	ES	0.3998
IS	0.4578	LU	0.3789	IS	0.4839	IT	0.5157	IS	0.3842	US	0.6472	DK	0.456	DK	0.5887
BE	0.487	DK	0.6871	DE	0.5049	US	0.5354	BE	0.5064	LU	0.7066	DE	0.468	US	0.6473
DE	0.5598	US	0.7619	BE	0.5086	JP	0.6414	DE	0.5476	JP	0.764	US	0.6591	IT	0.6814
CH	0.673	JP	0.7914	US	0.6245	DK	0.742	US	0.6187	DK	0.8124	CH	0.7274	JP	0.8625
US	0.6849	CH	1.0464	JP	0.6855	SE	1.0698	JP	0.6599	DE	1.1791	JP	0.8157	DE	1.0786
JP	0.7052	SE	1.0838	CH	0.7201	DE	1.1194	CH	0.7126	SE	1.193	IS	0.8383	CH	1.2286
SE	1.0203	DE	1.1203	SE	1.0916	CH	1.2105	SE	0.9811	CH	1.2678	SE	1.1707	SE	1.2686
FI	1.1486	FI	1.3044	FI	1.1418	FI	1.4376	FI	1.1266	FI	1.4296	FI	1.3317	FI	1.775

Annex IV - continued

9th EXPERT				10th EXPERT				11th EXPERT			
INPUT		OUTPUT		INPUT		OUTPUT		INPUT		OUTPUT	
LV	-0.6606	CY	-0.9646	MT	-0.814	CY	-0.9477	MT	-0.7028	CY	-0.9206
MT	-0.6574	BG	-0.8997	SK	-0.6125	BG	-0.869	RO	-0.6544	EL	-0.8414
EL	-0.5701	EL	-0.7837	LV	-0.6088	EL	-0.7976	LV	-0.65	BG	-0.8405
RO	-0.559	HU	-0.7402	RO	-0.5894	LV	-0.7754	BG	-0.5532	LV	-0.7964
TR	-0.5539	LV	-0.7082	CZ	-0.5287	RO	-0.7192	EL	-0.54	LT	-0.7252
BG	-0.4395	IS	-0.6622	TR	-0.4962	EE	-0.7094	TR	-0.483	EE	-0.6799
SK	-0.4309	EE	-0.6593	BG	-0.4853	LT	-0.6965	CY	-0.4139	TR	-0.6522
ES	-0.4241	TR	-0.6475	PL	-0.48	TR	-0.6781	CZ	-0.4121	IS	-0.6273
IE	-0.4007	LT	-0.6417	EL	-0.4741	PL	-0.645	PL	-0.4104	PL	-0.5957
CY	-0.3977	PL	-0.6257	HU	-0.4679	HU	-0.5917	ES	-0.345	HU	-0.5855
CZ	-0.3698	RO	-0.5295	PT	-0.4361	IS	-0.5478	IE	-0.3414	RO	-0.4967
PL	-0.3537	NO	-0.4335	IT	-0.4288	SK	-0.4727	LU	-0.3191	NO	-0.3778
LT	-0.3418	MT	-0.4151	CY	-0.4062	SI	-0.4059	LT	-0.3154	MT	-0.3633
IT	-0.2279	SK	-0.398	ES	-0.258	NO	-0.3423	HU	-0.3085	SK	-0.3619
HU	-0.2252	SI	-0.3905	LT	-0.2306	MT	-0.2977	PT	-0.2329	SI	-0.2639
LU	-0.1975	CZ	-0.219	LU	-0.1714	CZ	-0.264	IT	-0.1958	CZ	-0.1965
PT	-0.1374	UK	-0.0059	SI	-0.0747	PT	-0.1694	SK	-0.1083	PT	-0.1633
SI	-0.0936	IE	0.0326	IE	-0.068	ES	0.0814	EE	-0.0874	UK	0.0063
EE	-0.0069	PT	0.0734	EE	0.0186	IE	0.1127	SI	-0.0684	ES	0.0507
NO	0.1192	ES	0.1901	AT	0.0411	UK	0.1838	NO	0.1419	IE	0.0694
FR	0.1433	FR	0.235	NO	0.2124	FR	0.2742	AT	0.2153	FR	0.2338
UK	0.2075	BE	0.2444	NL	0.2132	BE	0.2831	FR	0.2573	BE	0.2371
AT	0.2198	NL	0.3101	FR	0.2794	IT	0.39	UK	0.2814	NL	0.3692
DK	0.2983	AT	0.3504	DK	0.4225	AT	0.4084	NL	0.2986	IT	0.421
NL	0.2993	LU	0.3825	UK	0.4357	NL	0.4121	DK	0.2987	AT	0.4259
BE	0.4488	IT	0.4983	DE	0.5081	LU	0.4773	IS	0.4062	LU	0.5912
IS	0.469	US	0.6335	BE	0.5258	US	0.7266	BE	0.5077	US	0.6533
DE	0.5616	DK	0.7503	CH	0.5629	DK	0.7627	DE	0.5515	JP	0.7195
CH	0.6328	JP	0.8008	IS	0.662	JP	0.816	US	0.6376	DK	0.7785
JP	0.7082	DE	1.0895	US	0.7016	CH	1.1823	CH	0.6788	SE	1.1479
US	0.7287	SE	1.2505	JP	0.768	DE	1.1871	JP	0.6915	DE	1.1633
SE	1.0384	CH	1.2651	SE	1.0779	SE	1.2406	SE	1.0328	CH	1.1889
FI	1.1724	FI	1.6178	FI	1.2014	FI	1.3911	FI	1.1427	FI	1.4321

Annex V – Correlation matrix of the (budget allocation) weights given by the eleven experts

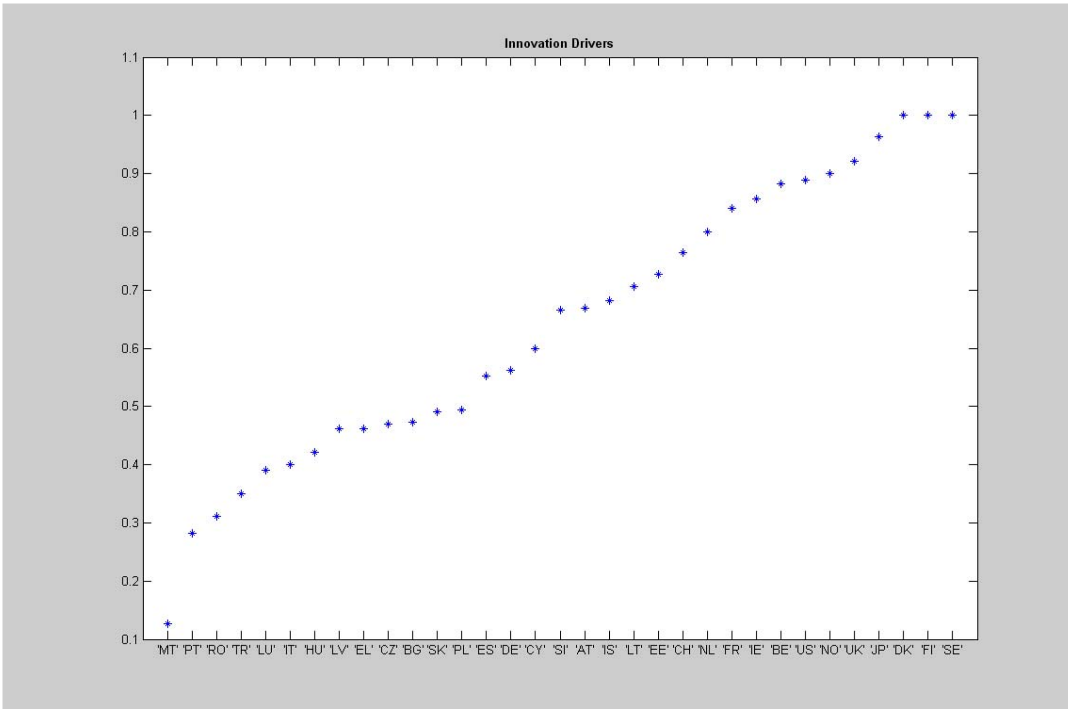
#1	1.0000										
#2	0.6454	1.0000									
#3	0.4891	0.6935	1.0000								
#4	0.6507	0.6388	0.7388	1.0000							
#5	0.6632	0.8148	0.4889	0.6537	1.0000						
#6	0.8601	0.7739	0.4601	0.5966	0.8187	1.0000					
#7	0.8238	0.5877	0.3451	0.4928	0.7261	0.9071	1.0000				
#8	0.6196	0.7709	0.6487	0.6059	0.5141	0.6075	0.3823	1.0000			
#9	0.8244	0.7818	0.5265	0.5387	0.7850	0.8802	0.8267	0.6178	1.0000		
#10	0.6439	0.7552	0.5756	0.6786	0.7065	0.6482	0.5794	0.7464	0.6693	1.0000	
#11	0.8436	0.6867	0.4111	0.5806	0.7935	0.9214	0.9758	0.4872	0.8477	0.7014	1.0000
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11

Annex VI – Innovation index scores and rankings (innovation input and innovation output) with three alternative weighting methods

