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The Relationship between Education and Innovation

Evidence from European indicators

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List of abbreviations

ACC	Acceding Countries (European Union Members after May 1st 2004)
CC	Candidate countries
CEDEFOP	The European centre for the development of vocational training
CIS4	Continuous innovation Survey (fourth round)
CVT	Continuous vocational training
CVTS	Continuing vocational training Survey
trcvt	Training enterprises providing courses
troth	Training enterprises providing other types of training
EAY	Educational attainment of the youth
EEA	European Economic Area
EIS	European innovation scoreboard
EPO	European Patent Office
ESL	Early school leavers
EU 15	European Union, 15 members previous to May 1st 2004
EUR	Eurozone – BE, DE, EL, ES, FR, IE, IT, LU, NL, AT, PT, FI
EUROSTAT	Statistical office of the European Communities
EURYDICE	The information network on education in Europe
EXdiverse	Innovation diversity (component of the Exploratory innovation scoreboard)
EXinnfri	Innovation friendly market (component of the Exploratory innovation scoreboard)
EXinngov	Innovation governance (component of the Exploratory innovation scoreboard)
EXinnoinv	Innovation investment (component of the Exploratory innovation scoreboard)
EXinnskills	Innovation skills (component of the Exploratory innovation scoreboard)
EXIS	Exploratory innovation scoreboard
EXkflow	Knowledge flows (component of the Exploratory innovation scoreboard)
GBAORD	Government budget appropriations or outlays on R&D
GDP	Gross domestic product
ICT	Information and communication technologies
inidrv	Innovation drivers (component of the European innovation scoreboard)
inientrep	Innovation and entrepreneurship (component of the European innovation scoreboard)
iniKC	Knowledge creation (component of the European innovation scoreboard)
inoapp	Applications (component of the European innovation scoreboard)
inoav	Innovation output average (average of inoapp and inoip)
inoip	Intellectual property (component of the European innovation scoreboard)
ISCED	International standard classification for education
JRC	Joint research centre of the European Commission
LFS	Labour Force Survey
LLL	Lifelong learning participation
MST	Mathematics, Science and technology
NMS	New Member States of the European Union
NACE	General industrial classification of economic activities within the European Communities
OECD	Organization for Economic Cooperation and Development
OldMS	Old Member States of the European Union
PISA	Programme for International Student Assessment
PISArL	Percentage of pupils with level 1 or bellow on PISA reading literacy scale
R&D	Research and development
S&T	Science and technology fields of studies
SII	Summary innovation index
trent	Training enterprises
USPTO	United States Patent and Trademark Office
VET	Vocational education and training

Country abbreviations

Old Member States

Eu-15: European Union, 15 members previous to May 1st 2004

AT	Austria
BE	Belgium
DE	Germany
DK	Denmark
EL	Greece
ES	Spain
FI	Finland
FR	France
IE	Ireland
IT	Italy
LU	Luxembourg
NL	Netherlands
PT	Portugal
SE	Sweden

New Member States

AAC: Acceding Countries (EU members after May 1st 2004)

BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
EE	Estonia
HU	Hungary
LT	Lithuania
LV	Latvia
MT	Malta
PL	Poland
RO	Romania
SI	Slovenia
SK	Slovak Republic

CC: Candidate Countries

HR	Croatia
TR	Turkey

Other countries

CA	Canada
CH	Switzerland
CHI	China
IS	Iceland
JP	Japan
NO	Norway
US	United States

1 Introduction - Importance of education for innovation

There is a general consensus that education is a pre-condition for innovation. Research has been usually focused on the connection between higher education and their role on national innovation systems, as well as in company characteristics that promote innovation. There is less research on the relationship between formal schooling and its impact on national innovation systems. In general, it is agreed that certain foundational skills are necessary to participate in the knowledge society and that those skills, especially ICT skills and entrepreneurship will be associated with higher levels of innovation.

The major problem is that such relationships are very difficult to empirically verify and would imply a research design very costly and complex. A first step to investigate this relationship is to relate different educational indicators, with other indicators related to innovation. This is the purpose of the present paper, mainly exploratory. It explores the relationship between country-level indicators on both education and innovation: special focus is made on benchmarks indicators for education and composite indicators on innovation.

The paper uses Pearson correlations as the exploratory tool and cluster analysis to further identify communalities among countries. In addition, the paper explores if educational indicators are related to specific output indicators. The paper is divided into 4 parts. The first section is this brief introduction; the second presents the methodological choice, the indicators chosen for the analysis and its limitations. The third part represents the core of the paper. It is divided in five subsections. First is presents the relationship between company training indicators and innovation, secondly the relationship between each of the five educational benchmarks and innovation. Thirdly it explores possible grouping of countries according to innovation and educational indicators. Fourth, it present the relationship between educational indicators and specific output indicators derived from CIS4. And fifth the section relates other educational indicators (not the benchmarks) with innovation. The paper finalize with a summary of the findings and possible policy implications, especially in terms of measuring innovation in relation to education.

2 Definitions, concepts and methodological choice

2.1 Composite indicators to measure innovation

The Oslo manual (OECD, 2006) defines innovation as "a new significant improved product (good or service), or process, a new marketing method, or a new organizational method, business practices, workplace organization or external relations" (OECD, 2006, p. 46). This implies that there are four main modes (or areas) for innovation: (1) Product, (2) Process, (3) Marketing and (4) Organizational innovation. Innovation can occur by adopting new technologies developed by other firms (technologies in a broad sense), or by developing innovation in-house, mainly through R&D activities.

The concept of innovation is complex and has many different dimensions that are difficult to measure. The present paper relies heavily on the work of others that have elaborated ways of measuring different aspects of innovation systems in a country. Three such tools have been identified and will be used: European Innovation Scoreboard (EIS), Global Innovation Scoreboard (GIS) and the experimental innovation scoreboard (EXIS). These composite indicators will be correlated with educational indicators to explore possible links between education and innovation systems in a quantitative manner.

EIS provides an annual benchmark of the innovation performance for the 27 EU Member States and Croatia, Turkey, Iceland, Norway, Switzerland, the US and Japan. The overall benchmark is done by comparing rankings of the composite indicator, the Summary Innovation Index (SII). Thus SII will be used to carry on the exploratory analysis. SII is a score constructed with data for 25 indicators divided in five broad innovation areas within and input - output scheme (see Sajeva et al. 2006, p. 9):

A) Input
  (1) Innovation drivers (*inidrv*), which measures the structural conditions required for innovation, mainly in terms of educational attainment of the population;
  (2) Knowledge creation (*iniKC*), which measures aspects of R&D;
  (3) Innovation & entrepreneurship (*inientrep*), which measures mainly efforts for innovation at the company level;

B) Output
  (4) Applications (*inoapp*), which measures the performance, expressed in terms of labour and business activities, and their value added in innovative sectors; and
  (5) Intellectual Property (*inoip*), which measures the achieved results in terms of successful know-how in terms of patents and other innovative outputs, specially referred to high-tech sectors.

An average of the two output indicators (*inoav*) was also calculated in order to see if there is a relationship between innovation output and educational benchmarks.

Table 1: European Innovation Scoreboard (EIS) indicators and sources, 2006

	INPUT – INNOVATION DRIVERS (*inidrv*)	
1.1	S&E graduates per 1000 population aged 20-29	EUROSTAT
1.2	Population with tertiary education per 100 population aged 25-64	EUROSTAT, OECD
1.3	Broadband penetration rate (number of broadband lines per 100 population)	EUROSTAT
1.4	Participation in life-long learning per 100 population aged 25-64	EUROSTAT
1.5	Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	EUROSTAT
	INPUT – KNOWLEDGE CREATION (*iniKC*)	
2.1	Public R&D expenditures (% of GDP)	EUROSTAT, OECD
2.2	Business R&D expenditures (% of GDP)	EUROSTAT, OECD
2.3	Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	EUROSTAT, OECD
2.4	Share of enterprises receiving public funding for innovation	EUROSTAT (CIS4)
	INPUT – INNOVATION & ENTREPRENEURSHIP (*inientrep*)	
3.1	SMEs innovating in-house (% of all SMEs)	EUROSTAT (CIS3)[1]
3.2	Innovative SMEs co-operating with others (% of all SMEs)	EUROSTAT (CIS4)
3.3	Innovation expenditures (% of total turnover)	EUROSTAT (CIS4)
3.4	Early-stage venture capital (% of GDP)	EUROSTAT
3.5	ICT expenditures (% of GDP)	EUROSTAT
3.6	SMEs using organisational innovation (% of all SMEs)	EUROSTAT (CIS4)
	OUTPUT – APPLICATIONS (*inoapp*)	
4.1	Employment in high-tech services (% of total workforce)	EUROSTAT
4.2	Exports of high technology products as a share of total exports	EUROSTAT
4.3	Sales of new-to-market products (% of total turnover)	EUROSTAT (CIS4)
4.4	Sales of new-to-firm products (% of total turnover)	EUROSTAT (CIS4)
4.5	Employment in medium-high and high-tech manufacturing (% of total workforce)	EUROSTAT
	OUTPUT – INTELLECTUAL PROPERTY (*inoip*)	
5.1	EPO patents per million population	EUROSTAT
5.2	USPTO patents per million population	EUROSTAT, OECD
5.3	Triadic patent families per million population	EUROSTAT, OECD
5.4	New community trademarks per million population	OHIM[2]
5.5	New community designs per million population	OHIM[7]

[1] CIS4 data for the indicator on the share of SMEs innovating in-house were not available.

[2] Office for Harmonization in the Internal Market (Trade Marks and Designs): http://oami.eu.int/

GIS was created in order to compare the innovation performance of the EU with other non-EU member states (see Hollanders and Arundel, 2006). It has similar areas than the EIS but it is composed of less number of indicators. The indicators are in many cases from other sources due to the availability of the data that makes GIS a different measure than EIS to some extent. The list of indicators for GIS is presented in table 2. The present paper can only have a limited use of this indicator, since the availability of educational indicators for other countries is scarce. In the present paper only the overall GIS scores will be considered for the relationships.

Table 2: Global Innovation Scoreboard indicators (GIS) and sources, 2006

	INPUT – INNOVATION DRIVERS	
1.1	New S&T graduates	UNESCO
1.2	Labour force with completed tertiary education	WORLD BANK (WORLD DEVELOPMENT INDICATORS)
1.3	Research per million population	WORLD BANK (WORLD DEVELOPMENT INDICATORS)
	INPUT – KNOWLEDGE CREATION	
2.1	Public R&D expenditures (% of GDP)	OECD, WORLD DEVELOPMENT INDICATORS
2.2	Business R&D expenditures (% of GDP)	OECD, WORLD DEVELOPMENT INDICATORS
2.3	Scientific articles per million population	WORLD BANK (WORLD DEVELOPMENT INDICATORS)
	INPUT - DIFFUSSION	
3.1	ICT expenditures (% of GDP)	WITSA/IDC (DIGITAL PLANET 2004)
	OUTPUT – APPLICATIONS	
4.1	Exports of high technology products as a share of total exports	WORLD BANK (WORLD DEVELOPMENT INDICATORS)
4.2	Share of medium-high/high-tech activities in manufacturing value added	UNIDO (INDUSTRIAL DEVELOPMENT SCOREBOARD)
	OUTPUT – INTELLECTUAL PROPERTY	
5.1	EPO patents per million population	OECD
5.2	USPTO patents per million population	OECD
5.3	Triadic patent families per million population	OECD

EXIS is an experimental composite indicator developed by Arundel and Hollanders (2005). It explores other aspects of innovation, mainly focusing on firm level data. EXIS is divided in six thematic areas (see Arundel and Hollanders, 2005 for further explanation):

(1) Innovation diversity (*EXdiverse*): is compounded of seven indicators that refer to different types of innovation. High levels in this composite mean that the country has a good variety of innovation outputs.
(2) Innovation-friendly markets (*EXinnfri*): It is compounded of four indicators that refer to how friendly the markets are for innovation.
(3) Knowledge flows (*EXkflow*): It is compounded of four indicators from CIS3 and covers the sourcing of valuable knowledge. Countries ranking high in this composite are countries that have firms that valuate the knowledge coming from outside as important for innovation.
(4) Innovation investment (*EXinnoinv*): There are five indicators in this area that include a proxy for investment in process innovation, two indicators for the use of government programmes to support innovation and two indicators for innovation finance.
(5) Innovation skills (*EXinnskills*): This thematic index uses firm-level information to assess the level of skills of a country
(6) Innovation governance (*EXinngov*): This thematic index is compounded of four indicators. They cover the appropriateness of regulatory and government policies to encourage innovation.

The EXIS indicators cover a broader range of innovation activities than EIS, plus EXIS includes more indicators on background conditions, such as the receptiveness of the market.