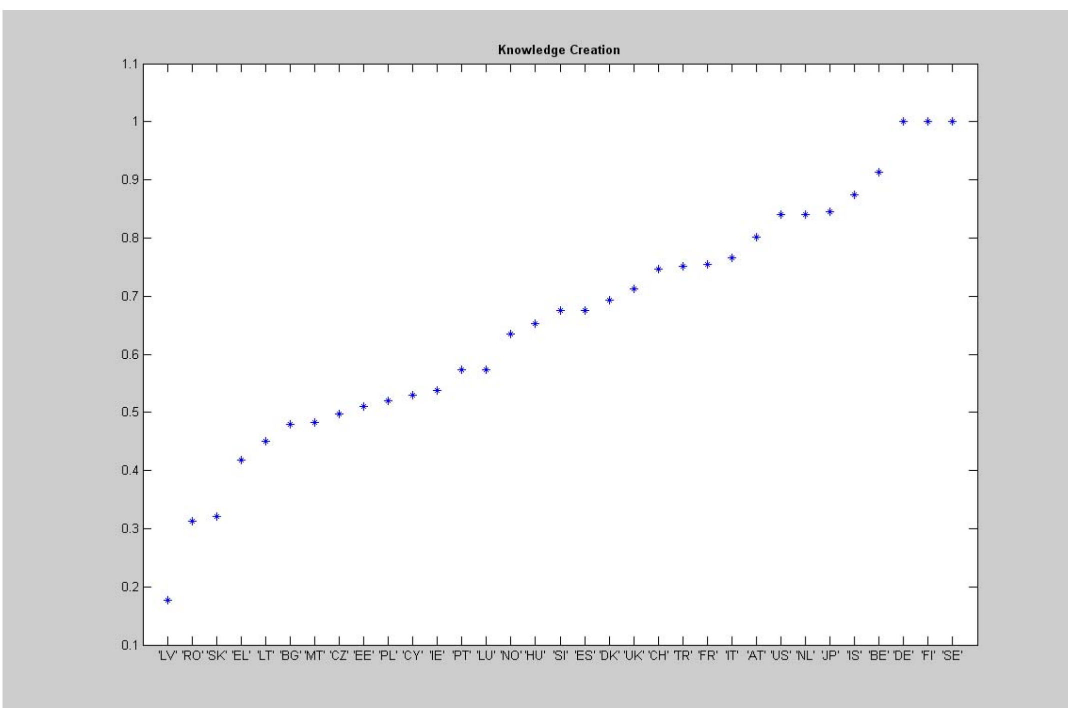
Country Ranking	Budget allocation (average weights)				Equal weights				Factor Analysis			
	input		output		input		output		input		output	
1	**FI**	1.19	**FI**	1.56	**FI**	1.15	**FI**	1.29	**FI**	1.16	**FI**	1.40
2	**SE**	1.09	**SE**	1.20	**SE**	1.01	**CH**	1.17	**SE**	1.07	**SE**	1.13
3	**JP**	0.74	**CH**	1.19	**JP**	0.71	**SE**	1.16	**JP**	0.68	**CH**	1.10
4	**US**	0.67	**DE**	1.10	**US**	0.68	**DE**	1.12	**US**	0.64	**DE**	0.98
5	**CH**	0.66	**JP**	0.83	**BE**	0.54	**JP**	0.84	**BE**	0.59	**JP**	0.89
6	**IS**	0.52	**DK**	0.70	**CH**	0.52	**DK**	0.76	**CH**	0.54	**US**	0.77
7	**DE**	0.51	**US**	0.69	**DE**	0.45	**US**	0.73	**DK**	0.49	**DK**	0.65
8	**BE**	0.49	**IT**	0.45	**DK**	0.40	**LU**	0.56	**IS**	0.44	**FR**	0.35
9	**DK**	0.37	**AT**	0.33	**IS**	0.37	**NL**	0.44	**DE**	0.43	**LU**	0.32
10	**UK**	0.34	**LU**	0.28	**UK**	0.35	**AT**	0.41	**NL**	0.35	**IT**	0.30
11	**FR**	0.29	**NL**	0.27	**NL**	0.34	**FR**	0.32	**NO**	0.32	**AT**	0.29
12	**NL**	0.27	**FR**	0.27	**FR**	0.22	**UK**	0.27	**UK**	0.31	**NL**	0.29
13	**NO**	0.17	**BE**	0.23	**NO**	0.22	**BE**	0.26	**AT**	0.16	**IE**	0.28
14	**AT**	0.13	**ES**	0.11	**AT**	0.18	**IT**	0.26	**FR**	0.13	**UK**	0.25
15	**EE**	-0.06	**IE**	0.10	**EE**	0.01	**IE**	0.22	**EE**	0.04	**BE**	0.21
16	**SI**	-0.08	**UK**	0.04	**SI**	-0.05	**MT**	-0.06	**SI**	0.01	**MT**	0.15
17	**IE**	-0.24	**PT**	-0.02	**IE**	-0.18	**ES**	-0.08	**LU**	-0.13	**ES**	0.00
18	**LU**	-0.26	**CZ**	-0.14	**LU**	-0.24	**CZ**	-0.23	**IE**	-0.22	**CZ**	-0.12
19	**LT**	-0.28	**MT**	-0.23	**LT**	-0.27	**NO**	-0.30	**CY**	-0.28	**PT**	-0.20
20	**PT**	-0.29	**SI**	-0.32	**ES**	-0.28	**SI**	-0.36	**LT**	-0.30	**SI**	-0.37
21	**IT**	-0.30	**SK**	-0.35	**IT**	-0.29	**PT**	-0.39	**ES**	-0.31	**NO**	-0.39
22	**SK**	-0.30	**NO**	-0.43	**HU**	-0.34	**HU**	-0.41	**IT**	-0.37	**HU**	-0.40
23	**ES**	-0.34	**RO**	-0.53	**CY**	-0.34	**IS**	-0.48	**TR**	-0.38	**SK**	-0.43
24	**HU**	-0.35	**HU**	-0.59	**PT**	-0.36	**SK**	-0.48	**HU**	-0.41	**IS**	-0.56
25	**PL**	-0.42	**PL**	-0.60	**PL**	-0.38	**PL**	-0.65	**EL**	-0.43	**PL**	-0.64
26	**CZ**	-0.44	**TR**	-0.64	**BG**	-0.44	**TR**	-0.70	**PL**	-0.44	**EE**	-0.66
27	**CY**	-0.46	**EE**	-0.66	**CZ**	-0.45	**EE**	-0.71	**PT**	-0.47	**TR**	-0.68
28	**BG**	-0.53	**IS**	-0.68	**TR**	-0.47	**RO**	-0.76	**CZ**	-0.51	**RO**	-0.71
29	**TR**	-0.53	**LT**	-0.68	**EL**	-0.52	**LT**	-0.78	**BG**	-0.52	**LT**	-0.75
30	**EL**	-0.54	**LV**	-0.76	**RO**	-0.56	**BG**	-0.82	**RO**	-0.53	**LV**	-0.79
31	**LV**	-0.62	**EL**	-0.82	**SK**	-0.58	**LV**	-0.83	**SK**	-0.59	**EL**	-0.82
32	**RO**	-0.66	**BG**	-0.87	**LV**	-0.63	**EL**	-0.84	**LV**	-0.63	**BG**	-0.84
33	**MT**	-0.76	**CY**	-1.01	**MT**	-0.78	**CY**	-0.93	**MT**	-0.84	**CY**	-1.00

Annex VII – Innovation Index scores sorted in increasing order of country performance based on "benefit of the doubt weights"