Table 3: Exploratory innovation scoreboard (EXIS) indicators and sources

Theme 1: Innovation Diversity (*EXdiverse*)		
1. Percentage of all firms that are strategic innovators	CIS-3	2000
2. Percentage of all firms that are intermittent innovators	CIS-3	2000
3. Value-added as a percent of turnover	STAN	2002
4. Percentage of all firms that are non-technical innovators (introduced an organizational, design or advanced management technique)	CIS-3	1998 - 2000
5. Percentage of firms that applied for one or more patents	CIS-3	2000
6. Number of domestic community trademarks per million population	WIPO	2001
7. Number of domestic industrial designs per million population	WIPO	2001
Theme 2: Innovation friendly market (*EXinnfri*)		
1. Percentage of total population under age 25	SBS population statistics	2001
2. Average time to sales takeoff for consumer products	Tellis et al, 2003	1950 - 1994
3. Index for the sophistication of local buyers (actively seeking the latest products, technologies, and processes)	World Economic Forum (table8.04)	2003
4. Percent of innovative and non-innovative firms (separately) that give a high importance to a lack of customer responsiveness to new goods or services as a barrier to their ability to innovate.	CIS-3	1998 - 2000
Theme 3: Knowledge flows (*EXkflow*)		
1. Percentage of all firms collaborating internationally on innovation	CIS-3 1998 –	2000
2. Share of all firms finding higher education knowledge sources to be of medium or high importance to their innovation activities.	CIS-3	1998 - 2000
3. Share of all firms giving a high importance to at least one external source of knowledge for their innovation activities.	CIS-3	1998 - 2000
4. Transnationality Index (indicator of inward flows of embodied and tacit knowledge) for 2000 (average of FDI inflows as a percent of gross fixed capital formation 1998-2000, FDI inward stock as a percent of 2000 GDP, value added of foreign affiliates as a percent of GDP in 2000, and employment of foreign affiliates as a percent of total 2000 employment	UNCTAD, World Investment Report 2003	1998 - 2000
Theme 4: Innovation investment (*EXinnoinv*)		
1. Composite index for finance availability based on loan access and venture capital availability	World Economic Forum,	2004 2003
2. Gross investment in machinery and equipment as a percentage of total value added	SBS	2002
3. Share of firms that receive public subsidies to innovate	CIS-3	1998 - 2000
4. Policy uptake rate, or average percent of all eligible innovation support programmes used by innovative SMES (20-499 employees)	Innobarometer 2004	2004
5. Percent of innovative and non-innovative firms (separately) that give a high importance to either innovation costs or lack of finance as a barrier to innovate.	CIS-3	1998 - 2000
Theme 5: Innovation skills (*EXinnskills*)		
1. Percent private sector employees whose job requires continual learning. From the Third European WCS of 8081 randomly selected individuals in all EU-15 countries. Private sector employees are divided into four groups depending on their job characteristics: learning, lean production, Taylorism, and traditional/craft.	Working Conditions Survey, Lorenz 2003	2000
2. Percent of all employees with higher education	CIS-3 1998 –	2000
3. Percentage of employees that have participated in Continuing Vocational Training (CVT), defined as training measures or activities financed by the enterprise, partly or wholly, for employees with a working contract.	CVTS	1999
4. Average hours of CVT per employee.	CVTS	1999
Theme 6: Innovation governance (*EXinngov*)		
1. Composite index for government waste based on responses to 1) do government subsidies to business in your country keep uncompetitive industries alive artificially or do they improve the productivity of industries?, 2) how common is the diversion of public funds to companies, individuals or groups due to corruption?, and 3) how high is the public trust in the financial honesty of politicians? The higher the number of the index, the *less* waste. Therefore, we could call this a government efficiency index.	World Economic Forum,	2004 2003
2. Composite index for innovation policies based on measures of the 1) effectiveness of IPRs, 2) size and availability of R&D tax credits and subsidies (3.07), 3) costs of tariff restrictions.	World Economic Forum	2004 2003
3. Composite index for the cost of starting a business based on four indicators (number of procedures, time in days, cost as a percentage of average income, minimum capital required as a percentage of average income)	World Bank	2003
4. Composite index for domestic product regulation (inward oriented policies), including economic and administrative regulation.	Nicoletti et al (OECD)	1998
5. Percent of all firms that give a high importance to environmental benefits from technical innovation.	CIS-3	2000

In the case of education, the paper will use educational benchmark indicators. The European Commission proposed five benchmarks to monitor the progress towards the Lisbon Objectives in education and training. In the present paper these five benchmarks indicators will be correlated with the above referred innovation composite indexes in order to explore relationships between education and innovation systems at a country level. These five benchmarks are:

(1) Youth educational attainment (EAY): measure as the percentage of the population aged 20-24 having completed at least upper secondary education.
(2) Early School Leavers (ESL): Percentage of the population aged 18-24 with at most lower secondary education and not in education
(3) Lifelong learning (LLL): percentage of the population aged 25-64 participating in education and training
(4) Mathematics, Science and Technology graduates (MST): Number of graduates in MST fields per 1000 population aged 20-29.
(5) Reading Literacy (PISALr): Percentage of pupils with level 1 or bellow on PISA reading literacy scale.

In all the different composite indexes for innovation, certain educational indicators are included. They are mainly referred to as innovation drivers. For example, EIS includes three of the five benchmarks in education as indicators for innovation drivers, and a fourth education-related indicator (population with tertiary education). Therefore, certain level of association can be expected. Because of this, it will be interesting to see if educational indicators also relate to innovation outputs (patents or intellectual property).

In addition of the five benchmarks, other educational indicators will be considered to measure their association with the composite indexes presented above.

2.2 Methodology and limitations

It is important to make clear at this point some limitations that the approach adopted here have in terms of the kind of conclusions that one can provide. The present paper is mainly exploratory, and as such, it aims at making questions rather than finding answers. The main exploratory tool used in the paper is the Pearson correlation. Measures of association indicate "in quantitative terms the extent to which a change in the value of one variable is related to a change in the value of another variable (Argyrous, 1997, p. 313). In any associative measure it is important to look at the direction of the association. That is to say, the association can be negative or positive. Secondly, it is important to look at the strength of the association. In this particular case, associations from 0 to .3 are referred to as weak; associations between .4 and .6 are referred to as medium and associations between .7 and 1 are referred to as strong. Two main factors are important to consider when looking at the correlation data: (1) the number of data points used for calculating the Pearson correlation, and (2) the possible outliers that might be "driving" the association. In the case of the present data set, Turkey is a clear outlier in innovation (SII=0), early school leaving and Youth Educational Attainment. Thus, Turkey will have too much impact on the measure of association and because of this reason it was removed from the analysis. Turkey is in some of the figures, but it has not been used for the calculations.

The five indicators used as educational benchmarks measure specific characteristics of the educational system of a country and they do not represent the educational system as a whole, but only specific aspects of it. In a similar way, the innovation indexes are restricted to the availability of indicators. Further, education and innovation are two complex phenomena that are influenced by many different factors. Therefore, even though the paper presents indicators as evidence for innovation and education, there are several aspects that are not measured here that might be driving the correlations. Further studies accounting for more contextual information are necessary in order to complement the present results.

Also necessary to consider when looking at the results is that the performance in certain educational indicators will only have an impact on innovation few years later, when the people the benchmark refers to are integrated into the labour market and can be part of innovation processes. Because of this reason, the tables will present correlations of the last five years of the educational benchmark indicators with the last year available of EIS. In this way, it is possible to evaluate if time plays a role and see in what way. In certain cases, it was possible to correlate educational indicators back to 1991 and observed the results. In the case of EIS, it was possible correlate also different years of EIS with the educational benchmarks. However, the results tended to be very much depending on the number of countries available (usually fewer than from the year 2000) and therefore, no much conclusions could be drawn from these analysis.

Finally, it is important to mention that the correlations are carried out at the country level. The study, therefore, relates education and innovation at the country level. As an example, it is not possible to know that a firm that provides training (as measured in CVTs) will be more innovative than any other; we can only know that in countries where companies provide more CVTs there is better innovation performance. This is important in order to not make misleading interpretation of the results.

3 The importance of education and training for innovation: country level evidence from indicators

3.1 Relationship between company training indicators and innovation

The present section present the relationship between certain indicators derived from the Continuous Vocational Training Survey (CVTS) with the composite indexes of SII (scores of EIS), GIS and EXIS and some of its sub-domains. Only EXIS includes some indicators derived from CVTS. It seems clear that company-training efforts to maintain and renew their human capital will be an important part of the input of any innovation system. Bassanini et al. (2005, p. 68) have shown that training participation rates are higher in companies that introduced innovative product or processes, but this results are mediated by belonging to a high-intensive training (such as Scandinavian countries) or low-intensive training country.

Table 4 and 5 are to some extent supporting that countries with high provision of training in companies are also high on innovation. Table 4 shows the results of the Pearson correlation between certain indicators of CVTs and the Summary Innovation index (SII), used for calculating EIS. The CVTS indicators used are the following:

- “Training enterprises” (*trent*): Percentage of companies that provide training as a percentage of all companies.
- “CVTs training enterprises (*trcvt*): Percentage of companies that provide Continuous Vocational Training courses as a percentage of all companies.
- “Other training enterprises” (*troth*): Percentage of companies that provide other type of training different than CVT courses as a percentage of all companies.

The three of the CVTS indicators correlate significantly (at 0.01 level) and strongly (above .7) with many of the SII components. The highest association is presented between the overall SII and percentage of companies providing CVTs (see figure 1). It is easy to see that there is a leading group, with the Nordic countries at the top, both in terms of CVTs and innovation, and a group at the bottom with new Member States and southern European Countries.

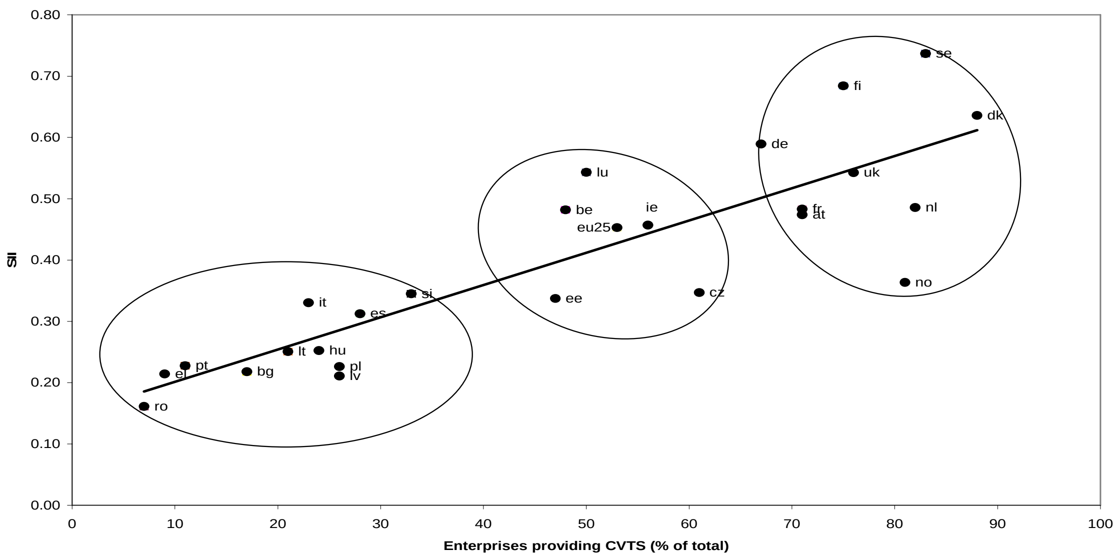

Figure 1: Enterprises providing CVTS as a percentage of total number of enterprises, 1999 by Summary Innovation Index (SII), 2005

Table 4: Bivariate Pearson correlation between CVTS indicators and SII (Summary innovation Index)

		trent	trcvt	trotr
SII	Pearson Correlation	.847(**)	.861(**)	.779(**)
	Sig. (2-tailed)	0	0	0
	N	25	25	25
GrowthSII	Pearson Correlation	-0.011	-0.108	0.068
	Sig. (2-tailed)	0.96	0.608	0.747
	N	25	25	25
inidrv	Pearson Correlation	.829(**)	.817(**)	.783(**)
	Sig. (2-tailed)	0	0	0
	N	25	25	25
iniKC	Pearson Correlation	.730(**)	.782(**)	.616(**)
	Sig. (2-tailed)	0	0	0.001
	N	25	25	25
inientrep	Pearson Correlation	.725(**)	.663(**)	.732(**)
	Sig. (2-tailed)	0	0	0
	N	25	25	25
inoapp	Pearson Correlation	.595(**)	.639(**)	.572(**)
	Sig. (2-tailed)	0.002	0.001	0.003
	N	25	25	25
inoip	Pearson Correlation	.691(**)	.736(**)	.590(**)
	Sig. (2-tailed)	0	0	0.002
	N	25	25	25
inoav	Pearson Correlation	.712(**)	.760(**)	.634(**)
	Sig. (2-tailed)	0	0	0.001
	N	25	25	25
inno	Pearson Correlation	.611(**)	.607(**)	.584(**)
	Sig. (2-tailed)	0.001	0.001	0.002
	N	25	25	25

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

It is interesting to note that the countries with low levels of training supply are generally closer to the line than those at with high rate of training company efforts. This means that the linear relationship seems to be more precise in the case of low-intensive training countries, as Bassanini et al. (2005) had shown. In other words, in countries where there is a high level of training supply, innovation seems to depend less on training efforts than in countries where there is a low degree of training supply.

In a similar way, CVTS indicators present strong and significant (at 0.01 level) associations with the overall EXIS composite and four of the six thematic areas. EXIS had two indicators in its innovation skills component that where taken from CVTS. They are not the ones used here as CVTS indicators, but all of them are highly related, and thus, the high level of association. The highest correlation in the table is between percentage of training enterprises and the EXIS thematic area of innovation skills. It is surprising to some extent that the relationship between innovation investment and training is not higher. This comes to say that countries where companies are investing a lot in training do not invest as much in innovation (as measured here).

Table 5: Bivariate Pearson correlation CVTS indicators, GIS and EXIS

		trent	trcvt	trotr
GSII	Pearson Correlation	.852(**)	.885(**)	.758(**)
	Sig. (2-tailed)	.000	.000	.000
	N	25	25	25
EXIS	Pearson Correlation	.850(**)	.801(**)	.802(**)
	Sig. (2-tailed)	.000	.000	.000
	N	19	19	19
EXdiverse	Pearson Correlation	.443(*)	.470(*)	.387
	Sig. (2-tailed)	.044	.032	.083
	N	21	21	21
EXinnfri	Pearson Correlation	.807(**)	.752(**)	.765(**)
	Sig. (2-tailed)	.000	.000	.000
	N	20	20	20
EXkflow	Pearson Correlation	-.099	-.260	.031
	Sig. (2-tailed)	.669	.255	.895
	N	21	21	21
EXinnoinv	Pearson Correlation	.327	.361	.194
	Sig. (2-tailed)	.137	.099	.386
	N	22	22	22
EXinnskills	Pearson Correlation	.891(**)	.855(**)	.857(**)
	Sig. (2-tailed)	.000	.000	.000
	N	16	16	16
EXinngov	Pearson Correlation	.829(**)	.811(**)	.757(**)
	Sig. (2-tailed)	.000	.000	.000
	N	22	22	22

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

3.2 Educational benchmarks and its relationship with composite indicators for innovation

Benchmark #1, Educational attainment of youth

The indicator "Youth educational attainment", refers to the percentage of the population aged 20-24 having completed at least upper secondary education. It is an indicator considered within the SII as one of the five indicators for innovation drivers. In this sense, it could be expected that certain degree of association with this index will be found. However, the correlations with all the components of IIS are weak or near zero (see table 6).

The association of SII and adult educational attainment (EAA) presents similar results (see table 19 in annex). The association between SII and adult educational attainment are slightly higher, but remain weak, except in the case of innovation drivers, where there are moderate associations (significant at 0.05 level).

The correlations are driven by the outliers of Portugal, Malta and Iceland as can be seen in figure 2 (see also table 20 in the annex). Figure 2 shows the relationship between Youth educational attainment in 2002 and the scores in SII. This year presented the highest correlation (.12) between the two variables. The black line represents the relationship between the two variables taking into account all the countries, and the red line represents the relationship taking away the three outliers of PT, MT and IS. Turkey (TR), although in the graph has not been taking into account for the calculations since it represents too much of an outlier. The blue line shows the linear regression of all the Old Member States (15 countries), while the pink line shows the linear relationship within the New member States (12 countries). It is clear that Young Educational Attainment (EAY) and innovation present a stronger correlation in the case of old member States than in New Member States, mainly driven by the scores of Portugal, Spain and Italy (see table 21 in the annex).

In the case of adult educational attainment Portugal and Malta have a stronger impact too, taking away these two countries the correlation becomes weaker in all the aspects of SII (see figure 3).

Table 6: Bivariate Pearson correlation between educational attainment of youth (EAY), 2000 - 2005 and SII, 2006

		eay00	eay01	eay02	eay03	eay04	eay05lst
SII	Pearson Correlation	.077	.105	.116	.076	.062	.062
	Sig. (2-tailed)	.687	.581	.542	.689	.745	.753
	N	30	30	30	30	30	28
GrowthSII	Pearson Correlation	-.080	-.152	-.128	-.102	-.077	-.091
	Sig. (2-tailed)	.673	.422	.502	.593	.687	.647
	N	30	30	30	30	30	28
inidrv	Pearson Correlation	.267	.334	.336	.301	.286	.299
	Sig. (2-tailed)	.153	.071	.070	.106	.125	.122
	N	30	30	30	30	30	28
iniKC	Pearson Correlation	.077	.092	.110	.078	.067	.083
	Sig. (2-tailed)	.686	.628	.562	.683	.726	.675
	N	30	30	30	30	30	28
inientrep	Pearson Correlation	-.036	-.042	-.010	-.031	-.037	-.022
	Sig. (2-tailed)	.854	.831	.959	.873	.848	.914
	N	29	29	29	29	29	27
inoapp	Pearson Correlation	.005	.006	-.010	-.011	-.022	-.082
	Sig. (2-tailed)	.981	.975	.958	.953	.909	.678
	N	30	30	30	30	30	28
inoip	Pearson Correlation	.011	.037	.041	-.011	-.023	-.033
	Sig. (2-tailed)	.955	.848	.830	.952	.906	.867
	N	30	30	30	30	30	28
inoav	Pearson Correlation	.010	.029	.025	-.013	-.025	-.061
	Sig. (2-tailed)	.959	.880	.895	.946	.894	.756
	N	30	30	30	30	30	28

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

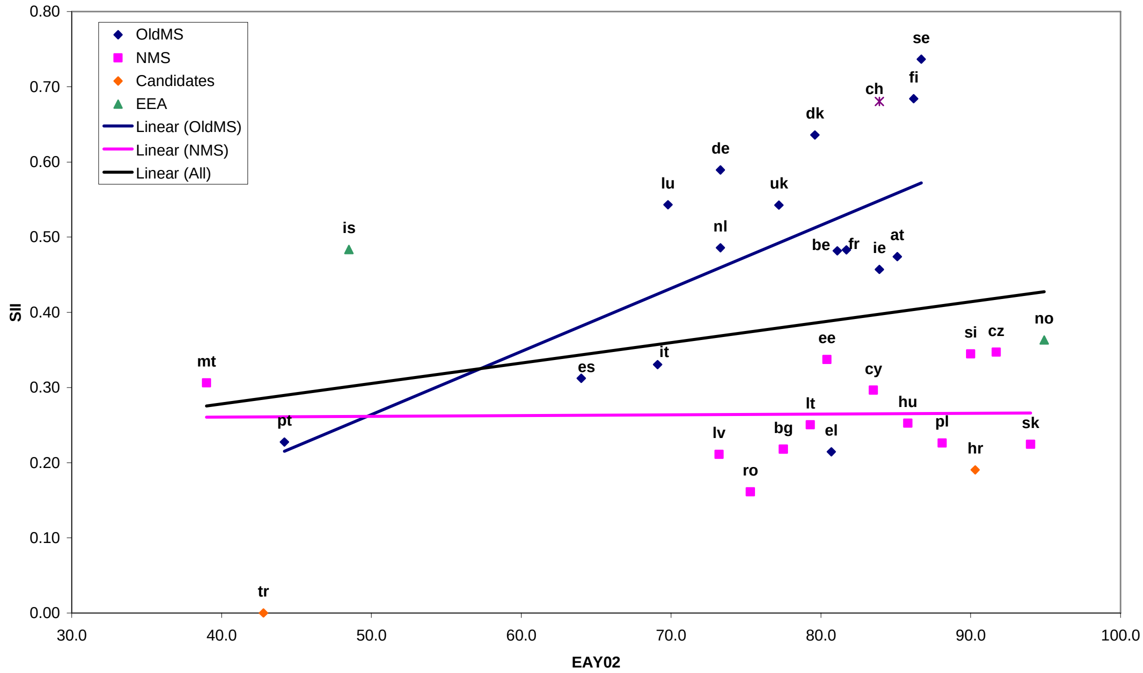

Figure 2: Educational attainment of youth, 2002 by Summary Innovation Index, 2005

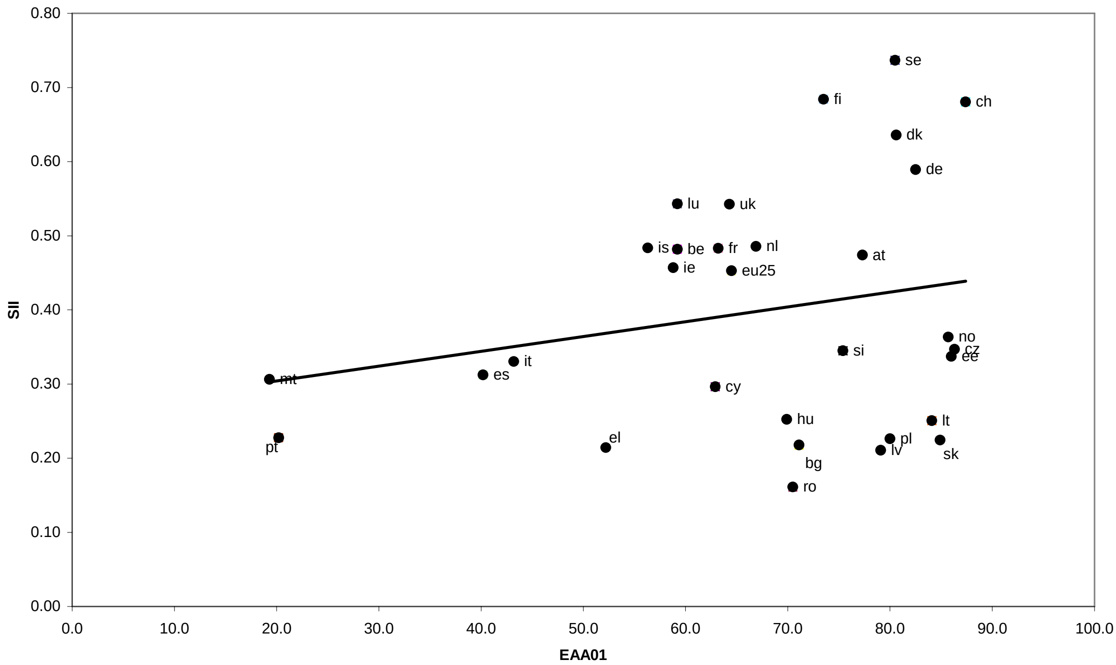

Figure 3: Educational attainment of adults, 2001 by Summary Innovation Index, 2005

In the case of EXIS and GIS, educational attainment of youth presents a similar pattern (see table 7). It does not present strong correlation with GIS. In relation to EXIS It presents moderate significant correlations at 0.05 level with "innovation friendly markets". This seems to show that innovative markets are related with having more young people having completed secondary education. In other words, it seems that the more educated the youth is, the more innovative friendly a country will be. It is interesting to note that if one compares correlation results of youth and adult educational attainment, it is only youth education which presents significant correlations with innovation friendly markets. The correlations in the case of the adult population are slightly lower. This might support the idea that younger cohorts (and better educated) are more "innovation friendly". EXIS only has data fro few of the old Member States, and this could explain why the correlations are usually higher than in the case of SII.

Youth educational attainment also correlates moderately with the innovation skill component of EXIS, since this relates to the level of education of the population as whole and their participation in training. The correlations present a decrease pattern the closer we get to the year 2005, this might be due to the fact that the reference years for EXIS are usually 1999 or 2000.

In terms of outliers, Portugal is at the bottom of both the EXIS scores and of the educational indicator. This drives slightly the correlations (see table 22 annex), that become not significant at any point (except with innovation skills in the year 2002) when removing Portugal from the analysis.

Table 7: Bivariate Pearson correlation between Young educational attainment (EAY), GIS and EXIS

		eay00	eay01	eay02	eay03	eay04	eay05lst
GSII	Pearson Correlation	.180	.178	.167	.148	.147	.158
	Sig. (2-tailed)	.342	.348	.370	.426	.429	.404
	N	30	30	31	31	31	30
EXIS	Pearson Correlation	.351	.285	.300	.269	.258	.276
	Sig. (2-tailed)	.141	.236	.212	.266	.286	.267
	N	19	19	19	19	19	18
EXdiverse	Pearson Correlation	.074	-.020	-.027	-.045	-.038	-.003
	Sig. (2-tailed)	.738	.927	.902	.838	.863	.988
	N	23	23	23	23	23	22
EXinnfri	Pearson Correlation	.440(*)	.463(*)	.467(*)	.418	.416	.419
	Sig. (2-tailed)	.046	.035	.033	.059	.060	.075
	N	21	21	21	21	21	19
EXkflow	Pearson Correlation	.376	.358	.385	.421	.417	.394
	Sig. (2-tailed)	.084	.102	.077	.051	.053	.077
	N	22	22	22	22	22	21
EXinnoinv	Pearson Correlation	.046	.042	.050	.048	.028	.015
	Sig. (2-tailed)	.832	.847	.818	.823	.897	.945
	N	24	24	24	24	24	23
EXinnskills	Pearson Correlation	.604(*)	.619(*)	.622(*)	.581(*)	.551(*)	.543(*)
	Sig. (2-tailed)	.013	.011	.010	.018	.027	.036
	N	16	16	16	16	16	15
EXinngov	Pearson Correlation	-.026	.016	.019	-.038	-.033	-.028
	Sig. (2-tailed)	.902	.940	.931	.858	.877	.902
	N	24	24	24	24	24	22

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Benchmark #2, Early school leavers

In general, it is well known the fact that higher levels of educational attainment are associated with higher levels of participation in lifelong learning and higher levels of employment, as well as lower levels of unemployment. It is crucial, therefore, that education and training are seen from an early age as necessary steps towards the fulfilment of a career. In this way, Member States agreed to lower the level of early school leavers, to get to 10% in 2010.

Table 8 shows the correlation between the percentage of school leavers and the different components of SII. The correlations are negative, moderate (around 0.5) and significant at 0.05 for the year 2000 with innovation driver (*inidrv*), knowledge creation (*iniKC*), intellectual property (*inoip*) and with the average of the output composite indicators (*innoav*). For the rest of the years there are no significant associations, except in the case of innovation drivers (*inidrv*). Portugal and Malta are outliers in the relationship between early school leavers and SII. Taking away Portugal and Malta for the analysis (see table 23 in the annex) the association for the year 2000 becomes slightly stronger (more negative) in the year 2000 but weaker for the rest of the years. This happens with the rest of the components that where related. Such "behaviour" can be explained, as in the case of Young educational attainment, because there are more countries with data in later years (closer to 2005). Carrying the analysis only with those countries that have data for all the 5 years, this depreciation in the association disappears. In this case, however, associations describe above become significant (at 0.05 level) in all years except in 2005 (see table 24 in the annex). This suggests that there are certain number of countries (CZ, IE, LA, PL, SL, SK) that do not seem to present this association between ESL and innovation. As it was the case with young educational attainment, most of these countries are New Member States. Figure 3 shows the relationship between Early School leaving for the year 2002 and SII. The pink line shows the relationship in the New Member States, while the blue line represents the linear relationship of the Old Member States. The pattern presented in Youth educational attainment is repeated here (see also table 25 in the annex).