Innovation drivers

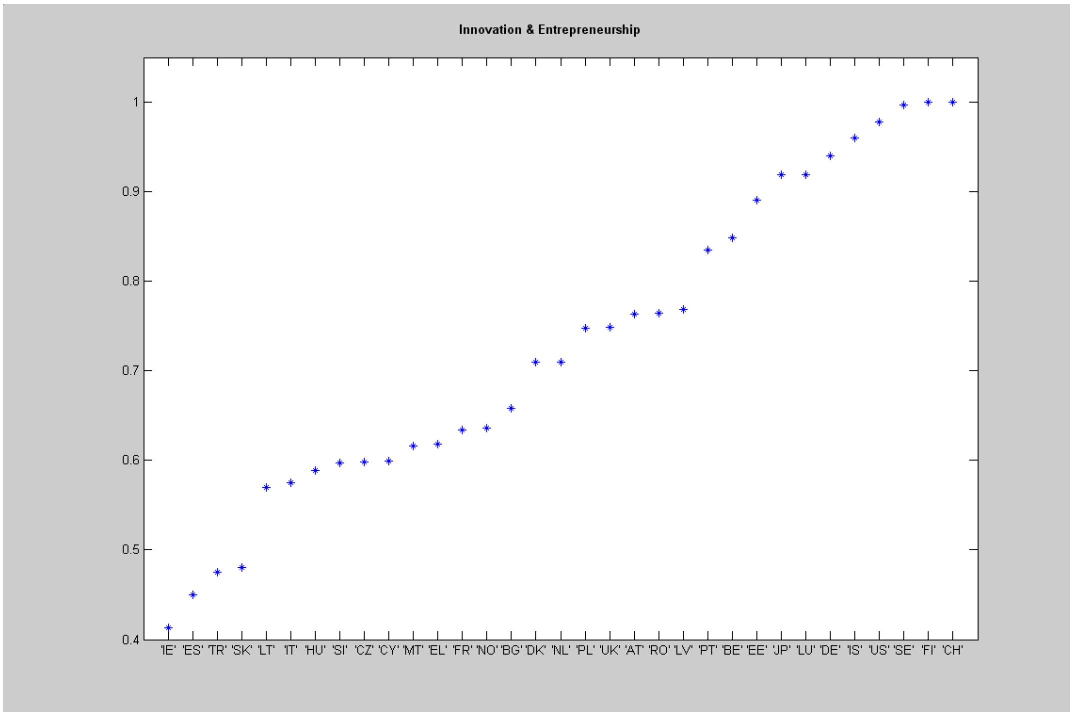


Knowledge creation

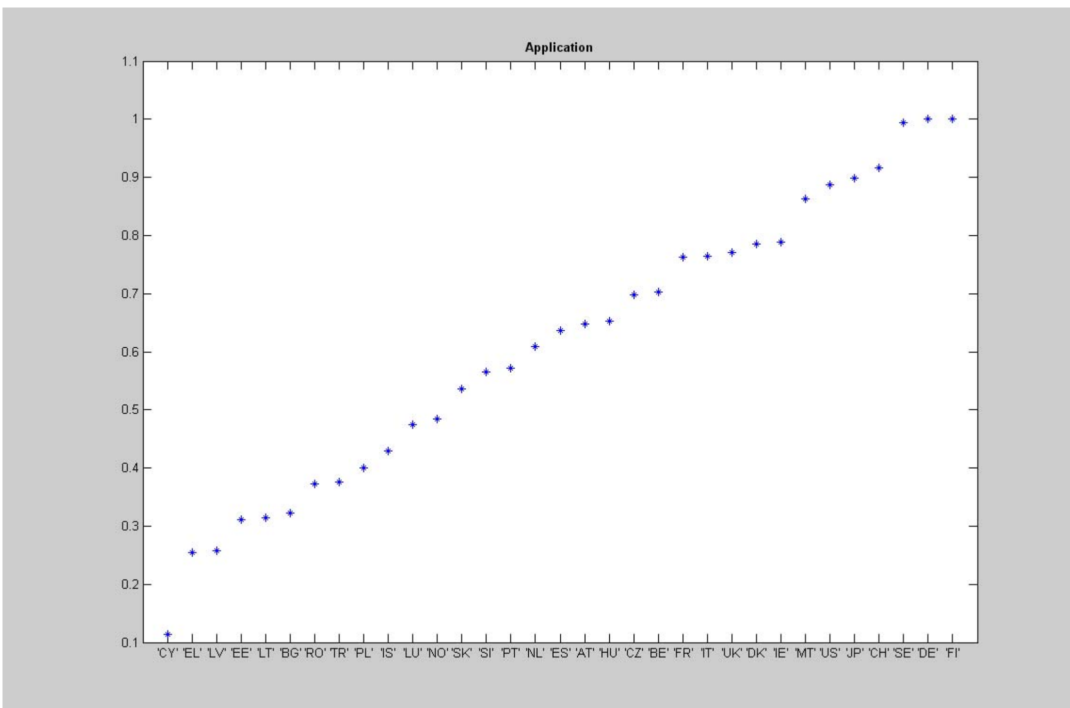


Annex VII – continued

Innovation & entrepreneurship

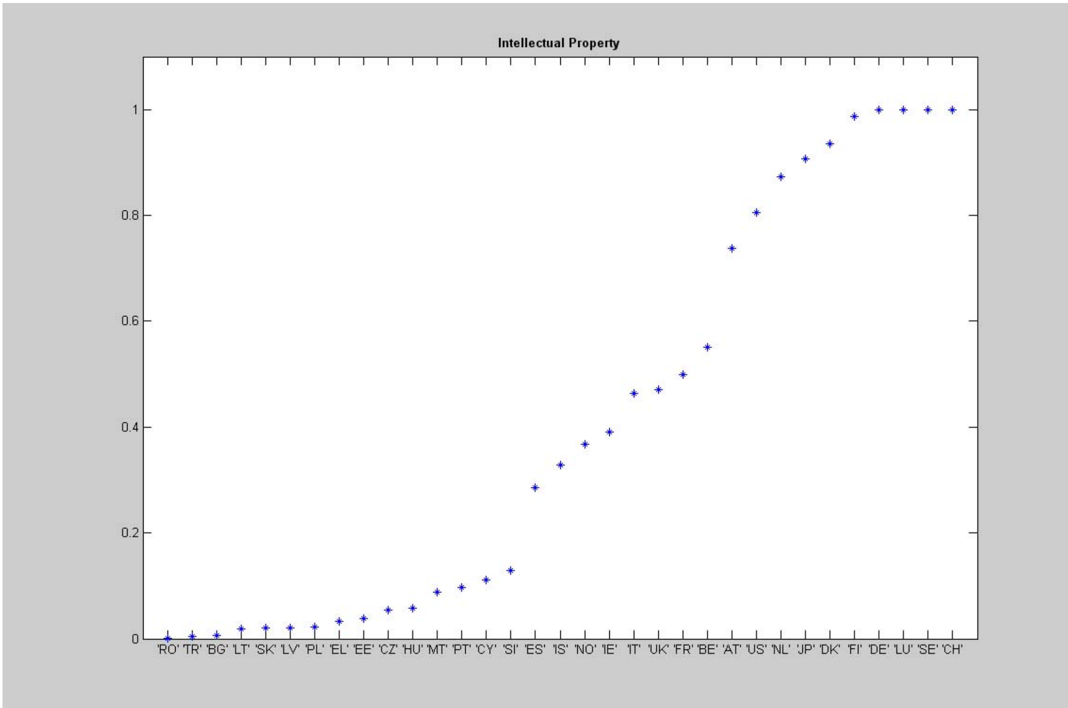


Application

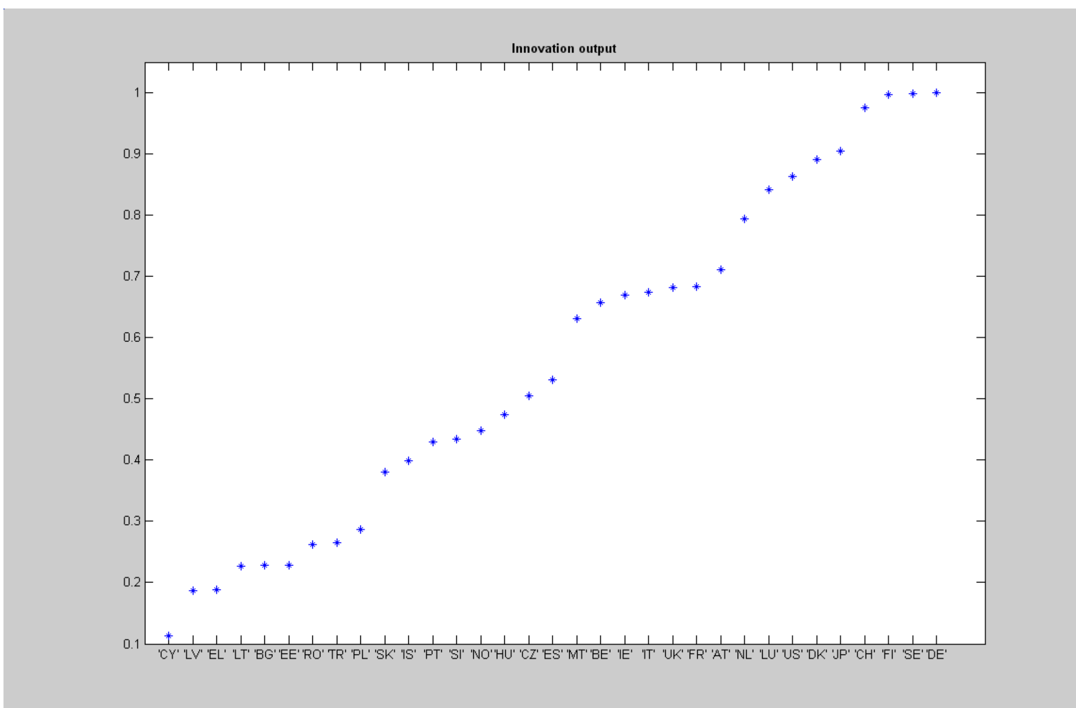


Annex VII – continued

Intellectual property



Innovation output

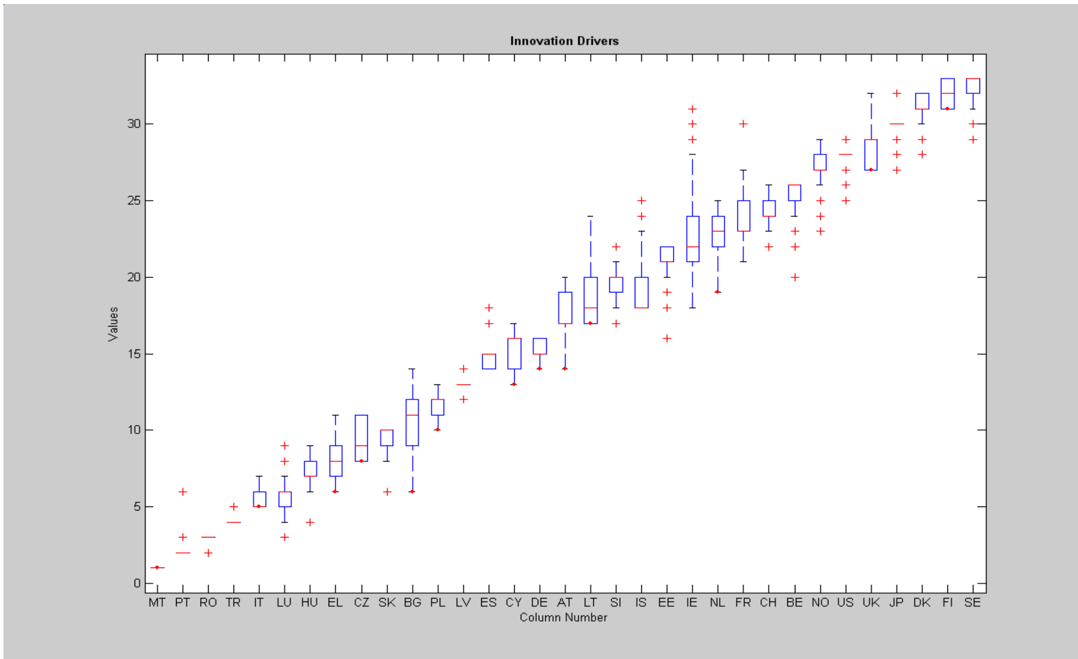


Annex VIII – The scores of the innovation index calculated with the BOD method

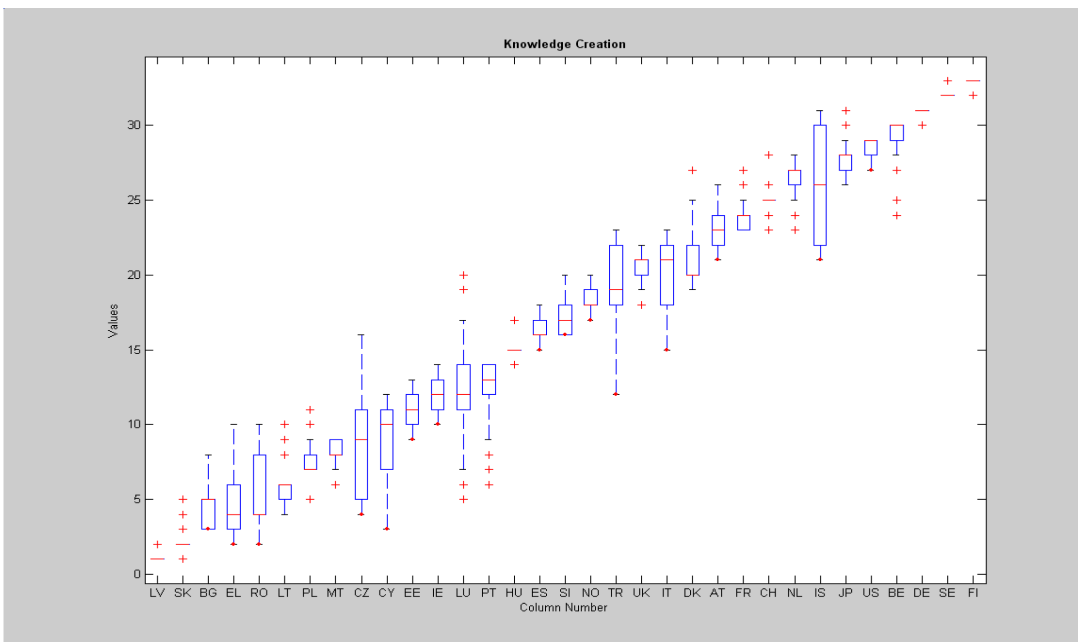
	Innovation Drivers		Knowledge Creation		Innovation & Entrepreneurship		Application		Intellectual Property		Input		Output
MT	0.1270	LV	0.1776	IE	0.4135	CY	0.1145	RO	0.0008	SK	0.4533	CY	0.1136
PT	0.2815	RO	0.3126	ES	0.4497	EL	0.2548	TR	0.0053	MT	0.4738	LV	0.1874
RO	0.3106	SK	0.3202	TR	0.4748	LV	0.2586	BG	0.0062	RO	0.5230	EL	0.1880
TR	0.3508	EL	0.4185	SK	0.4808	EE	0.3109	LT	0.0193	EL	0.5260	LT	0.2262
LU	0.3904	LT	0.4497	LT	0.5698	LT	0.3148	SK	0.0213	CZ	0.5387	BG	0.2279
IT	0.4008	BG	0.4798	IT	0.5746	BG	0.3229	LV	0.0213	LV	0.5480	EE	0.2289
HU	0.4205	MT	0.4830	HU	0.5883	RO	0.3732	PL	0.0230	BG	0.5616	RO	0.2615
LV	0.4616	CZ	0.4965	SI	0.5977	TR	0.3766	EL	0.0321	TR	0.5789	TR	0.2652
EL	0.4619	EE	0.5106	CZ	0.5987	PL	0.4008	EE	0.0377	HU	0.5849	PL	0.2875
CZ	0.4692	PL	0.5195	CY	0.5988	IS	0.4296	CZ	0.0543	CY	0.5850	SK	0.3813
BG	0.4731	CY	0.5301	MT	0.6159	LU	0.4749	HU	0.0583	ES	0.5894	IS	0.3990
SK	0.4908	IE	0.5373	EL	0.6178	NO	0.4837	MT	0.0880	LT	0.6092	PT	0.4298
PL	0.4933	PT	0.5730	FR	0.6344	SK	0.5356	PT	0.0974	PL	0.6207	SI	0.4340
ES	0.5530	LU	0.5733	NO	0.6357	SI	0.5645	CY	0.1115	IT	0.6292	NO	0.4489
DE	0.5627	NO	0.6343	BG	0.6579	PT	0.5723	SI	0.1294	PT	0.6367	HU	0.4738
CY	0.5986	HU	0.6530	DK	0.7099	NL	0.6087	ES	0.2862	SI	0.6562	CZ	0.5047
SI	0.6658	SI	0.6745	NL	0.7102	ES	0.6359	IS	0.3277	IE	0.6614	ES	0.5310
AT	0.6684	ES	0.6752	PL	0.7475	AT	0.6483	NO	0.3677	LU	0.6980	MT	0.6304
IS	0.6813	DK	0.6938	UK	0.7482	HU	0.6519	IE	0.3913	NO	0.7587	BE	0.6576
LT	0.7057	UK	0.7122	AT	0.7636	CZ	0.6977	IT	0.4645	EE	0.7603	IE	0.6699
EE	0.7271	CH	0.7457	RO	0.7644	BE	0.7032	UK	0.4712	AT	0.7625	IT	0.6738
CH	0.7645	TR	0.7510	LV	0.7685	FR	0.7627	FR	0.4995	FR	0.7700	UK	0.6814
NL	0.7997	FR	0.7539	PT	0.8345	IT	0.7635	BE	0.5513	NL	0.8007	FR	0.6837
FR	0.8396	IT	0.7661	BE	0.8485	UK	0.7715	AT	0.7377	UK	0.8215	AT	0.7109
IE	0.8563	AT	0.8021	EE	0.8910	DK	0.7855	US	0.8055	DK	0.8421	NL	0.7938
BE	0.8826	US	0.8402	JP	0.9186	IE	0.7893	NL	0.8731	CH	0.8706	LU	0.8425
US	0.8889	NL	0.8403	LU	0.9190	MT	0.8628	JP	0.9071	IS	0.8757	US	0.8630
NO	0.8998	JP	0.8447	DE	0.9405	US	0.8877	DK	0.9354	BE	0.8903	DK	0.8904
UK	0.9207	IS	0.8746	IS	0.9599	JP	0.8978	FI	0.9876	DE	0.8927	JP	0.9043
JP	0.9626	BE	0.9137	US	0.9780	CH	0.9159	DE	1.0000	US	0.9207	CH	0.9748
DK	1.0000	DE	1.0000	SE	0.9970	SE	0.9934	LU	1.0000	JP	0.9244	FI	0.9963
FI	1.0000	FI	1.0000	FI	1.0000	DE	1.0000	SE	1.0000	SE	0.9994	SE	0.9980
SE	1.0000	SE	1.0000	CH	1.0000	FI	1.0000	CH	1.0000	FI	1.0000	DE	1.0000