Table 8: Bivariate Pearson correlation between Early school leavers (ESL) and SII

		esl00	esl01	esl02	esl03	esl04	esl05lst
SII	Pearson Correlation	-.503(*)	-.387	-.333	-.322	-.325	-.251
	Sig. (2-tailed)	.012	.051	.072	.083	.079	.197
	N	24	26	30	30	30	28
GrowthSII	Pearson Correlation	.344	.242	.133	.085	.061	.042
	Sig. (2-tailed)	.100	.234	.485	.655	.750	.830
	N	24	26	30	30	30	28
inidrv	Pearson Correlation	-.640(**)	-.575(**)	-.459(*)	-.475(**)	-.473(**)	-.446(*)
	Sig. (2-tailed)	.001	.002	.011	.008	.008	.017
	N	24	26	30	30	30	28
iniKC	Pearson Correlation	-.477(*)	-.379	-.310	-.307	-.310	-.247
	Sig. (2-tailed)	.018	.056	.095	.099	.095	.205
	N	24	26	30	30	30	28
inientrep	Pearson Correlation	-.374	-.249	-.216	-.231	-.224	-.174
	Sig. (2-tailed)	.079	.229	.260	.227	.244	.385
	N	23	25	29	29	29	27
inoapp	Pearson Correlation	-.016	.019	-.092	-.071	-.096	.008
	Sig. (2-tailed)	.941	.925	.628	.709	.614	.968
	N	24	26	30	30	30	28
inoip	Pearson Correlation	-.471(*)	-.349	-.266	-.230	-.237	-.153
	Sig. (2-tailed)	.020	.081	.155	.221	.208	.436
	N	24	26	30	30	30	28
inoav	Pearson Correlation	-.341	-.243	-.230	-.195	-.210	-.103
	Sig. (2-tailed)	.103	.232	.222	.302	.265	.602
	N	24	26	30	30	30	28

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

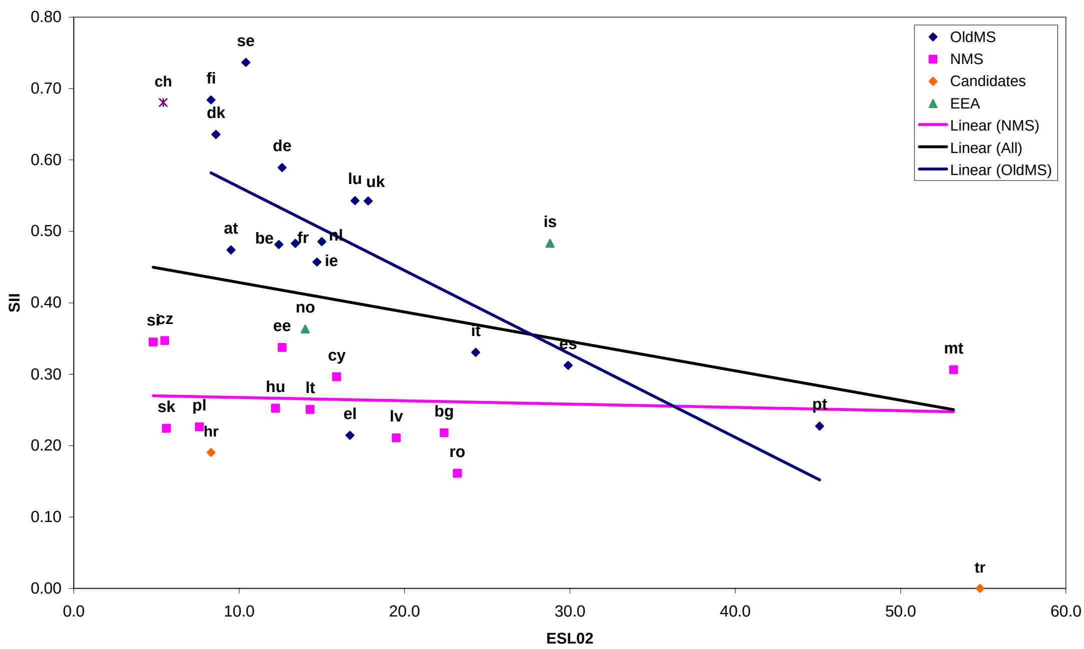

Figure 4: Early School Leaving, 2002 by SII, 2005

In general terms, and considering mainly (24 countries) early school living is associated to some extent with lower levels of innovation at a general level. Or in other words, countries with higher levels of early school leavers tend to have lower levels of innovation. The decreasing association observed when one consider time series, can be attributed to the major number of countries that later years have, that increase the "noise' of the association, making it weaker.

One could argue that these associations between ESL and SII can be explained because of the correlation that "Early school leavers" presents with "youth educational attainment" (around -.9). If this would be the case, one could expect higher degree of association in the later than in the former, which is not the case. Therefore, "early school leavers" might be a better indicator of innovative drivers of a country. Maintaining low the number of students that leave school early is more related to innovation capacity of a country than the quality of the young human capital (measured as educational attainment of youth).

Early school leavers, as is the case with EIS, are negatively related to GIS and EXIS (see table 9). The decreasing pattern is also present the closer to 2005 one gets, except in the case of innovation friendly markets. It is again, with innovation friendly markets and with innovation skill components of EXIS that the correlations are significant (at 0.05 level) and stronger (around -.7 for innovation skills and -.55 for innovation friendly). It seems that less drop outs in schools are associated with having more innovation friendly markets.

Table 9: Bivariate Pearson correlation between Early School Leavers (ESL), GIS and EXIS

		esl00	esl01	esl02	esl03	esl04	esl05lst
GSII	Pearson Correlation	-.508(*)	-.392(*)	-.320	-.340	-.350	-.307
	Sig. (2-tailed)	.011	.047	.079	.061	.054	.099
	N	24	26	31	31	31	30
EXIS	Pearson Correlation	-.665(**)	-.537(*)	-.450	-.483(*)	-.483(*)	-.448
	Sig. (2-tailed)	.004	.021	.053	.036	.036	.062
	N	17	18	19	19	19	18
EXISserv	Pearson Correlation	-.565(*)	-.401	-.320	-.369	-.348	-.328
	Sig. (2-tailed)	.015	.089	.169	.109	.133	.170
	N	18	19	20	20	20	19
EXdiverse	Pearson Correlation	-.367	-.200	-.090	-.064	-.093	-.033
	Sig. (2-tailed)	.122	.398	.681	.772	.674	.885
	N	19	20	23	23	23	22
EXinnfri	Pearson Correlation	-.595(**)	-.556(*)	-.489(*)	-.542(*)	-.548(*)	-.562(*)
	Sig. (2-tailed)	.007	.013	.024	.011	.010	.012
	N	19	19	21	21	21	19
EXkflow	Pearson Correlation	-.336	-.401	-.344	-.367	-.369	-.409
	Sig. (2-tailed)	.172	.089	.117	.093	.091	.066
	N	18	19	22	22	22	21
EXinnoinv	Pearson Correlation	-.139	-.006	-.028	-.043	-.062	-.061
	Sig. (2-tailed)	.559	.979	.897	.843	.775	.784
	N	20	22	24	24	24	23
EXinnskills	Pearson Correlation	-.707(**)	-.705(**)	-.665(**)	-.711(**)	-.712(**)	-.711(**)
	Sig. (2-tailed)	.003	.003	.005	.002	.002	.003
	N	15	15	16	16	16	15
EXinngov	Pearson Correlation	-.444	-.322	-.147	-.137	-.160	-.133
	Sig. (2-tailed)	.065	.166	.492	.523	.456	.555
	N	18	20	24	24	24	22

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Benchmark #3: Lifelong learning participation

Lifelong learning participation is an indicator derived from the LFS. It refers to the percentage of the working age population (aged 16-64) that reported attending some type of training in the four weeks previous to the survey. It is one of the five indicators for innovation drivers of the SII. In the present knowledge economy, it is necessary a continuous updating of skills and knowledge. Table 10 presents the correlation between this indicator in different years and the different aspects of the SII.

Lifelong learning participation is the benchmark indicator in education that correlated the highest with the SII components. The correlation with the overall rate is above 0.7 and significant at 0.01 level for all the years. The association is stronger the closer one gets to 2005. This is due to how the SII was created, probably using as the reference year 2005 (or years closer to this). As could be expected also, lifelong learning presents high correlations with the innovation driver component of SII. The associations with the rest of the components are around .6, getting higher than .7 by the year 2003 for input components (knowledge creation and entrepreneurship).

Table 10: Bivariate Pearson correlation between Lifelong learning and SII

		lll00	lll01	lll02	lll03	lll04	lll05lst
SII	Pearson Correlation	.749(**)	.731(**)	.735(**)	.775(**)	.803(**)	.821(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	24	27	32	32	32	30
GrowthSII	Pearson Correlation	-.318	-.350	-.288	-.299	-.279	-.263
	Sig. (2-tailed)	.130	.073	.110	.096	.122	.161
	N	24	27	32	32	32	30
inidrv	Pearson Correlation	.783(**)	.768(**)	.757(**)	.832(**)	.837(**)	.826(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	24	27	32	32	32	30
iniKC	Pearson Correlation	.651(**)	.639(**)	.612(**)	.728(**)	.720(**)	.764(**)
	Sig. (2-tailed)	.001	.000	.000	.000	.000	.000
	N	23	26	30	30	30	28
inientrep	Pearson Correlation	.609(**)	.579(**)	.595(**)	.700(**)	.704(**)	.695(**)
	Sig. (2-tailed)	.003	.002	.001	.000	.000	.000
	N	22	25	29	29	29	27
inoapp	Pearson Correlation	.378	.378	.348	.300	.338	.394(*)
	Sig. (2-tailed)	.076	.057	.059	.107	.068	.038
	N	23	26	30	30	30	28
inoip	Pearson Correlation	.663(**)	.664(**)	.664(**)	.611(**)	.663(**)	.692(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	24	27	32	32	32	30
inoav	Pearson Correlation	.628(**)	.631(**)	.635(**)	.585(**)	.637(**)	.676(**)
	Sig. (2-tailed)	.001	.000	.000	.000	.000	.000
	N	24	27	32	32	32	30

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

In relation to output indicators for innovation, Lifelong learning correlates around 0.65 with the intellectual property component, but presents a weaker association with applications (around .3). In fact, only the year 2005 present significant correlation at 0.05 level with application, but relatively weak, while the rest of the years the correlations are not significant. When looking at the average of both innovation outputs, the correlations become of around 0.65 again. To a certain extent, this suggests that lifelong learning is more associated with the results achieved in innovation in terms of know-how, but is little related to the performance of countries in terms of business activities and their value added for innovation (application indicators). In other words, training is related with the production of the innovations and not with the profit associated with new products or having higher levels of employment in high-tech. This is in line with the results in the correlations of CVTS, where training enterprises correlate around .1 higher with intellectual property than with applications. We cannot assume causality in these relationships, and thus, it is not possible to know if higher levels of participation are due to the fact that the country having more know-how, needs to keep it up, or if because there is more participation in lifelong learning, the country perform better in know-how.

These results are probably driven by the good performance in this indicator of the Nordic countries and UK and Switzerland which are also relatively high in SII and the low performance both in lifelong learning and innovation of countries such as Bulgaria, Romania or Croatia. Interesting enough, the relationship of these two indicators does seem to hold both for New and Old Member States. Due to the low number of New Member States the correlations fluctuate a lot. In years where there is information for the 12 New member States, correlations are lower than for old Member States.

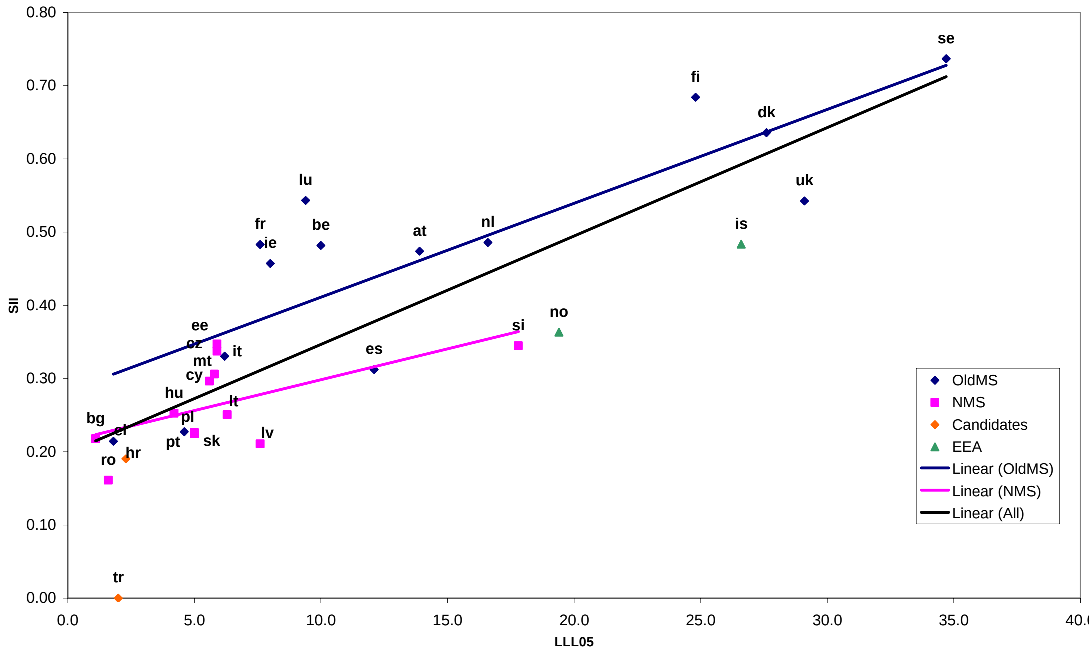

Figure 5: Lifelong learning participation, 2005 by SII, 2005

Although they are weak relationships and not significant, it is interesting to note that lifelong learning, as in the case of youth educational attainment, correlates negatively with growth in SII. This is probably because the countries with lower level of growth are the ones that have higher levels of innovation performance, both in terms of inputs and outputs.

In the case of EXIS, lifelong learning presents the strongest correlations among the educational benchmarks with this experimental composite indicator and with the GIS (see table 11). Lifelong learning participation correlates above .7 and significantly at 0.01 with the general EXIS index in all years and with the innovation skills component. Especially interesting is the fact that lifelong learning participation relates to innovation governance (in the year 20005, .85). The reference year for this specific composite index of innovation governance is 2003 in 3 indicators and 1998 and 2000. This suggests that the association between policies that promote innovation and higher participation in lifelong learning can be found 3 years after the policy has been assessed. In other words, the results suggest that innovation policies might also have an impact on lifelong learning participation. As in previous cases, it is important to note that a correlation is a measure of association, and that no causality can be assumed. We can only see that countries that had in the year 2000 to 2003 better conditions for innovation have higher levels of lifelong learning the further the years go. Unfortunately, it is not really possible to rule out other intervening factors, such as other type of labour market policies that might be concomitant to innovation policies.

Lifelong learning presents moderate relationships with innovation friendly markets. This suggests, again, that countries with higher levels of participation in education are more innovative friendly than those with lower levels of participations. Underlying this connection with innovation friendliness could be the fact that higher levels of participation in lifelong learning are also associated with higher levels of educational attainment.

Table 11: Bivariate Pearson correlation between Lifelong learning participation, GIS and EXIS

	lll00	lll01	lll02	lll03	lll04	lll05lst

GSII	Pearson Correlation	.755(**)	.746(**)	.715(**)	.751(**)	.751(**)	.817(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	23	26	31	31	31	30
EXIS	Pearson Correlation	.733(**)	.755(**)	.765(**)	.725(**)	.726(**)	.739(**)
	Sig. (2-tailed)	.001	.000	.000	.000	.000	.000
	N	17	18	19	19	19	18
EXISserv	Pearson Correlation	.769(**)	.737(**)	.724(**)	.778(**)	.758(**)	.767(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	18	19	20	20	20	19
EXdiverse	Pearson Correlation	.077	.075	.098	.128	.185	.283
	Sig. (2-tailed)	.754	.752	.656	.562	.399	.202
	N	19	20	23	23	23	22
EXinnfri	Pearson Correlation	.543(*)	.504(*)	.495(*)	.685(**)	.614(**)	.623(**)
	Sig. (2-tailed)	.016	.028	.022	.001	.003	.004
	N	19	19	21	21	21	19
EXkflow	Pearson Correlation	-.102	-.105	-.064	.009	.012	-.055
	Sig. (2-tailed)	.688	.669	.778	.969	.959	.814
	N	18	19	22	22	22	21
EXinnoinv	Pearson Correlation	.313	.373	.337	.304	.295	.299
	Sig. (2-tailed)	.179	.087	.108	.149	.162	.166
	N	20	22	24	24	24	23
EXinnskills	Pearson Correlation	.729(**)	.730(**)	.745(**)	.779(**)	.755(**)	.728(**)
	Sig. (2-tailed)	.002	.002	.001	.000	.001	.002
	N	15	15	16	16	16	15
EXinngov	Pearson Correlation	.774(**)	.752(**)	.710(**)	.820(**)	.816(**)	.847(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	17	20	24	24	24	22

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Benchmark #4: Number of Tertiary graduates in MST

The number of tertiary graduates in mathematics, science and technology (MST) is usually referred as a necessity to maintain the supply of qualified personnel to provide innovation. The EIS uses the indicator “number of MST graduates per 1000 population aged 20-29” within the knowledge drivers. The correlations between MST graduates and SII components are presented in table 12. MST graduates correlates the most, as could be expected, with innovation drivers (around .65, except in 2004 that it is around .58). With this component it presents significant correlations at 0.01 level. It correlates significantly (at 0.01 level) and moderately (around 0.5) with the overall SII. It seems that countries with higher levels of MSTs have an overall better performance in SII. There are also other significant associations at 0.05 level with other innovation aspects in some years. In general, weak correlations exists with knowledge creation indicators, entrepreneurship and intellectual property outputs. No significant associations exist with applications. This is the only benchmark that presents significant correlations with Growth in SII (at 0.05 level) in the years 2000, 2002 and 2003. These correlations, in any case, are relatively weak (around .4).

New and Old Member States present a different pattern in association of MST. New Member States have high number of graduates in MST while they have low levels of innovation. The opposite is the case for Old Member States (see figure 5 and table 26 in the annex). MST graduates might have an influence only if other institutional and contextual characteristics appear in a National Innovation System.

Table 12: Bivariate Pearson correlation between Tertiary graduates in MST and SII

		mst00	mst01	mst02	mst03	mst04lst
SII	Pearson Correlation	.453(*)	.507(**)	.522(**)	.509(**)	.500(**)
	Sig. (2-tailed)	.012	.005	.004	.003	.005
	N	30	29	29	32	30
GrowthSII	Pearson Correlation	-.386(*)	-.329	-.387(*)	-.361(*)	-.280
	Sig. (2-tailed)	.035	.081	.038	.042	.134
	N	30	29	29	32	30
inidrv	Pearson Correlation	.645(**)	.671(**)	.666(**)	.641(**)	.582(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.001
	N	28	27	27	30	28
iniKC	Pearson Correlation	.404(*)	.419(*)	.431(*)	.382(*)	.315
	Sig. (2-tailed)	.027	.024	.020	.037	.103
	N	30	29	29	30	28
inientrep	Pearson Correlation	.322	.398(*)	.410(*)	.345	.384
	Sig. (2-tailed)	.101	.044	.038	.078	.058
	N	27	26	26	27	25
inoapp	Pearson Correlation	.229	.261	.247	.252	.318
	Sig. (2-tailed)	.242	.188	.215	.195	.114
	N	28	27	27	28	26
inoip	Pearson Correlation	.268	.368(*)	.412(*)	.386(*)	.374(*)
	Sig. (2-tailed)	.153	.050	.026	.029	.042
	N	30	29	29	32	30
inoav	Pearson Correlation	.292	.379(*)	.406(*)	.426(*)	.448(*)
	Sig. (2-tailed)	.118	.043	.029	.015	.013
	N	30	29	29	32	30

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

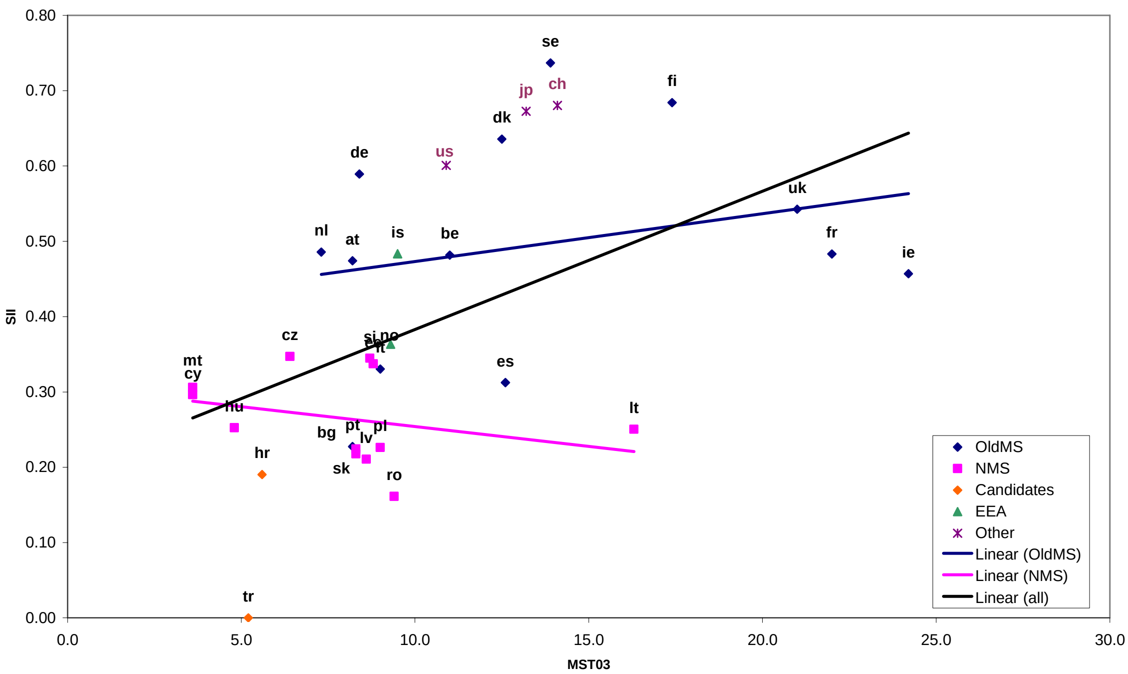

Figure 6: Number of graduates in Mathematics, Science and Technology (MST) per 1000, 2003 by SII, 2005

The MST graduates indicator presented moderate correlations with the EIS, however, in the case of EXIS, it only correlates moderately and significantly with innovation governance (see table 13). It seems that policies for innovation are associated with countries that have higher levels of MST, but the countries are not necessarily more innovative friendly.

The number of MST graduates presents similar associations with GIS than with SII. It also presents moderate associations (around .5) and significant (at 0.05 level) for the years 2001 and 2002 with EXIS. Interesting enough, the component of EXIS that is driving the correlation, is most likely Innovation governance that present moderate, significant correlations with all the years of MST. This seems to show that countries with more MST graduates tend to have more friendly innovation policies. This might be related to the general level of innovation of the country.

Table 13: Bivariate Pearson correlation between number of MST graduates, GIS and EXIS

		mst00	mst01	mst02	mst03	mst04lst
GSII	Pearson Correlation	.503(**)	.521(**)	.488(**)	.489(**)	.412(*)
	Sig. (2-tailed)	.005	.004	.008	.005	.026
	N	30	29	28	31	29
EXIS	Pearson Correlation	.373	.524(*)	.559(*)	.398	.236
	Sig. (2-tailed)	.127	.031	.025	.114	.380
	N	18	17	16	17	16
EXISserv	Pearson Correlation	.482(*)	.491(*)	.554(*)	.386	.304
	Sig. (2-tailed)	.037	.033	.017	.102	.219
	N	19	19	18	19	18
EXdiverse	Pearson Correlation	.118	.256	.272	.243	.064
	Sig. (2-tailed)	.600	.262	.246	.289	.788
	N	22	21	20	21	20
EXinnfri	Pearson Correlation	.375	.432	.379	.392	.379
	Sig. (2-tailed)	.114	.074	.120	.096	.121
	N	19	18	18	19	18
EXkflow	Pearson Correlation	-.072	-.095	.034	-.117	.012
	Sig. (2-tailed)	.757	.690	.890	.624	.962
	N	21	20	19	20	19
EXinnoinv	Pearson Correlation	.306	.360	.365	.278	.046
	Sig. (2-tailed)	.155	.100	.104	.210	.842
	N	23	22	21	22	21
EXinnskills	Pearson Correlation	.261	.371	.345	.303	.282
	Sig. (2-tailed)	.348	.192	.248	.292	.351
	N	15	14	13	14	13
EXinngov	Pearson Correlation	.527(**)	.523(**)	.503(*)	.508(**)	.486(*)
	Sig. (2-tailed)	.008	.009	.012	.009	.016
	N	24	24	24	25	24

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Benchmark #5: Reading literacy results

Basic skills are a necessity to be able to operate in the new economy. Reading skills are a must for participating in the knowledge economy. This last benchmark is derived from the Program for International Student Assessment (PISA). PISA measures among other things, student achievement in reading, science and maths for 15 years old. There are data for years 2000 and 2003. The benchmark in education refers only to reading literacy, and it set the goal of having a decrease of 20% in the number of students with low level (level 1 or bellow) in reading literacy in comparison with the year 2000.

The indicator presented here refers to the percentage of pupils with level 1 or bellow on PISA reading literacy scale. Table 14 presents also the correlations between EIS components and the overall results of PISA scales in math and science. In the case of percentage of students with low level of literacy skills, the correlations are negative in all cases except with Growth of SII; and they are significant with several of the components of EIS. As could be expected it correlates stronger and negatively with the innovation driver component of EIS. These correlations are partly driven by the outliers Finland and Romania and Bulgaria. Finland is the country with fewer students with low literacy skills, and is among the countries with higher level of innovation, while the opposite is the case for Romania and Bulgaria. Running the correlations without these three countries the figures do not substantially change, although some associations become weaker.

Low literacy levels in the student population correlates negatively and significantly at 0.05 level in both available years with the overall SII, the innovation drivers and knowledge creation components. The highest (negative) correlation is with innovation driver component (-.79) in the year 2003.