Annex IX – Robustness analysis

Innovation drivers

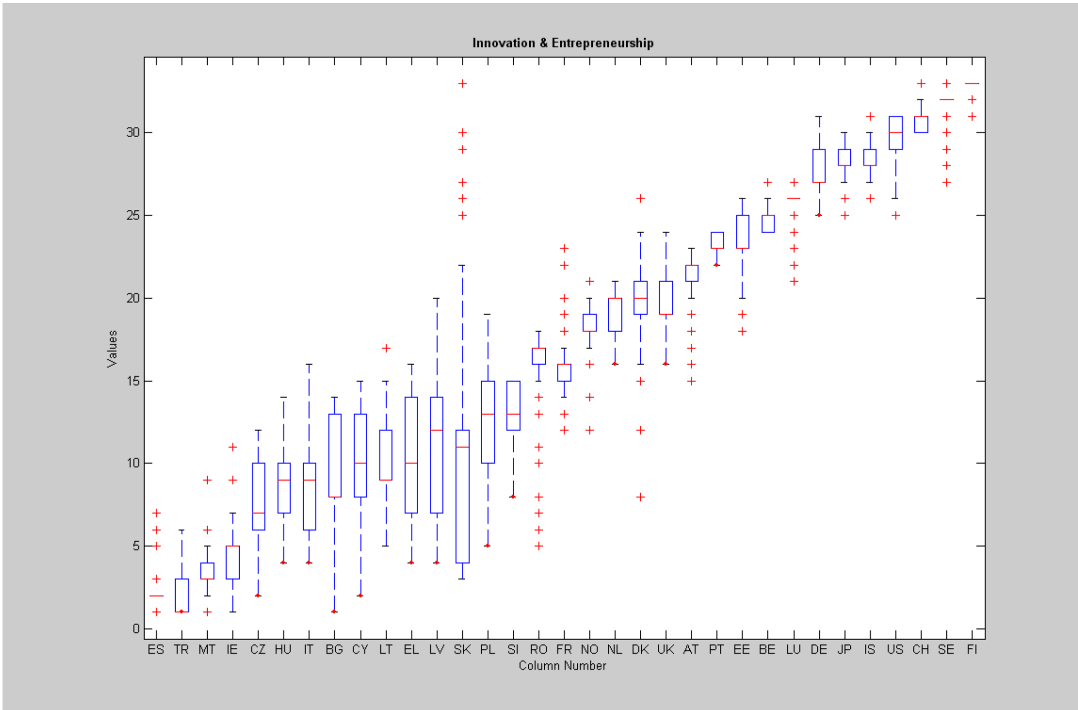


Knowledge creation

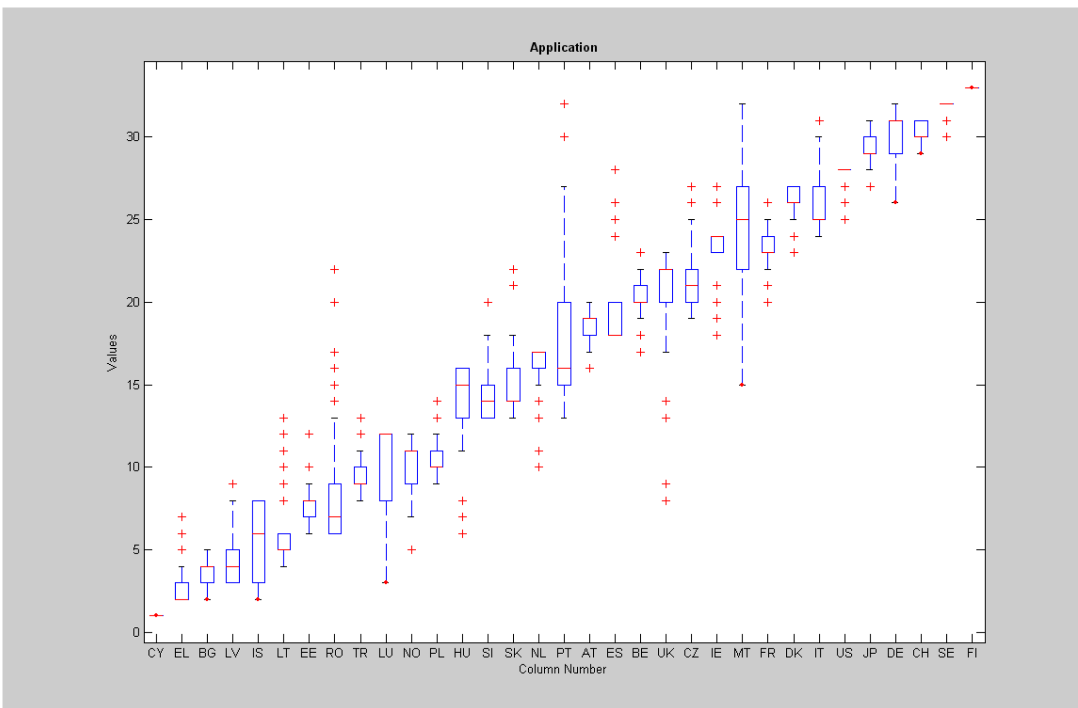


Annex IX – continued

Innovation & entrepreneurship

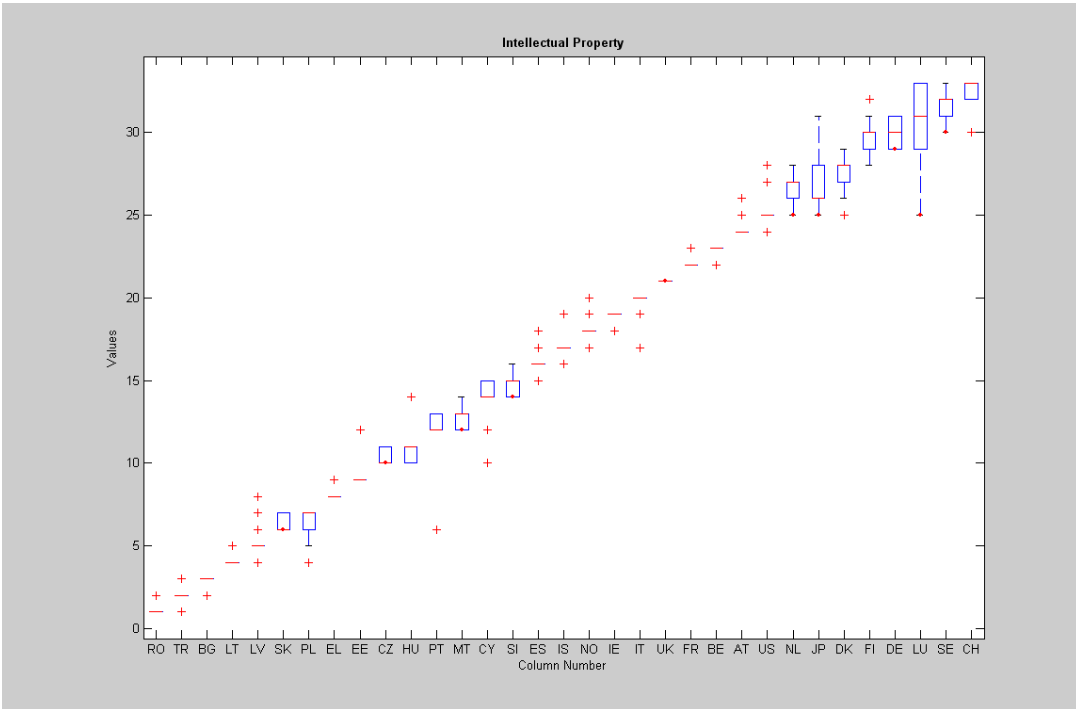


Application

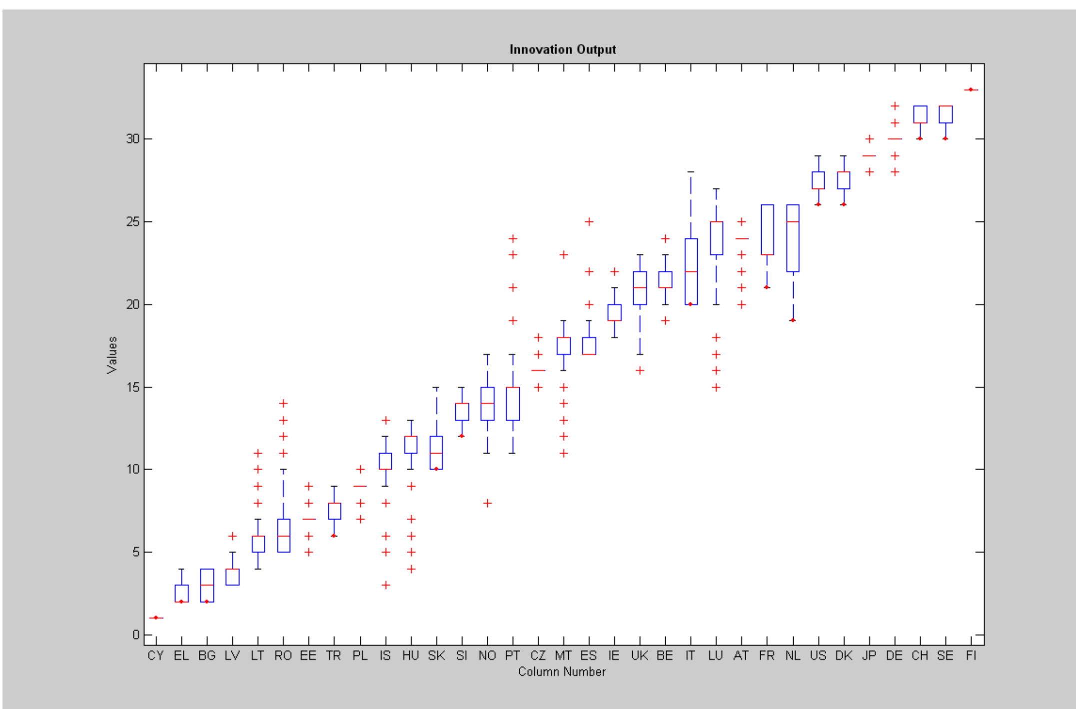


Annex IX – continued

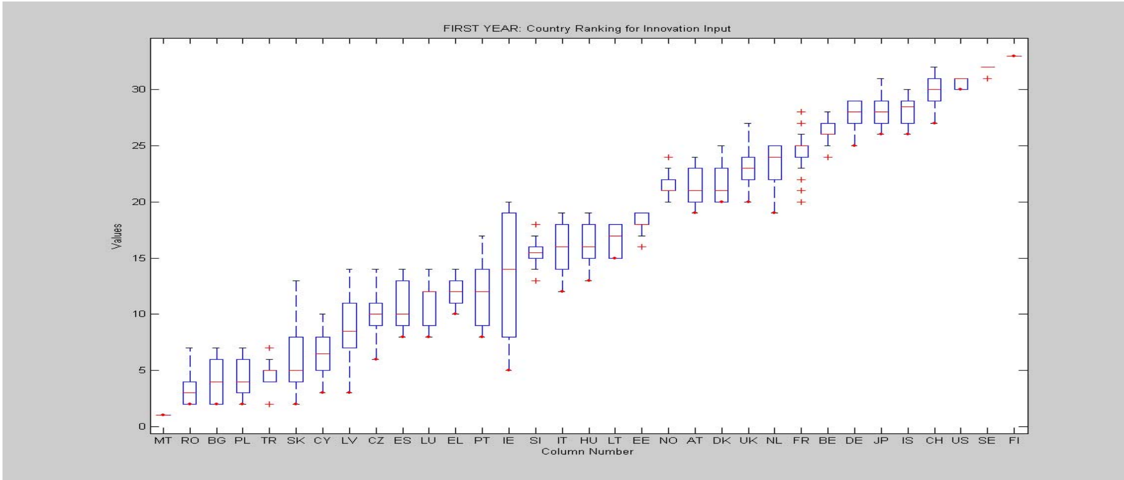
Intellectual property

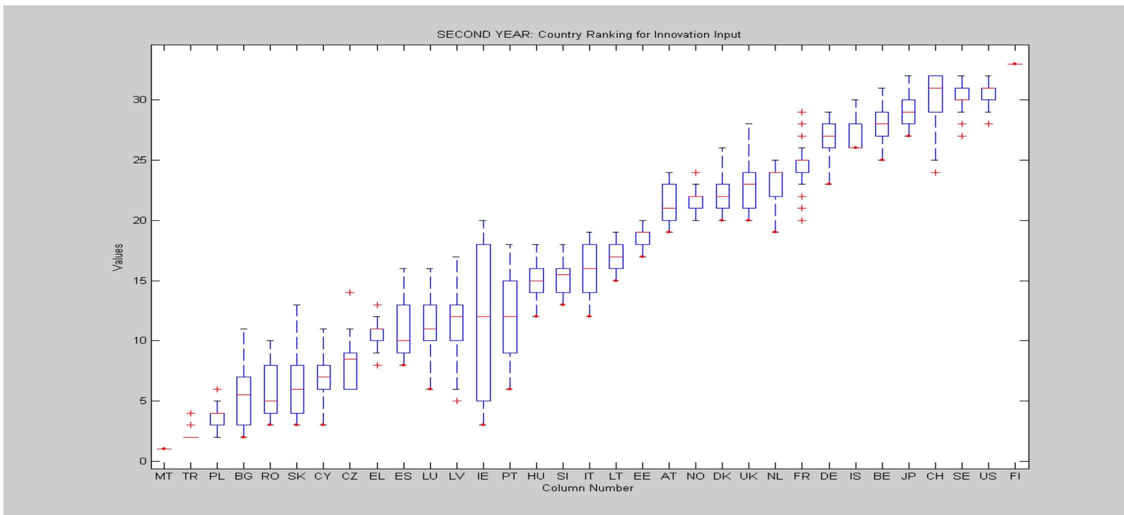


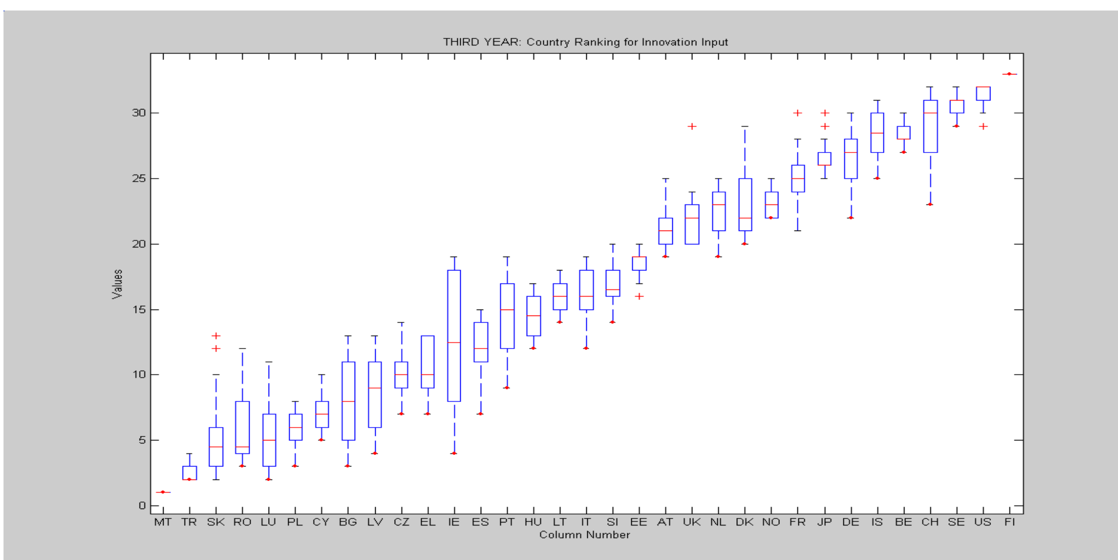
Innovation output



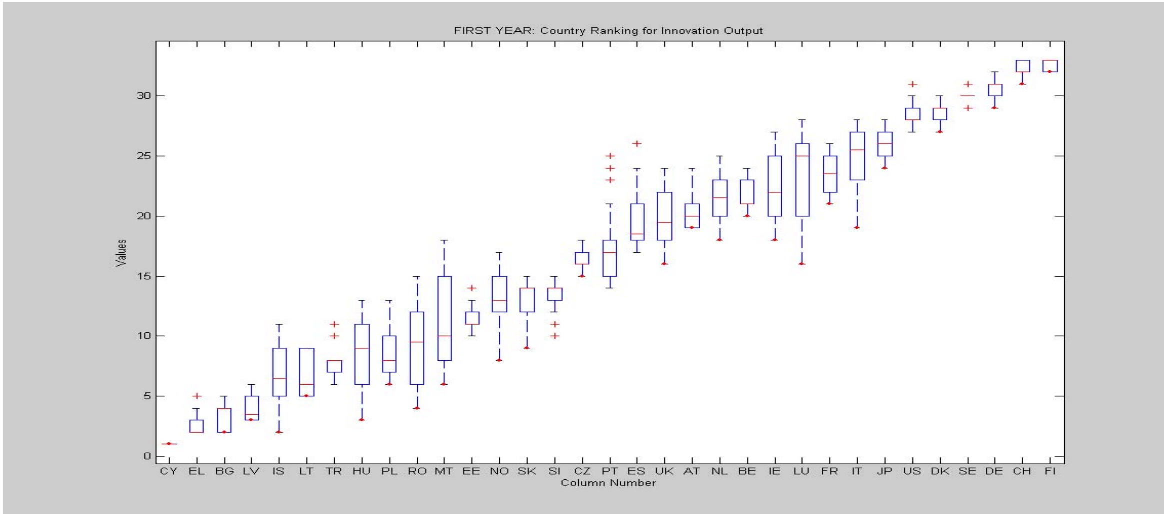
Annex X – Robustness analysis for trends – Innovation Input

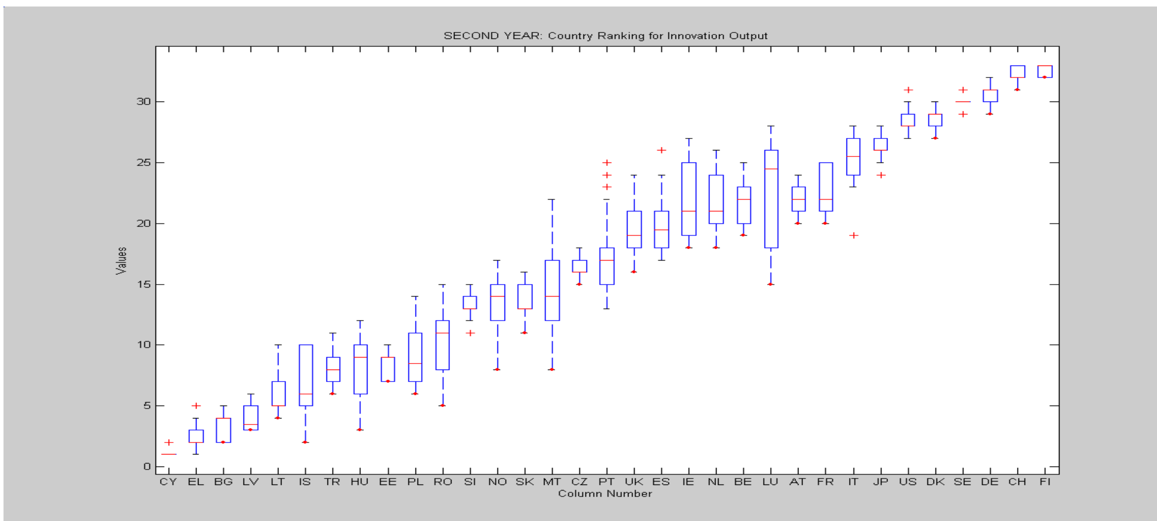


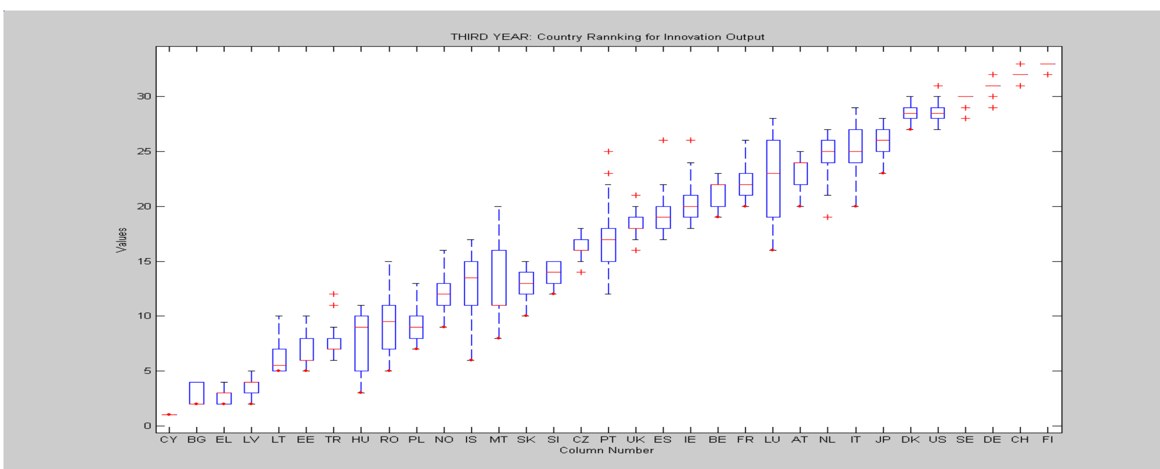




Annex XI – Robustness analysis for trends – Innovation Output







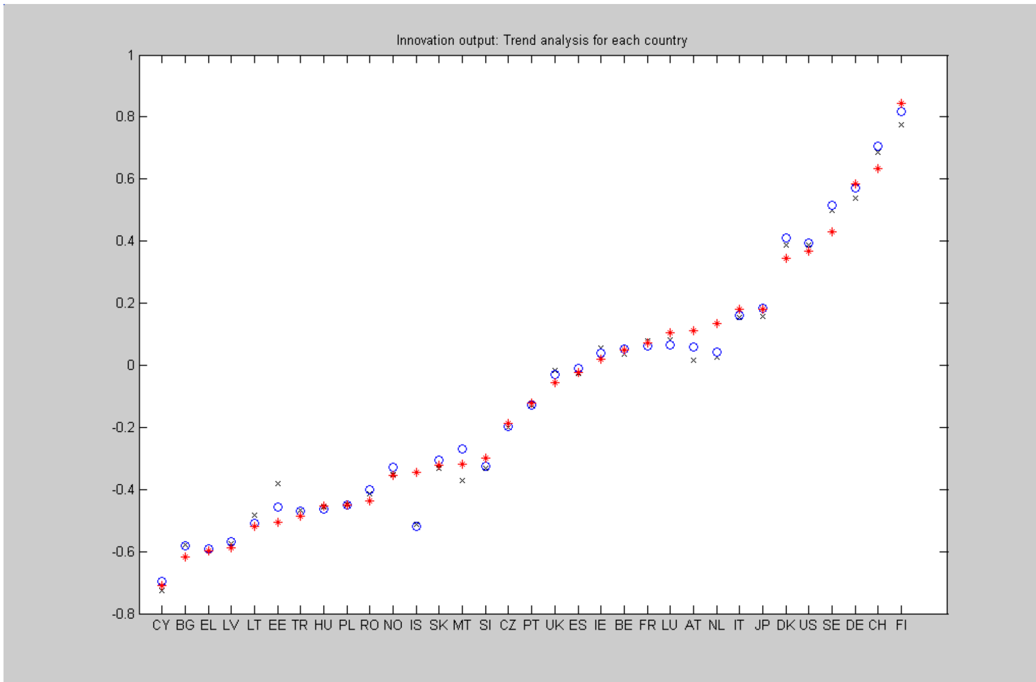
Annex XII – Average index values for innovation *input* in the three years

Country	YEAR 1	YEAR 2	YEAR 3
BE	0.2651	0.3201	0.3524
CZ	-0.3002	-0.3069	-0.2686
DK	0.0701	0.1122	0.1739
DE	0.3091	0.2832	0.2961
EE	-0.0965	-0.0711	-0.0315
EL	-0.2558	-0.271	-0.2637
ES	-0.2833	-0.2531	-0.2077
FR	0.1574	0.1818	0.219
IE	-0.2056	-0.2361	-0.2029
IT	-0.1756	-0.162	-0.1122
CY	-0.3903	-0.3398	-0.341
LV	-0.3289	-0.2391	-0.292
LT	-0.1351	-0.1192	-0.1017
LU	-0.274	-0.2464	-0.3725
HU	-0.1637	-0.1739	-0.148
MT	-0.6119	-0.5869	-0.5542
NL	0.1239	0.1267	0.1448
AT	0.0477	0.0394	0.0817
PL	-0.4156	-0.4074	-0.3469
PT	-0.239	-0.2219	-0.1453
SI	-0.1654	-0.1544	-0.0834
SK	-0.3793	-0.3563	-0.3855
FI	0.7188	0.7404	0.8055
SE	0.5588	0.3761	0.4353
UK	0.1081	0.1258	0.147
BG	-0.4376	-0.36	-0.2943
RO	-0.4488	-0.3623	-0.3609
TR	-0.4203	-0.4571	-0.469
CH	0.4085	0.3624	0.3989
IS	0.3295	0.2952	0.3617
NO	0.0373	0.0743	0.1721
US	0.4529	0.3769	0.4515
JP	0.3312	0.3473	0.2952