Table 14: Bivariate Pearson correlation between Low literacy levels in PISA, other PISA results and SII

		pisar1L00	pisar1L03lst	pisam00	pisam03	pisas00	pisas03
SII	Pearson Correlation	-.503(*)	-.641(**)	.709(**)	.763(**)	.525(*)	.611(**)
	Sig. (2-tailed)	.014	.001	.000	.000	.010	.001
	N	23	25	23	25	23	25
GrowthSII	Pearson Correlation	.482(*)	.253	-.357	-.155	-.382	-.173
	Sig. (2-tailed)	.020	.223	.094	.459	.072	.407
	N	23	25	23	25	23	25
inidrv	Pearson Correlation	-.653(**)	-.785(**)	.816(**)	.745(**)	.599(**)	.562(**)
	Sig. (2-tailed)	.001	.000	.000	.000	.004	.005
	N	21	23	21	23	21	23
iniKC	Pearson Correlation	-.579(**)	-.486(*)	.685(**)	.638(**)	.607(**)	.534(**)
	Sig. (2-tailed)	.004	.016	.000	.001	.002	.007
	N	23	24	23	24	23	24
inientrep	Pearson Correlation	-.221	-.457(*)	.478(*)	.423(*)	.203	.205
	Sig. (2-tailed)	.335	.033	.028	.050	.377	.360
	N	21	22	21	22	21	22
inoapp	Pearson Correlation	-.466(*)	-.264	.593(**)	.719(**)	.547(*)	.534(*)
	Sig. (2-tailed)	.033	.234	.005	.000	.010	.011
	N	21	22	21	22	21	22
inoip	Pearson Correlation	-.231	-.431(*)	.471(*)	.618(**)	.244	.388
	Sig. (2-tailed)	.289	.031	.023	.001	.262	.055
	N	23	25	23	25	23	25
inoav	Pearson Correlation	-.338	-.507(**)	.543(**)	.748(**)	.365	.532(**)
	Sig. (2-tailed)	.115	.010	.007	.000	.087	.006
	N	23	25	23	25	23	25

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Looking into PISA results for literacy, mathematics and science, the three scales correlate positively and strongly (above 0.7) in many cases with several components of the SII. All of them, and in the two years available present significant correlations at 0.05 level with the overall scale SII. This means that in general terms, higher levels of student achievement is associated with higher levels of innovation. The first PISA results refer to the year 2000, it is not clear, therefore, that the young generations tested in PISA are fully participating in the innovation efforts of the country. However, this relationships seems to show to some degree that countries with high PISA results will probably maintain the innovative capacity in the coming years.

Interesting enough, mathematic results present the highest correlations with the innovation components. All of these correlations, except in the case of growth, are significant (at 0.05 level). Science skills present lower levels of association than mathematics and literacy with the overall scale of SII. Mathematic results are comparatively more associated with innovation outputs than the other PISA scales, especially in the year 2003. In general, one could say that PISA results are also a good indicator of the innovation drivers of a country.

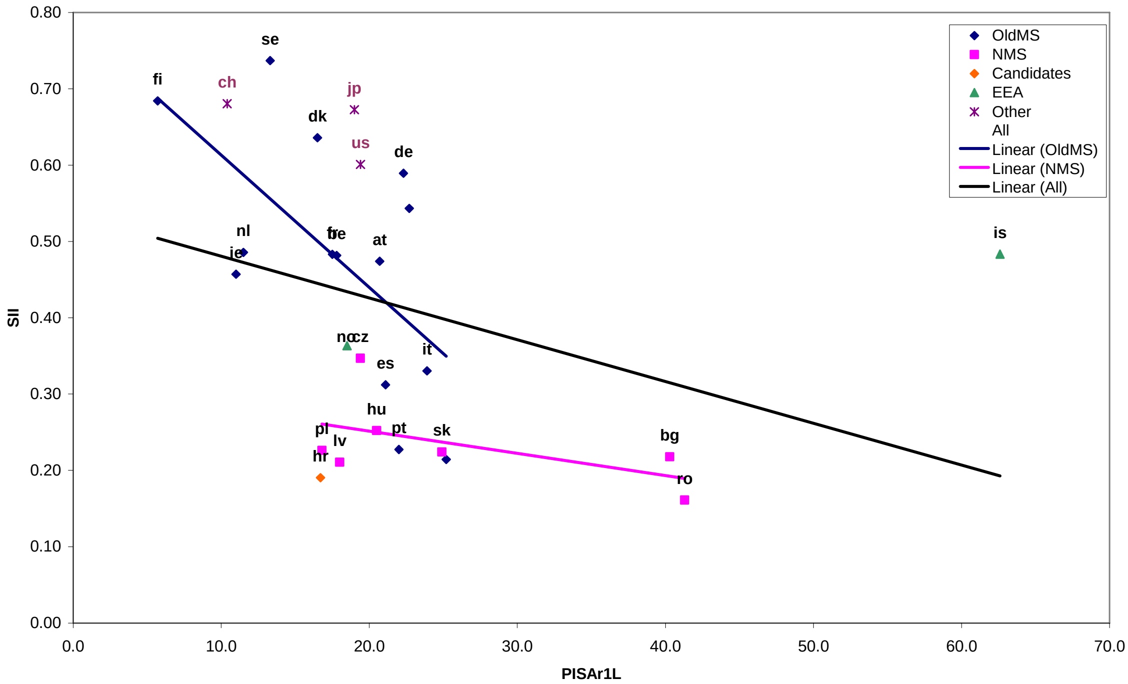

Figure 7: Percentage of pupils with PISA low literacy levels, 2003 by SII, 2005

The PISA indicator of percentage of students with level 1 or lower in the reading scale is also negatively correlated in the case of GIS and EXIS (see table 15). In the case of GIS both years of PISA correlate significantly at 0.01, while in the case of EXIS it is only the year 2003 that correlates. The EXIS components that relate to this PISA indicator are innovation friendly markets (-.8 for the year 2003, significant at 0.01 level), suggesting that higher level of skills in young population are associated with more friendly markets. It is also negatively and significantly correlated (-.7) for the year 2003 with innovative skills and in the both years for innovation governance. Countries that have lower levels of low skilled youngsters seem to have higher levels of innovation governance.

As in the case of EIS, mathematic scales, and especially in the year 2003 are the ones that are related the most with innovative capacities of a country. The relationships, again, are restricted to innovation friendly markets, innovation skills and innovation government. Science scales present lower levels of associations with the EXIS composite.

The number of countries to calculate this correlation is between 15 and 20, so one has to be cautious when interpreting the results. Also interesting to note is that there are fewer numbers of new Member States to calculate this correlations, suggesting, once more, that the relationships found are more prominent in old Member States that in new Members.

Table 15: Bivariate Pearson correlation between PISA results, GIS and EXIS

		pisar1L00	pisar1L03lst	pisam00	pisam03	pisas00	pisas03
GSII	Pearson Correlation	-.644(**)	-.573(**)	.747(**)	.719(**)	.635(**)	.567(**)
	Sig. (2-tailed)	.001	.003	.000	.000	.002	.004
	N	22	24	22	24	22	24
EXIS	Pearson Correlation	-.377	-.747(**)	.619(*)	.745(**)	.436	.510(*)
	Sig. (2-tailed)	.166	.001	.014	.001	.105	.044
	N	15	16	15	16	15	16
EXISserv	Pearson Correlation	-.674(**)	-.819(**)	.756(**)	.688(**)	.640(*)	.531(*)
	Sig. (2-tailed)	.006	.000	.001	.003	.010	.034
	N	15	16	15	16	15	16
EXdiverse	Pearson Correlation	-.066	-.245	.109	.310	.132	.301
	Sig. (2-tailed)	.802	.312	.678	.197	.613	.211
	N	17	19	17	19	17	19
EXinnfri	Pearson Correlation	-.441	-.791(**)	.563(*)	.716(**)	.379	.444
	Sig. (2-tailed)	.067	.000	.015	.001	.121	.065
	N	18	18	18	18	18	18
EXkflow	Pearson Correlation	.214	-.126	.102	-.010	.030	.166
	Sig. (2-tailed)	.426	.618	.707	.967	.912	.510
	N	16	18	16	18	16	18
EXinnoinv	Pearson Correlation	-.480(*)	-.417	.271	.274	.391	.404
	Sig. (2-tailed)	.044	.075	.277	.256	.109	.086
	N	18	19	18	19	18	19
EXinnskills	Pearson Correlation	-.385	-.716(**)	.667(**)	.778(**)	.467	.532(*)
	Sig. (2-tailed)	.157	.003	.007	.001	.079	.041
	N	15	15	15	15	15	15
EXinngov	Pearson Correlation	-.587(**)	-.683(**)	.615(**)	.466(*)	.487(*)	.198
	Sig. (2-tailed)	.005	.000	.003	.029	.025	.377
	N	21	22	21	22	21	22

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Five year average for benchmark indicators
Table 16 shows the Pearson correlation between the averages for the last five years in each educational indicator and the different aspects of SII. This table summarizes to some extent the previous tables. It shows that innovation performance is mainly related to lifelong learning (LLL), MST graduates (MST) and PISA low levels of results (PISAr1L), but less related to Educational attainment of the Youth (EAY) and early school leavers (ESL). This could be expected since lifelong learning and MST graduates are used to calculate the composite indicator SII. The most surprising results is that Educational attainment of Youth (EAY) does not present much association with SII, despite it is also used to calculate it. Also noteworthy is that Lifelong learning participation and low levels of PISA scores in reading, relate to the other input variables (which was not necessarily the case looking at each year separately). This is mainly due to the high performance of the Nordic countries and the low performance of the Romania and Bulgaria, especially in the case of PISA results.

Table 16: Bivariate Pearson correlation between five years average (2000-2005) of educational benchmark indicators and SII components

		average of EAY	average of ESL	average of LLL	average of MST	average of PISArL
SII	Pearson Correlation	.079	-.315	.641(**)	.439(*)	-.635(**)
	Sig. (2-tailed)	.679	.090	.000	.012	.000
	N	30	30	30	32	27
GrowthSII	Pearson Correlation	-.105	.116	-.183	-.476(**)	.359
	Sig. (2-tailed)	.581	.543	.332	.006	.066
	N	30	30	30	32	27
inidrv	Pearson Correlation	.303	-.471(**)	.749(**)	.656(**)	-.694(**)
	Sig. (2-tailed)	.103	.009	.000	.000	.000
	N	30	30	30	30	25
iniKC	Pearson Correlation	.080	-.296	.632(**)	.378(*)	-.640(**)
	Sig. (2-tailed)	.676	.112	.000	.033	.000
	N	30	30	30	32	27
inientrep	Pearson Correlation	-.033	-.209	.621(**)	.315	-.530(**)
	Sig. (2-tailed)	.866	.276	.000	.096	.006
	N	29	29	29	29	25
inoapp	Pearson Correlation	-.021	-.066	.275	.218	-.393
	Sig. (2-tailed)	.912	.728	.141	.248	.052
	N	30	30	30	30	25
inoip	Pearson Correlation	.002	-.238	.398(*)	.287	-.477(*)
	Sig. (2-tailed)	.994	.205	.029	.111	.012
	N	30	30	30	32	27
inoav	Pearson Correlation	-.008	-.199	.401(*)	.300	-.494(**)
	Sig. (2-tailed)	.967	.292	.028	.096	.009
	N	30	30	30	32	27

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

3.3 Cluster Analysis: Finding groups on innovation and education performance

Clustering innovation scores

As shown above certain groups of countries behave quite different from others in terms of educational benchmarks and innovation. In order to explore these differences, cluster analyses were carried out.

Cluster analysis is a group of statistical techniques that pertain to create groups in a given set of data through the estimation of the distance between the different data points. There are different ways of calculating the distance between two points as well as different ways of creating the groups. For the present paper, unless referred in the text, the cluster carried out will always be using between-groups linkage, using Euclidean distances.

Cluster analysis has been already used within the trend-chart program in several occasions; it is not the intention of this paper to repeat analysis already done in the innovation score card. Results from these publications will be used in combination with other cluster analysis specific for the purpose of this paper.

First, a cluster analysis was carried out in order to find groups of countries that perform similarly in the three composite indexes: EXIS, GIS and SII. The main drawback with this technique is that cases that do not have data in the three composites are not considered. The present results are not available for Bulgaria, Cyprus, Estonia, Ireland, Iceland, Japan, Latvia, Malta, Poland, Slovakia, United Kingdom and US. Therefore, the analysis accounts for a total of 18 countries with only few of the New member States. The figure 8 shows the dendrogram resulting from the cluster analysis. Two fairly clear groups appear, indicating high and low performers in innovation. Within the high performers, Sweden and Finland create a different sub-group; Germany forms a sub-group with Denmark; and France, Belgium, the Netherlands, Luxemburg and Norway form a third group. Within the low performers, Romania is "alone" while the rest of the countries form a relatively homogeneous group. These groups reflect high and low performers, since the three composite indexes correlate strongly. Only Hungary and Lithuania perform relatively higher in EXIS than in the other two composite indicators, suggesting that these two countries have a better performance on innovation when looking at a major range of innovation-related activities.