Annex XII – Average index values for innovation *output* in the three years

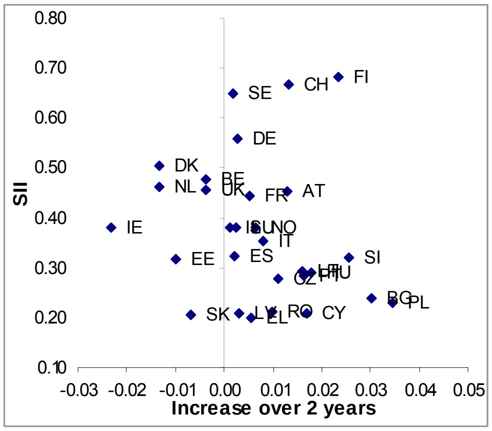
Country	YEAR 1	YEAR 2	YEAR 3
BE	0.035	0.0531	0.0482
CZ	-0.2	-0.1981	-0.1877
DK	0.3886	0.4109	0.3459
DE	0.5376	0.5706	0.5833
EE	-0.3827	-0.4574	-0.5056
EL	-0.5973	-0.5904	-0.5985
ES	-0.0262	-0.0106	-0.0239
FR	0.0779	0.0619	0.0732
IE	0.0552	0.04	0.0197
IT	0.1531	0.1612	0.1802
CY	-0.725	-0.695	-0.7085
LV	-0.5766	-0.5686	-0.5892
LT	-0.4839	-0.508	-0.519
LU	0.0824	0.0646	0.1044
HU	-0.4556	-0.4631	-0.4547
MT	-0.3715	-0.2681	-0.3186
NL	0.0266	0.0424	0.1361
AT	0.0166	0.058	0.1124
PL	-0.4472	-0.449	-0.4514
PT	-0.1281	-0.1278	-0.1226
SI	-0.3327	-0.3264	-0.2979
SK	-0.331	-0.3069	-0.3209
FI	0.7748	0.8164	0.8454
SE	0.4976	0.5171	0.4299
UK	-0.0161	-0.0309	-0.0569
BG	-0.5799	-0.5831	-0.6175
RO	-0.4145	-0.4019	-0.4368
TR	-0.467	-0.4708	-0.4859
CH	0.6879	0.7071	0.6341
IS	-0.5141	-0.5192	-0.3457
NO	-0.3521	-0.3278	-0.3561
US	0.3889	0.3952	0.3661
JP	0.1573	0.1825	0.1804

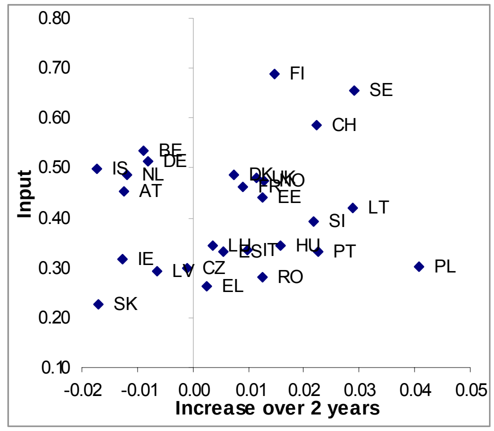
Annex XIII – Trend analysis for Innovation Output

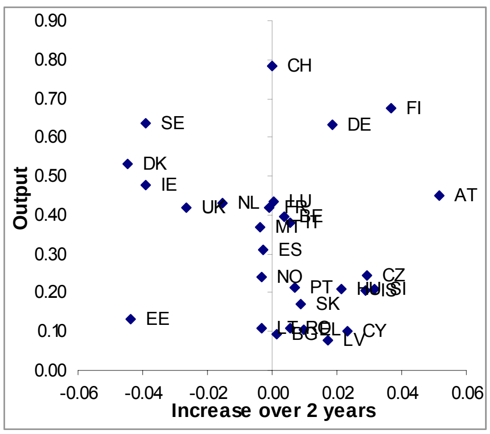


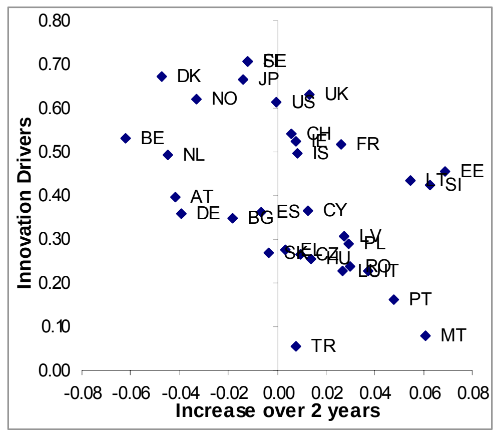
Innovation index for first year by black x, for second year by blue o and third year by red *.

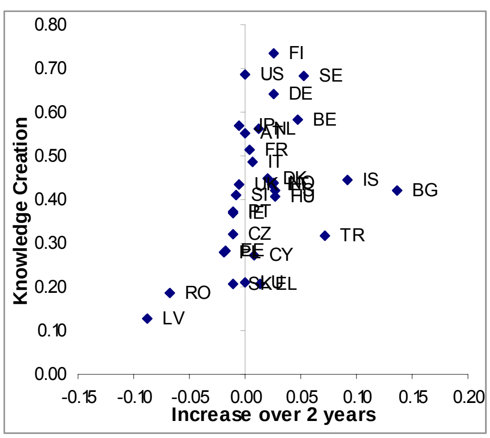
Annex XIV – Composite indicators and trends

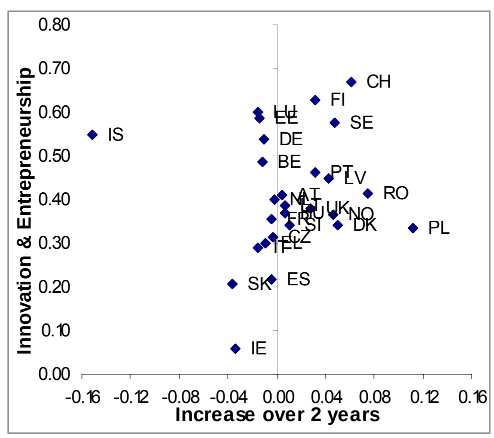


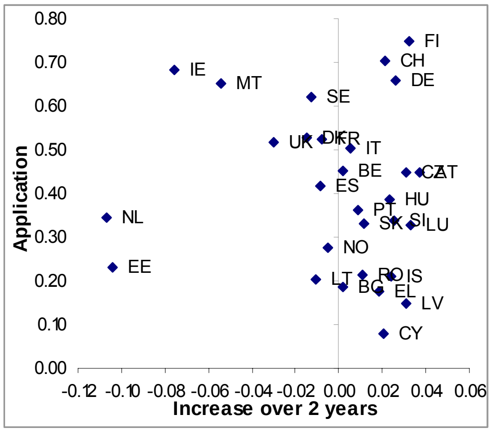


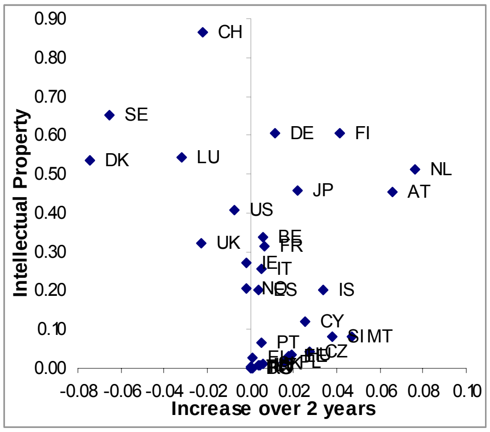




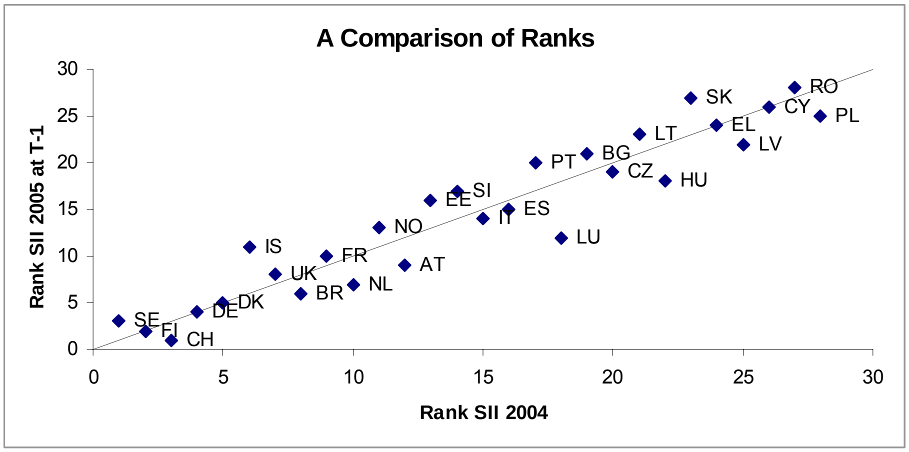


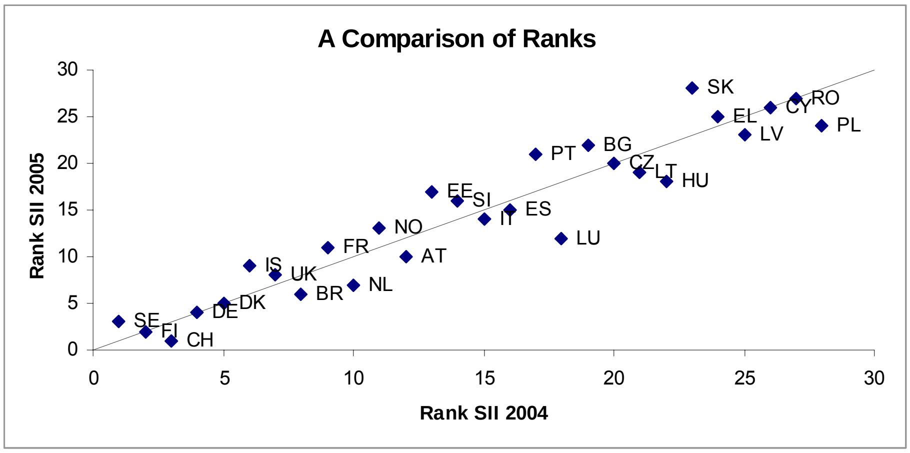


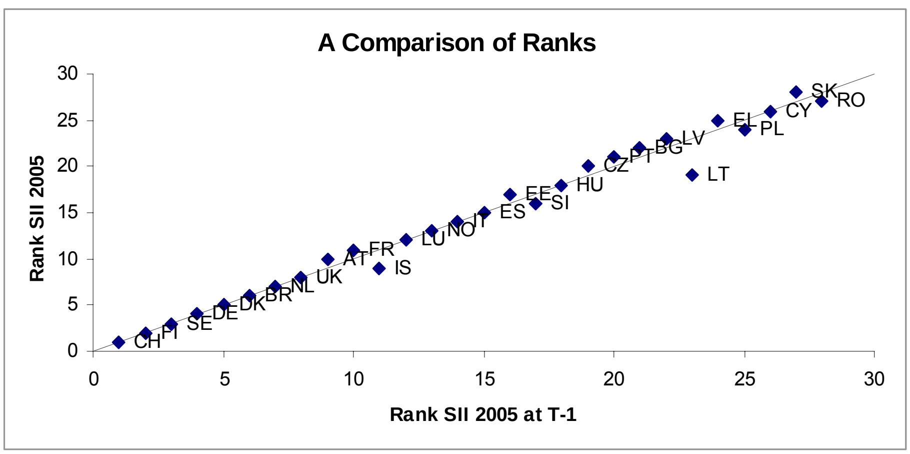

Application
Increase over 2 years
FI
CH
DE
IE
MT
SE
UK
IT
BE
ES
HU
PT
NL
NO
EE
LT
IS
EL
LV
CY


Intellectual Property
Increase over 2 years
CH
SE
DE
FI
DK
LU
NL
JP
AT
US
UK
FR
IT
IS
CY
PT

Annex XV – A comparison of ranks between the EIS 2004 and EIS 2005 (preliminary results)







Annex Table XVI – Imputed values

	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5
BE	92.7	137.2	215.4	101.1	107.5	88.2	131.2	101.1	11.5	209.6	38.3	9.6	2.7	112.0	114.5	49.0	123.5	41.6	5.1	13.9	97.3	110.8	117.4	96.7	93.8	110.0
CZ	51.4	56.7	10.8	67.0	119.0	69.1	60.0	103.6	3.7	11.6	24.6	6.2	1.1	4.0	149.1	39.0	99.7	69.1	7.2	7.3	132.0	8.1	6.4	2.4	30.8	12.4
DK	111.9	150.7	240.0	293.6	99.6	113.2	140.0	105.0	3.2	50.9	16.1	15.8	0.5	250.0	118.2	26.0	141.1	75.3	6.6	13.5	92.7	160.8	139.8	131.4	160.3	236.7
DE	73.4	115.0	103.1	63.8	94.9	114.7	140.0	113.6	12.1	201.6	46.2	9.2	2.7	82.0	107.3	65.0	104.1	82.6	6.2	23.4	167.3	225.3	229.0	193.8	133.2	174.3
EE	67.0	143.7	116.9	71.3	107.7	76.5	18.4	83.9	2.4	126.3	36.9	11.3	1.4	17.1	163.6	53.0	72.7	52.8	4.5	5.4	50.8	6.6	4.5	4.0	25.1	6.1
EL	72.1	84.1	3.1	39.4	106.9	64.2	16.8	48.1	8.9	113.3	17.5	6.3	2.1	32.0	87.3	59.0	54.9	41.6	2.9	8.9	30.2	6.1	3.2	1.5	28.2	1.3
ES	103.7	119.0	103.1	55.3	81.8	69.1	44.8	95.8	8.9	144.3	24.3	2.7	1.2	46.0	85.5	46.0	73.7	33.1	8.3	17.0	78.0	19.1	13.4	7.8	153.7	87.6
FR	185.3	109.3	126.2	83.0	104.5	122.1	114.4	106.7	10.3	50.8	29.2	9.3	2.5	114.0	101.8	23.0	127.6	114.6	5.7	11.7	98.5	110.2	113.6	99.6	84.1	83.3
IE	199.1	125.4	26.2	76.6	111.6	50.0	60.0	102.7	3.7	73.1	21.0	9.2	0.2	92.0	78.2	40.6	122.9	168.0	5.0	9.7	95.2	67.3	54.0	32.8	158.9	84.5
IT	56.0	50.9	93.8	50.0	91.5	88.2	44.8	113.3	14.8	59.9	31.0	3.0	2.0	20.0	90.9	49.0	91.8	39.9	9.5	16.1	112.4	55.9	50.6	36.6	94.7	152.0
CY	33.9	139.3	30.8	98.9	104.8	38.2	4.8	80.5	11.0	113.6	12.1	10.4	1.4	0.9	119.6	52.0	62.7	23.6	1.0	3.8	18.8	7.4	3.6	3.3	136.4	3.4
LV	69.7	85.9	23.1	96.8	100.7	36.8	13.6	46.8	2.0	73.9	15.9	4.0	2.6	11.4	178.2	36.0	72.4	15.2	4.3	7.2	28.0	4.5	0.4	3.0	3.4	6.0
LT	135.8	109.8	38.5	59.6	112.7	82.4	8.8	85.3	4.5	58.4	21.5	12.3	1.7	5.7	116.4	31.0	52.0	16.9	4.3	10.6	45.9	1.9	0.8	0.8	5.6	7.5
LU	17.6	77.2	87.7	67.0	91.0	19.7	129.5	42.1	7.4	191.1	39.2	5.3	1.3	149.6	125.9	74.0	92.2	164.6	2.1	7.3	20.6	150.7	160.7	104.8	662.6	157.9
HU	33.9	72.8	33.8	48.9	109.2	97.1	28.8	108.0	7.3	72.0	16.0	11.1	1.4	6.0	150.9	29.0	98.4	121.9	1.4	4.9	125.3	13.7	8.2	9.0	12.9	10.9
MT	24.8	42.7	53.8	53.2	62.7	62.6	5.6	83.4	5.5	110.9	12.2	2.4	1.9	1.9	130.1	53.1	92.8	311.8	4.1	6.7	93.0	13.2	4.2	2.1	78.2	11.3
NL	56.0	121.8	226.2	175.5	95.6	117.9	88.0	104.0	14.7	116.9	34.2	9.6	1.6	106.0	125.5	38.0	114.8	105.6	3.0	12.7	59.4	208.7	144.5	148.4	147.2	150.5
AT	67.0	78.1	133.8	127.7	111.6	98.5	97.4	100.4	19.2	25.6	35.5	8.8	1.8	52.0	110.9	58.0	104.1	86.0	4.6	13.2	94.1	130.9	109.1	94.3	183.0	171.7
PL	67.9	65.2	7.7	58.5	117.1	67.6	10.4	97.9	0.7	104.1	12.5	5.0	1.8	28.0	181.8	44.1	72.5	15.2	4.2	7.0	92.7	2.0	0.7	0.7	16.1	6.0
PT	59.6	51.8	98.5	51.1	64.1	79.4	20.8	90.5	13.7	12.9	36.2	7.0	2.6	102.0	120.0	51.0	45.5	41.6	10.8	15.1	48.0	3.2	2.2	2.2	55.2	31.6
SI	75.2	83.9	58.5	190.4	117.4	91.2	72.8	102.0	4.1	120.1	18.3	7.6	1.3	82.0	112.7	51.0	83.7	32.6	5.3	4.9	135.5	24.5	14.1	11.1	44.0	29.1
SK	68.8	55.7	6.2	48.9	119.5	30.9	29.6	92.2	1.8	5.7	12.5	3.3	3.1	6.0	110.9	10.0	79.6	19.1	6.6	6.2	121.2	3.2	3.2	2.1	3.4	7.0
FI	157.8	156.8	169.2	261.7	110.7	154.4	192.8	105.8	18.7	110.7	37.6	20.0	2.5	260.0	120.0	47.0	146.7	115.7	14.5	17.5	103.8	232.7	264.6	260.6	94.6	108.9
SE	113.8	128.5	186.2	380.9	113.0	141.8	265.6	113.2	9.1	91.4	35.2	13.4	1.6	322.0	138.2	44.0	152.0	73.6	8.5	21.1	106.5	233.2	312.7	252.0	127.9	105.9
UK	178.9	144.4	113.8	226.6	100.0	89.7	100.8	111.2	3.8	102.6	22.4	7.7	1.8	150.0	140.0	43.9	137.9	118.0	1.9	15.1	95.0	96.3	107.6	82.8	122.1	78.8
BG	72.5	100.7	41.5	13.8	99.5	58.8	7.2	93.9	1.0	101.0	12.5	7.2	0.7	3.8	185.5	47.3	84.3	16.3	2.1	3.8	70.6	2.7	1.4	0.0	0.3	1.0
RO	45.0	45.4	50.1	17.0	94.2	22.1	18.4	70.0	1.7	99.9	14.3	2.9	1.3	10.0	152.7	77.0	45.5	18.5	7.8	1.6	80.6	0.6	0.3	0.1	1.3	0.1
TR	49.4	45.3	47.6	50.9	97.9	69.1	15.2	88.9	5.1	264.9	13.7	2.6	1.9	13.3	58.2	62.4	74.4	10.1	4.3	7.3	80.2	0.7	0.4	0.0	1.2	2.4
CH	69.6	127.1	155.0	266.7	94.7	101.5	155.7	96.5	12.2	70.1	54.8	10.4	3.5	180.8	117.3	40.2	126.6	94.7	8.4	20.5	107.4	154.5	224.9	289.2	208.0	193.4
IS	83.5	125.9	144.2	258.1	66.6	194.1	141.6	47.7	4.8	180.7	46.5	12.5	1.7	128.4	131.4	54.0	148.5	11.2	0.8	3.2	29.5	91.1	96.8	41.0	68.0	20.7
NO	78.9	148.2	94.7	203.2	124.7	104.4	76.8	89.2	8.0	96.3	28.8	12.5	1.2	128.0	105.5	38.0	120.7	20.8	1.9	7.0	68.6	98.3	91.9	66.7	27.5	49.0
US	90.8	186.7	149.7	206.6	95.1	114.7	148.8	111.0	11.8	84.9	35.4	14.3	1.5	194.6	170.9	45.0	127.8	151.1	6.6	14.6	110.9	115.7	503.0	150.0	43.0	17.3
JP	117.4	177.9	177.8	249.5	95.6	117.6	185.6	105.1	13.7	38.7	41.4	13.5	1.5	216.4	141.8	36.6	142.5	127.5	7.2	16.7	102.7	124.8	457.2	255.4	12.9	18.2

Imputed data highlighted in green (or grey).

Annex XVII – Definitions and interpretations of the indicators

#	EIS 2005 indicators	Numerator	Denominator	Interpretation
1.1	New S&E graduates per 1000 population aged 20-29	Number of S&E (science and engineering) graduates. S&E graduates are defined as all post-secondary education graduates (ISCED classes 5a and above) in life sciences (ISC42), physical sciences (ISC44), mathematics and statistics (ISC46), computing (ISC48), engineering and engineering trades (ISC52), manufacturing and processing (ISC54) and architecture and building (ISC58).	The reference population is all age classes between 20 and 29 years inclusive.	The indicator is a measure of the supply of new graduates with training in Science & Engineering (S&E). Due to problems of comparability for educational qualifications across countries, this indicator uses broad educational categories. This means that it covers everything from graduates of one-year diploma programmes to PhDs. A broad coverage can also be an advantage, since graduates of one-year programmes are of value to incremental innovation in manufacturing and in the service sector.
1.2	Population with tertiary education per 100 population aged 25-64	Number of persons in age class with some form of post-secondary education (ISCED 5 and 6).	The reference population is all age classes between 25 and 64 years inclusive.	This is a general indicator of the supply of advanced skills. It is not limited to science and technical fields because the adoption of innovations in many areas, in particular in the service sectors, depends on a wide range of skills. Furthermore, it includes the entire working age population, because future economic growth could require drawing on the non-active fraction of the population. International comparisons of educational levels however are difficult due to large discrepancies in educational systems, access, and the level of attainment that is required to receive a tertiary degree. Differences among countries should be interpreted with caution.

#	EIS 2005 indicators	Numerator	Denominator	Interpretation
1.3	Broadband penetration rate (number of broadband lines per 100 population)	Number of broadband lines. Broadband lines are defined as those with a capacity equal to or higher than 144 Kbit/s.	Total population as defined in the European System of Accounts (ESA 1995).	Realising Europe's full e-potential depends on creating the conditions for electronic commerce and the Internet to flourish, so that the Union can catch up with its competitors by hooking up many more businesses and homes to the Internet via fast connections. The Community and the Member States are to make available in all European countries low cost, high-speed interconnected networks for Internet access and foster the development of state-of-the-art information technology and other telecom networks as well as the content for those networks (Lisbon European Council, 2000). The Barcelona European Council (2002) attached priority to the widespread availability and use of broadband networks throughout the Union by 2005 and the development of Internet protocol IPv6. Further development in this area requires accelerated broadband deployment; in this respect the Brussels European Council (2003) called on Member States to put in place national broadband / high speed Internet strategies by end 2003 and aim for a substantial increase in high speed Internet connections by 2005.
1.4	Participation in life-long learning per 100 population aged 25-64)	Number of persons involved in life-long learning. Life-long learning is defined as participation in any type of education or training course during the four weeks prior to the survey. Education includes both courses of relevance to the respondent's employment and general interest courses, such as in languages or arts. It includes initial education, further education, continuing or further training, training within the company, apprenticeship, on-the-job training, seminars, distance learning, and evening classes.	The reference population is all age classes between 25 and 64 years inclusive	A central characteristic of a knowledge economy is continual technical development and innovation. Individuals need to continually learn new ideas and skills or to participate in life-long learning. All types of learning of 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.

#	EIS 2005 indicators	Numerator	Denominator	Interpretation
1.5	Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	Number of persons aged 20-24 having completed at least upper secondary education, i.e. with an education level ISCED 3-4 minimum.	The reference population is all age classes between 20 and 24 years inclusive	The indicator measures the qualification level of the population aged 20-24 years in terms of formal educational degrees. In so far it provides a measure for the "supply" of human capital of that age group and for the output of education systems in terms of graduates. A study for OECD countries suggests a positive link between education and economic growth. According to this study an additional year of average school attainment is estimated to increase economic growth by around 5% immediately and by further 2.5% in the long run (De la Fuente and Ciccone, "Human capital in a global and knowledge-based economy", Final report for DG Employment and Social Affairs, 2002). Completed upper secondary education is generally considered to be the minimum level required for successful participation in a knowledge-based society. It is increasingly important not just for successful entry into the labour market, but also to allow students access to learning and training opportunities offered by higher education. School attainment is a primary determinant of individual income and labour market status. Persons who have completed at least upper secondary education have access to jobs with higher salaries and better working conditions. They also have a markedly higher employment rate than persons with at most lower secondary education (Employment in Europe 2004).
2.1	Public R&D expenditures (% of GDP)	Difference between GERD (Gross domestic expenditure on R&D) and BERD (Business enterprise expenditure on R&D). Both GERD and BERD according to Frascati-manual definitions, in national currency and current prices.	Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.	R&D expenditure represents one of the major drivers of economic growth in a knowledge-based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth. Recognising the benefits of R&D for growth and being aware of the rapidly widening gap between Europe's R&D effort and that of the principal partners of the EU in the world, the Barcelona European Council (March 2003) set the EU a target of increasing R&D expenditure to 3 per cent of GDP by 2010, two thirds of which should come from the business enterprise sector.