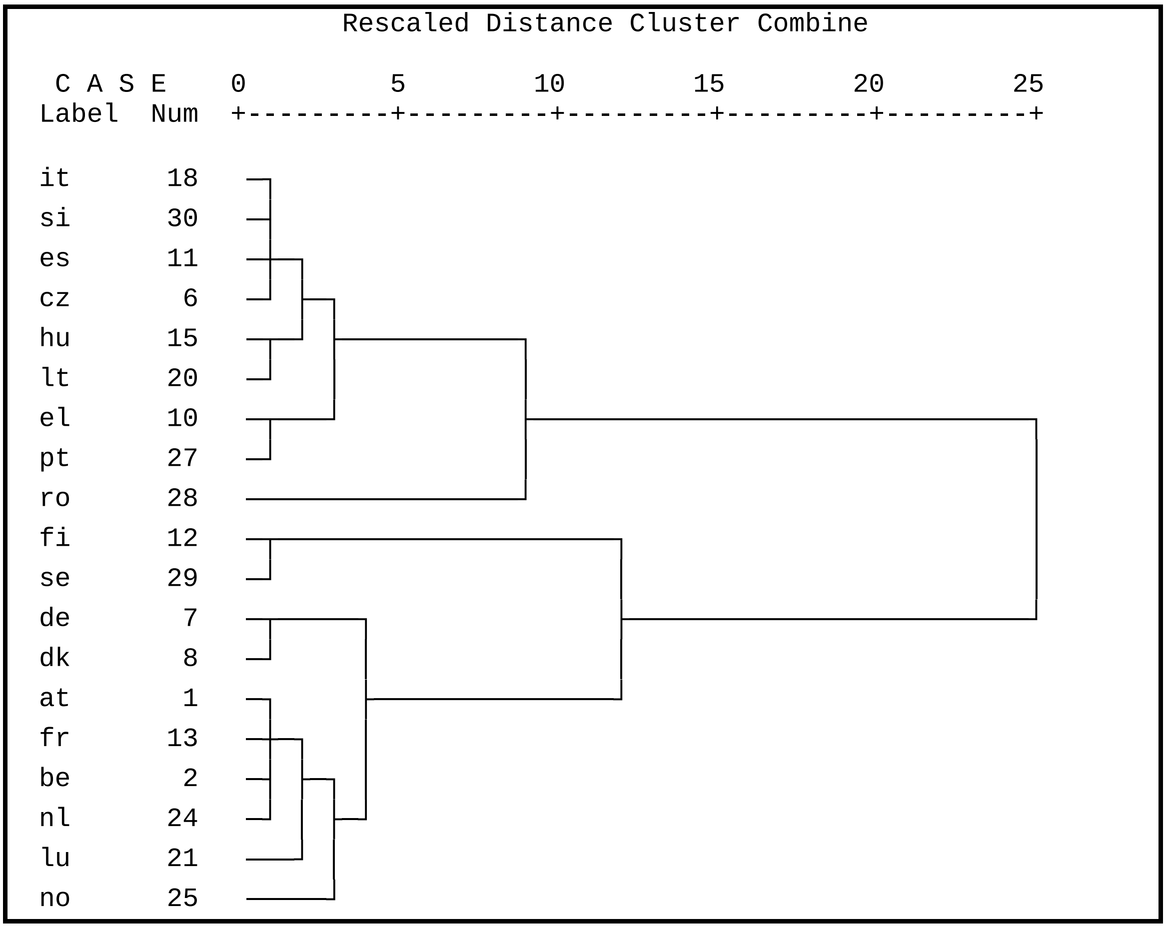

Figure 8: Dendrogram using average linkage (between groups) cluster analysis with composite indicators, EIS, GIS and EXIS.

Figure 8 shows the averages (from 2000 to 2005) for the benchmark indicators in each of the two groups obtained in the cluster analysis. The group of high achievers in innovation has slightly higher levels of educational attainment of youth and MST graduates; lower levels of early school leavers and slightly lower levels of students with low scores in reading literacy.

In this sense it seems relatively clear that the two groups differ mainly in early school leaving and in lifelong learning. In other words, taking away many of the New member States there seems to be a relationship between ESL and innovation. But considering new member states, this relationship is considerably reduced (see correlations in table 25 in the annex).

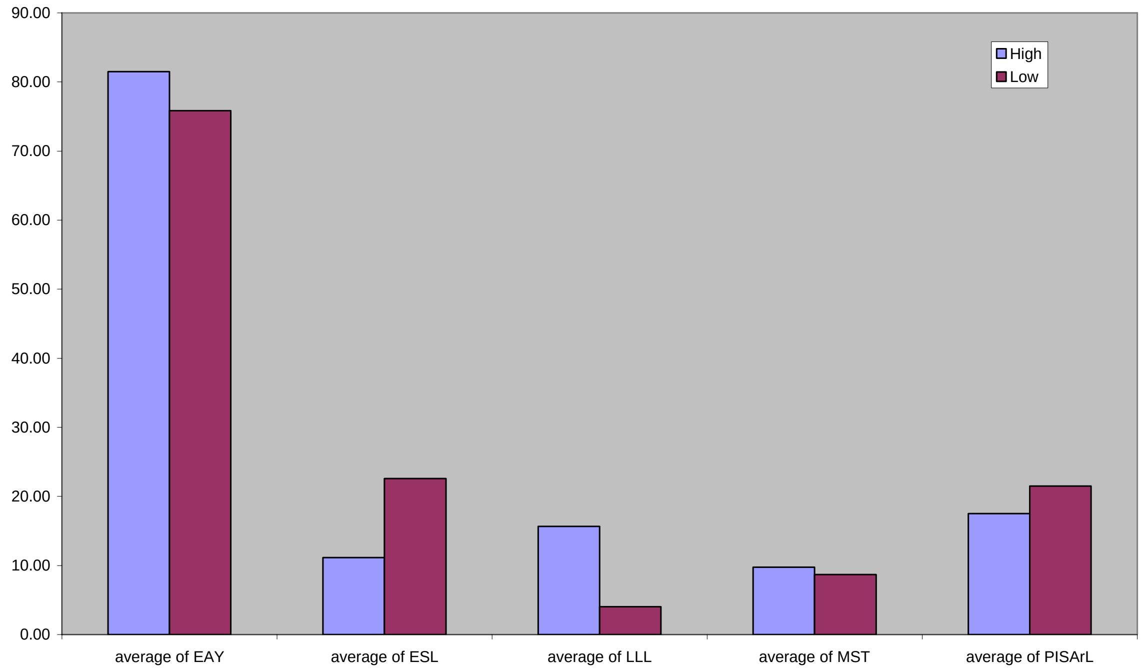

Figure 9: Average scores in the benchmark indicators per group (clusters calculated using average linkage (between groups) of SII, GIS, EXIS).

A similar analysis was carried out with the clusters presented in JRC and MERIT (2007) that divides in four groups the countries according to their performance in SII score and growth rate. They characterize the groups as:

1- *Innovation leaders* that are declining their lead (except in the case of Denmark)
2- *Innovation followers*, that score bellow the innovation leaders but above EU25.
3- *Catching up-countries*, with SII scores well bellow of the EU25 but with faster average growth
4- *Trailing countries,* with SII scores well bellow and growth bellow or little above EU25 average.

Figure 10 shows the average for each of the benchmark indicators by these four clusters. Youth educational attainment is higher for leaders and for catching-up countries, and it is the lowest for countries that are trailing. Early school leaving is highest in countries that are trailing, and is lowest in innovation leaders. Average lifelong learning participation present major differences between the first two groups and the rest showing that countries above the mean on innovation tend to have higher levels of lifelong learning participation. MST presents a similar pattern. Proportion of the student population with low literacy skills seems a common characteristic of countries catching up and trailing.

Leaders and catching up countries seem to have an advantage on the number of young people with high educational attainment and in having less early school leavers. This seems to suggest that early school leaving and young educational attainment might have an impact on innovation that the correlations could not “discover”. Lifelong learning seems to be an important factor for innovation, while low PISA results seems to be characteristic of low performers in innovation and specially of catching up countries. It is important to keep in mind that no causation can be derived from these results. For example, we cannot assume that increasing levels of lifelong learning in a country will mean that innovation will improve.

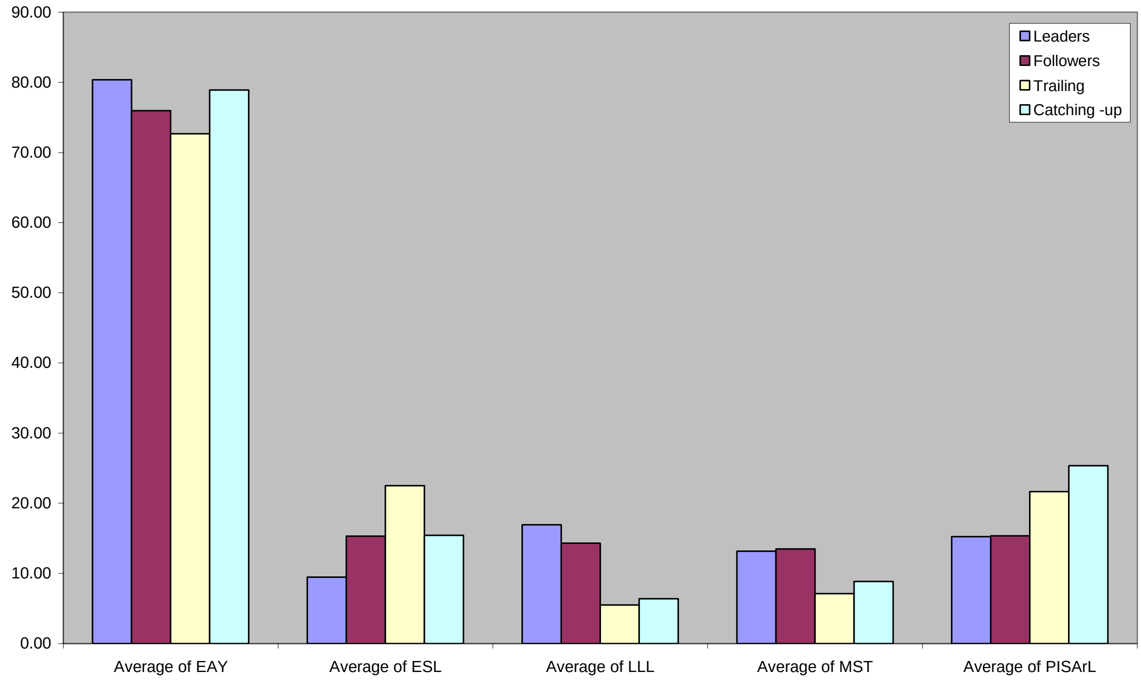

Figure 10: Average scores in the benchmark indicators per group (clusters taken from JRC and MERIT, 2007).

There is a risk of circularity in these results, since Young educational attainment, lifelong learning and MSTs are used to calculate the innovation driver (*inidrv*) indicator of the composite index SII. It is important, therefore, to explore groups of countries without taking into account this dimension of SII and relate them to the educational benchmarks. The dendrogram in figure 11 shows the results for the cluster analysis. Two clear groups of high and low achievers appear again and two sub-groups for each of these groups. Within the high achievers, groups H2 and H4 represent the leaders-followers distinction relatively clear. The lower performers form two sub-groups. The first group (GroupL1 in figure 10) is compounded of Greece, Latvia, Lithuania, Portugal and Estonia (Estonia relatively less similar to the previous four). These countries present the lowest levels of knowledge creation (aspects of R&D) and output indicators (Patents and performance in terms of business activities), while the second group (group L2 in figure 10) has the lowest levels for entrepreneurship (efforts of innovation at the company level).

Figure 11 presents the averages for each of the benchmark indicators in education for each of these groups. The group performing worse in innovation in most of the indicators, GroupL1, has low levels of youth educational attainment, participation in lifelong learning and high levels of early school leavers in comparison with the other group of low achievers. It is important to notice that this figure differs from figure 9 or 10 in that the clusters are not taking into account any educational indicators. Early school leaving and lifelong learning present the clearest pattern in relation to innovation. Countries that perform generally better in innovation perform better in these two aspects. Young educational attainment seems to give an “advantage” to the leaders and GroupL2 in respect to the other high and low achievers (followers and GroupL1 respectively); while this seems to be the opposite in MST and PISA. PISA seems to differentiate clearly between low and high achievers, but not so clearly between the countries within each group.

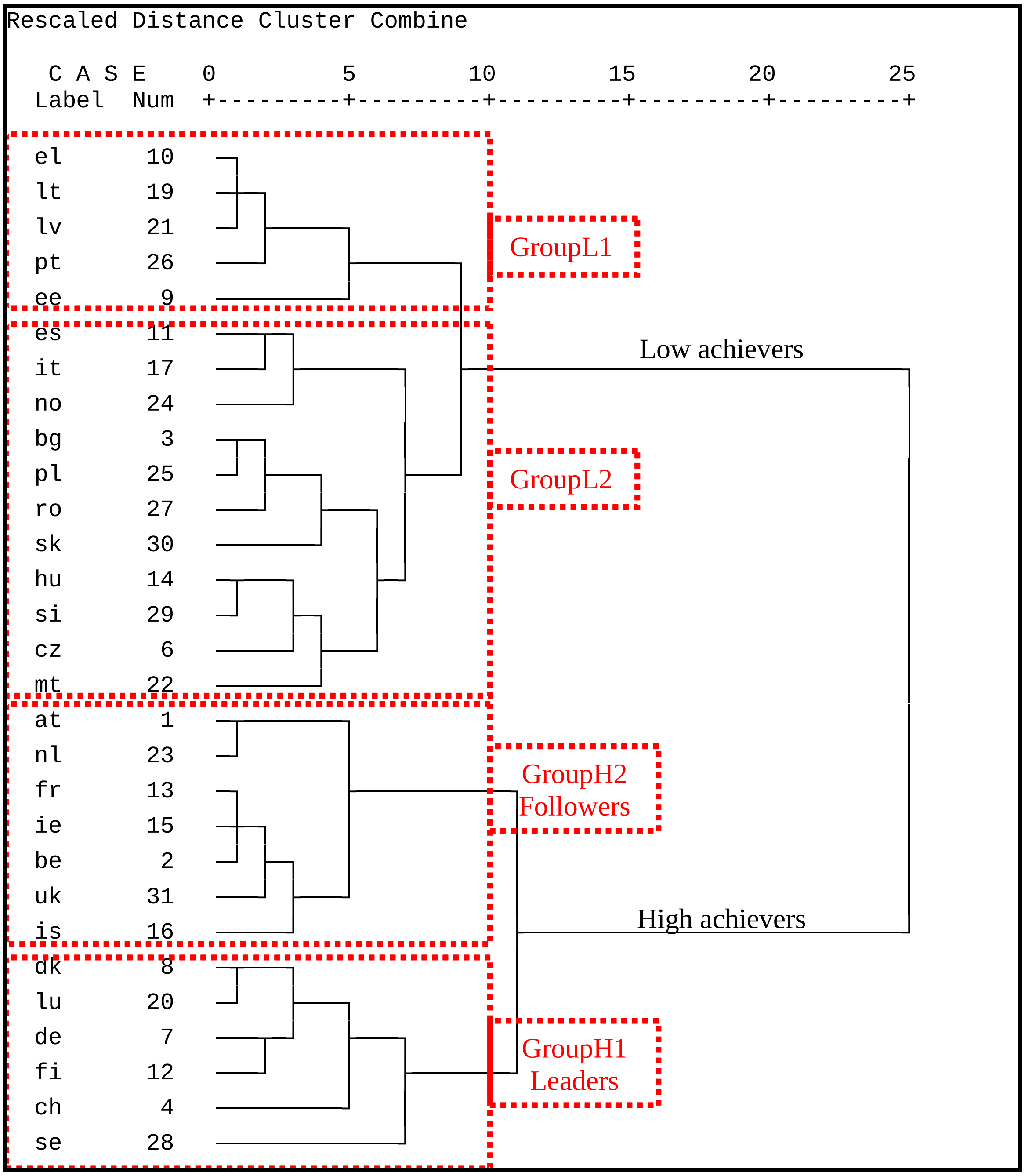

Figure 11: Dendrogram using average linkage (between groups) cluster analysis with scores of different aspects of SII, except Innovation drivers.