#	**EIS 2005 indicators**	**Numerator**	**Denominator**	**Interpretation**
2.2	Business R&D expenditures (% of GDP)	All R&D expenditures in the business sector (BERD), according to Frascati-manual definitions, in national currency and current prices.	Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.	The indicator captures the formal creation of new knowledge within firms. It is particularly important in the science-based sector (pharmaceuticals, chemicals and some areas of electronics) where most new knowledge is created in or near R&D laboratories.
2.3	Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	R&D expenditures in medium-high and high-tech manufacturing, in national currency and current prices. These include chemicals (NACE24), machinery (NACE29), office equipment (NACE30), electrical equipment (NACE31), telecommunications and related equipment (NACE32), precision instruments (NACE33), automobiles (NACE34) and aerospace and other transport (NACE35).	R&D expenditures in total manufacturing, in national currency and current prices.	This indicator captures whether a country invests in future technologies (medium-high and high-tech manufacturing industries) or rather in historical industries (medium-low and low-tech manufacturing industries). This follows a recent report published by the JRC (R&D expenditure scoreboard), which highlights that the R&D problem observed in Europe is more a business structure problem. In most sectors R&D intensity is as high in the EU as in the rest of the world, however the relative importance of R&D intensive sectors in the total business is relatively low in Europe.
2.4	Share of enterprises receiving public funding for innovation	Number of innovative enterprises that have received public funding. Public funding includes financial support in terms of grants and loans, including a subsidy element, and loan guarantees. Ordinary payments for orders of public customers are not included. (*Community Innovation Survey*)	Total number of enterprises, thus both innovating and non-innovating enterprises. (*Community Innovation Survey*)	This indicator measures the degree of government support to innovation. The indicator gives the percentage of all firms (innovators and non-innovators combined) that received any public financial support for innovation from at least one of three levels of government (local, national and the European Union).
2.5	University R&D expenditures financed by business sector	R&D expenditures in the higher education sector financed by business, in national currency and current prices.	Total R&D expenditures in the higher education sector (HERD), in national currency and current prices.	This indicator measures public private co-operation. University R&D financed by the business sector are expected to explicitly serve the more short-term research needs of the business sector.
3.1	SMEs innovating in-house (% of SMEs)	Sum of SMEs with in-house innovation activities. Innovative firms are defined as those who 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. (*Community Innovation Survey*)	Total number of SMEs. (*Community Innovation Survey*)	This indicator measures the degree to which SMEs, that have introduced any new or significantly improved products or production processes during the period 1998-2000, have innovated in-house. The indicator is limited to SMEs because almost all large firms innovate and because countries with an industrial structure weighted to larger firms would tend to do better.

#	EIS 2005 indicators	Numerator	Denominator	Interpretation
3.2	Innovative SMEs co-operating with others (% of SMEs)	Sum of SMEs with innovation co-operation activities. Firms with co-operation activities are those that had any co-operation agreements on innovation activities with other enterprises or institutions in the three years of the survey period. (*Community Innovation Survey*)	Total number of SMEs. (*Community Innovation Survey*)	This indicator measures the degree to which SMEs are involved in innovation co-operation. Complex innovations, in particular in ICT, often depend on the ability to draw on diverse sources of information and knowledge, or to collaborate on the development of an innovation. This indicator measures the flow of knowledge between public research institutions and firms and between firms and other firms. The indicator is limited to SMEs because almost all large firms are involved in innovation co-operation.
3.3	Innovation expenditures (% of turnover)	Sum of total innovation expenditure for enterprises, in national currency and current prices. Innovation expenditures includes the full range of innovation activities: in-house R&D, extramural R&D, machinery and equipment linked to product and process innovation, spending to acquire patents and licenses, industrial design, training, and the marketing of innovations. (*Community Innovation Survey*)	Total turnover for all enterprises, in national currency and current prices. (*Community Innovation Survey*)	This indicator measures total innovation expenditure as percentage of total turnover. Several of the components of innovation expenditure, such as investment in equipment and machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas. Overall, the indicator measures total expenditures on many activities of relevance to innovation. The indicator partly overlaps with the indicator on business R&D expenditures.
3.4	Early-stage venture capital (% of GDP)	Venture capital investment is defined as private equity raised for investment in companies. Management buyouts, management buyins, and venture purchase of quoted shares are excluded. Early-stage capital includes seed and start-up capital. *Seed* is defined as financing provided to research, assess and develop an initial concept before a business has reached the start-up phase. *Start-up* is defined as financing provided for product development and initial marketing, manufacturing, and sales. Companies may be in the process of being set up or may have been in business for a short time, but have not yet sold their product commercially.	Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.	The amount of early-stage venture capital is a proxy for the relative dynamism of new business creation. In particular for enterprises using or developing new (risky) technologies venture capital is often the only available means of financing their (expanding) business. *Note: in order to reduce volatility, the indicator is based on a two-year average.*

#	EIS 2005 indicators	Numerator	Denominator	Interpretation
3.5	ICT expenditures (% of GDP)	Total expenditures on information and communication technology (ICT), in national currency and current prices. ICT includes office machines, data processing equipment, data communication equipment, and telecommunications equipment, plus related software and telecom services.	Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.	ICT is a fundamental feature of knowledge-based economies and the driver of current and future productivity improvements. An indicator of ICT investment is crucial for capturing innovation in knowledge-based economies, in particular due to the diffusion of new IT equipment, services and software. One disadvantage of this indicator is that it is ultimately obtained from private sources, with a lack of good information on the reliability of the data. Another disadvantage is that part of the expenditures is for final consumption and may have few productivity or innovation benefits.
3.6	SMEs using non-technological change (% of SMEs)	CIS question 12.1 asks firms if, between 1998 and 2000, they implemented ‘advanced management techniques’, ‘new or significantly changed organizational structures’, or ‘significant changes in the aesthetic appearance or design in at least one product ’. A ‘yes’ response to at least one of these categories would identify a SME using non-technical change. (*Community Innovation Survey*)	Total number of SMEs. (*Community Innovation Survey*)	The Community Innovation Survey mainly asks firms about their technical innovation, Many firms, in particular in the services sectors, innovate through other non-technical forms of innovation. Examples of these are innovation through the introduction of advanced and more efficient management techniques or through the introduction of new and more efficient ways of organization. Evidence on non-technical innovation is scarce. This indicator tries to capture the extent that SMEs innovate through non-technical innovation.
4.1	Employment in high-tech services (% of total workforce)	Number of employed persons in the high-tech services sectors. These include post and telecommunications (NACE64), information technology including software development (NACE72) and R&D services (NACE73).	The total workforce includes all manufacturing and service sectors.	The high technology services both 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.

#	EIS 2005 indicators	Numerator	Denominator	Interpretation
4.2	Exports of high technology products as a share of total exports	Value of high-tech exports, in national currency and current prices. High-tech exports includes exports of the following products: aerospace; computers and office machinery; electronics-telecommunications; pharmaceuticals; scientific instruments; electrical machinery; chemistry; non-electrical machinery and armament (cf. OECD STI Working Paper 1997/2 for the SITC Revision 3 codes).	Value of total exports, in national currency and current prices.	The indicator measures the technological competitiveness of the EU i.e. the ability to commercialise the results of research and development (R&D) and innovation in the international markets. It also reflects product specialisation by country. Creating, exploiting and commercialising new technologies is vital for the competitiveness of a country in the modern economy. This is because high technology sectors are key drivers for economic growth, productivity and welfare, and are generally a source of high value added and well-paid employment. The Brussels European Council (2003) stressed the role of public-private partnerships in the research area as a key factor in developing new technologies and enabling the European high-tech industry to compete at the global level.
4.3	Sales of new-to-market products (% of turnover)	Sum of total turnover of new or significantly improved products for all enterprises. (*Community Innovation Survey*)	Total turnover for all enterprises, in national currency and current prices. (*Community Innovation Survey*)	This indicator measures the turnover of new or significantly improved products, which are also new to the market, as a percentage of total turnover. The product must be new to the firm, which in many cases will also include innovations that are world-firsts. The main disadvantage is that there is some ambiguity in what constitutes a 'new to market' innovation. Smaller firms or firms from less developed countries could be more likely to include innovations that have already been introduced onto the market elsewhere.
4.4	Sales of new-to-firm not new-to-market products (% of turnover)	Sum of total turnover of new or significantly improved products to the firm but not to the market for all enterprises. (*Community Innovation Survey*)	Total turnover for all enterprises, in national currency and current prices. (*Community Innovation Survey*)	This indicator measures the turnover of new or significantly improved products to the firm as a percentage of total turnover. These products are not new to the market. Sales of new to the firm but not new to the market products are a proxy of the use or implementation of elsewhere already introduced products (or technologies). This indicator is thus a proxy for the degree of diffusion of state-of-the-art technologies.

#	EIS 2005 indicators	Numerator	Denominator	Interpretation
4.5	Employment in medium-high and high-tech manufacturing (% of total workforce)	Number of employed persons in the medium-high and high-tech manufacturing sectors. These include chemicals (NACE24), machinery (NACE29), office equipment (NACE30), electrical equipment (NACE31), telecommunications and related equipment (NACE32), precision instruments (NACE33), automobiles (NACE34) and aerospace and other transport (NACE35).	The total workforce includes all manufacturing and service sectors.	The share of employment in medium-high and high technology manufacturing sectors is an indicator of the manufacturing economy that is based on continual innovation through creative, inventive activity. The use of total employment gives a better indicator than using the share of manufacturing employment alone, since the latter will be affected by the hollowing out of manufacturing in some countries.
5.1	EPO patents per million population	Number of patents applied for at the European Patent Office (EPO), by year of filing. The national distribution of the patent applications is assigned according to the address of the inventor.	Total population as defined in the European System of Accounts (ESA 1995).	The capacity of firms to develop new products will determine their competitive advantage. One indicator of the rate of new product innovation is the number of patents. This indicator measures the number of patent applications at the European Patent Office.
5.2	USPTO patents per million population	Number of patents granted by the US Patent and Trademark Office (USPTO), by year of grant. Patents are allocated to the country of the inventor, using fractional counting in the case of multiple inventor countries.	Total population as defined in the European System of Accounts (ESA 1995).	The capacity of firms to develop new products will determine their competitive advantage. One indicator of the rate of new product innovation is the number of patents. This indicator measures the number of patents granted by the US Patent and Trademark Office.
5.3	Triadic patent families per million population	Number of triad patents. A patent is a triad patent if and only if it is filed at the European Patent Office (EPO), the Japanese Patent Office (JPO) and is granted by the US Patent & Trademark Office (USPTO).	Total population as defined in the European System of Accounts (ESA 1995).	The disadvantage of both the EPO and USPTO patent indicator is that European countries respectively the US have a 'home advantage' as patent rights differ among countries. A patent family is a group of patent filings that claim the priority of a single filing, including the original priority filing itself, and any subsequent filings made throughout the world. Trilateral patent families are a filtered subset of patent families for which there is evidence of patenting activity in all trilateral blocks (USPTO, EPO, JPO). No country will thus have a clear 'home advantage'.

#	EIS 2005 indicators	Numerator	Denominator	Interpretation
5.4	Number of new community trademarks per million population	Number of new community trademarks. A trademark is a distinctive sign, which identifies certain goods or services as those produced or provided by a specific person or enterprise. The Community trademark offers the advantage of uniform protection in all countries of the European Union on the strength of a single registration procedure with the Office for Harmonization.	Total population as defined in the European System of Accounts (ESA 1995).	Successful innovation includes taking a new product to market. Trademarks play an important role in the marketing process. A trademark is a distinctive sign that identifies certain goods or services as those produced or provided by a specific person or enterprise. The system helps consumers identify and purchase a product or service because its nature and quality, indicated by its unique trademark, meets their needs (http://www.wipo.int).
5.5	Number of new community industrial designs per million population	Number of new community industrial designs. A registered Community design is an exclusive right for the outward appearance of a product or part of it, resulting from the features of, in particular, the lines, contours, colours, shape, texture and/or materials of the product itself and/or its ornamentation.	Total population as defined in the European System of Accounts (ESA 1995).	Successful innovation includes taking a new product to market. Industrial designs play an important role in the marketing process. An industrial design is the ornamental or aesthetic aspect of an article. The design may consist of three-dimensional features, such as the shape or surface of an article, or of two-dimensional features, such as patterns, lines or colour. Industrial designs are applied to a wide variety of products of industry and handicraft: from technical and medical instruments to watches, jewelry, and other luxury items; from housewares and electrical appliances to vehicles and architectural structures; from textile designs to leisure goods. To be protected under most national laws, an industrial design must appeal to the eye. This means that an industrial design is primarily of an aesthetic nature, and does not protect any technical features of the article to which it is applied (http://www.wipo.int).