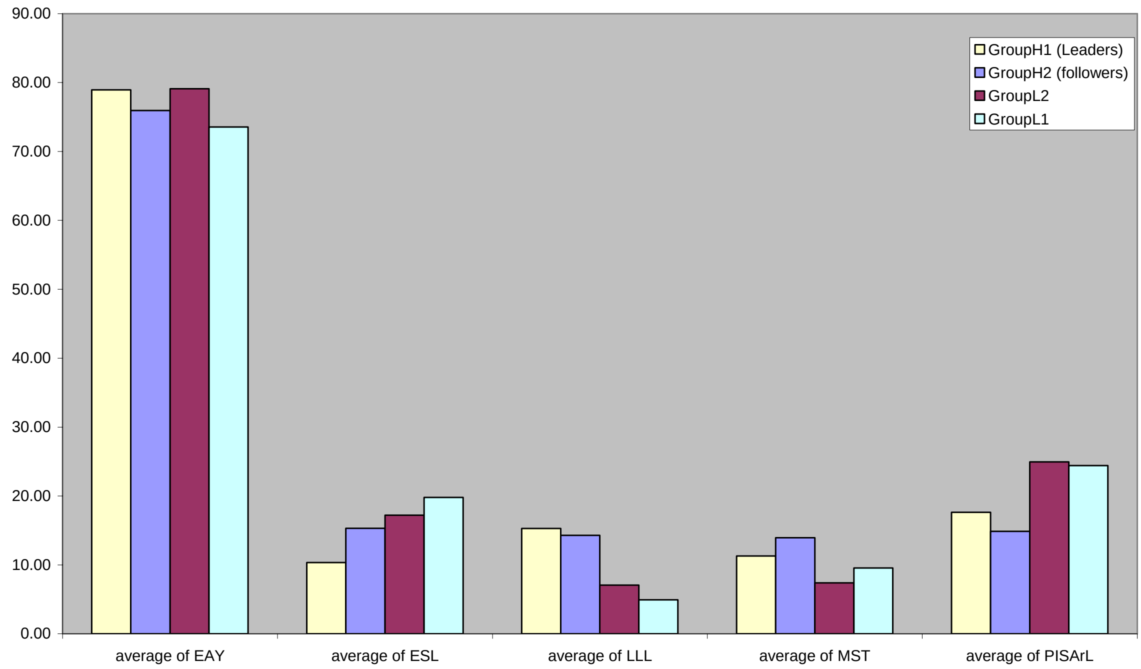

Figure 12: Average scores in the benchmark indicators per group (clusters calculated with SII aspects).

Clustering educational benchmark indicators

The previous section has explored clusters of countries in terms of innovation and then, it has illustrated differences and similarities between each cluster for educational indicators. The following section will try to identify group of countries that are similar in their educational indicators and explore how these groups perform in innovation. To some extent, this pertain to determine if groups found on innovation performance can be also found on education. Figure 13 presents the dendrogram resulting from the clustering using the (standardized) averages of the five benchmark indicators.

This type of dendrogram presents some difficulties for its interpretation, since the groups are aggregated far from each other in many cases. In other words, there are no major similarities between countries in terms of their average performance in educational indicators. There are certainly some groups that can be identified, but they are rather heterogeneous. For instance, Denmark, Sweden, Finland and the UK form what one could call the leaders in education. France and Ireland joint this group at a later stage. Iceland, Portugal, Italy and Spain form another group, rather heterogeneous. Luxembourg, Romania and Bulgaria form a group mainly linked because of the low results in PISA. The last group can be considered also relatively heterogeneous and encompasses different countries: Germany, Latvia, Greece and Hungary form a sub-group. Poland, Czech Republic and Slovakia another one and Austria is similar to Belgium.

It seems, from the figure that while SII created some how relatively clear grouping, educational benchmark indicators do not. This necessarily affects the correlations when looking at the relationship between education and innovation, as was obvious from the previous section. In other words, at the country level, educational performance (as measured with the five benchmark indicators) seems a phenomenon more heterogeneous than innovation.

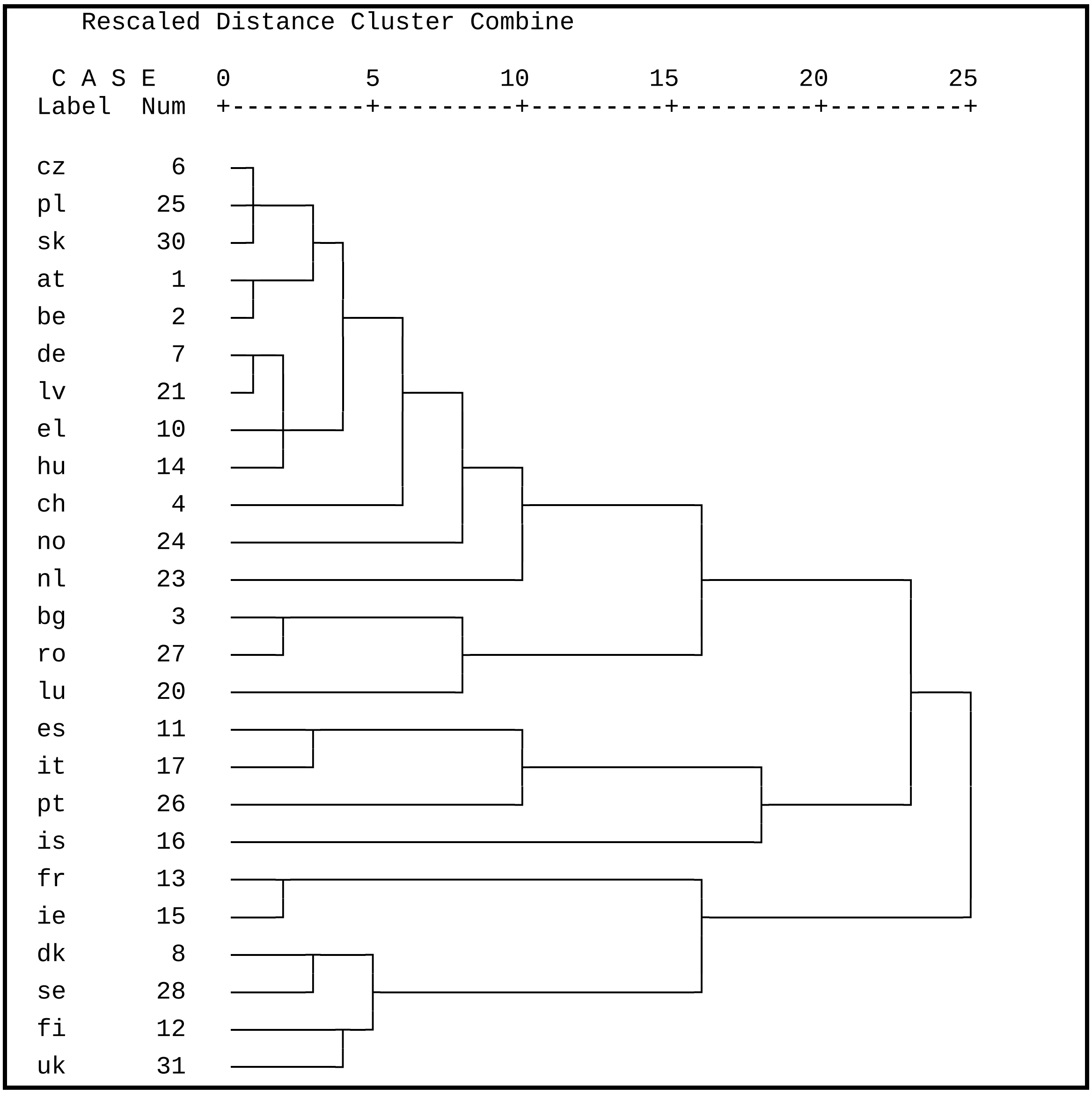

Figure 13: Dendrogram using average linkage (between groups) cluster analysis with averages (2000-2005) of the benchmarks indicators.

Clustering innovation and educational benchmark indicators

The following section will explore if there are groups of countries that behave similarly taking into account both innovation indicators and educational indicators. A cluster analysis was carried out with the three composite indicators of innovation (SII, GIS, EXIS) and the five averages of the educational indicators. Figure 14 shows a dendrogram difficult to interpret to some degree, especially in the upper corner (this type of 'formation" in the dendrogram might be artificially relating groups that do not exist). Austria, Belgium, The Netherlands, Norway and Luxembourg form a group characterize by having medium performance in the innovation indicators (just bellow the leaders) and a medium performance in educational benchmark indicators, with good levels of lifelong learning participation. Greece, Hungary and Chez Republic form a second group. This group is mainly characterized by having high levels of Young Educational attainment and low levels in all innovation indicators. A third group formed by Spain, Italy, Portugal and Romania, is mainly characterize by having the worst performance in average for all indicators. Their Youth educational attainment is low, they have high rates of early school leaving, low levels of lifelong learning and low levels of innovation, Romania is relatively different from the other three since it is a extreme case in almost all indicators. The last group, with Sweden, Denmark and Finland, is characterized by high levels on all the indicators.

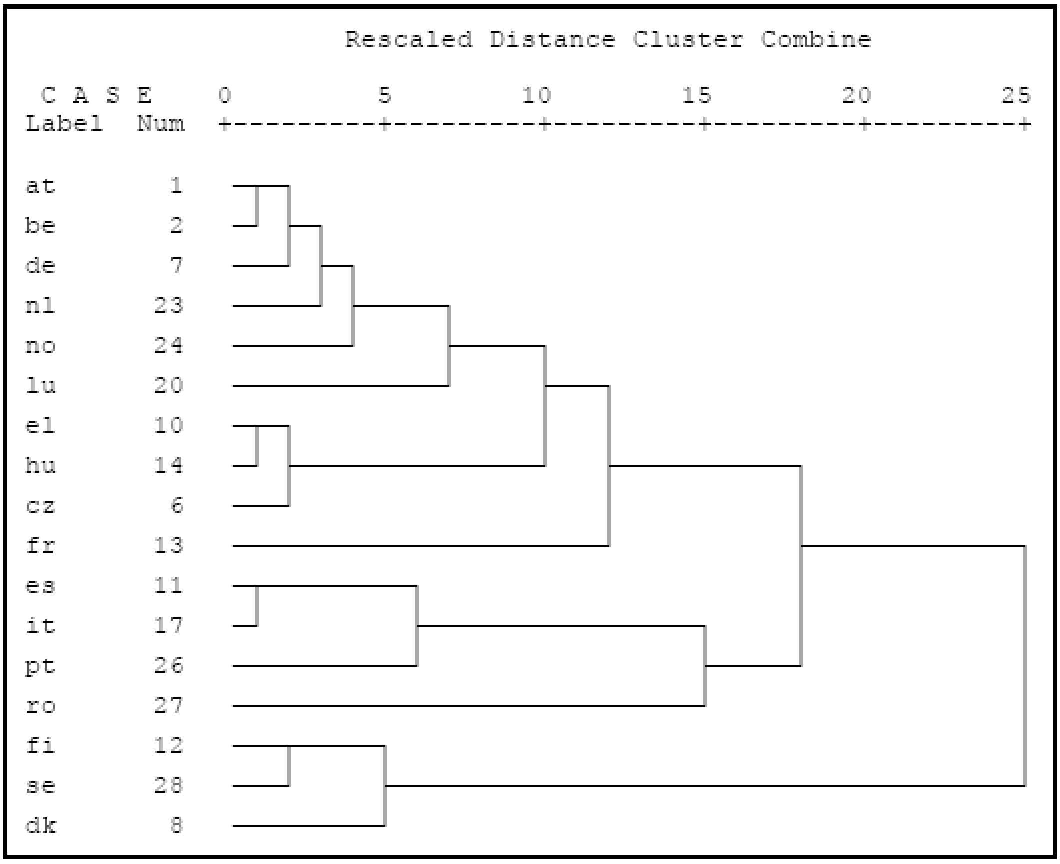

Figure 14: Dendrogram using average linkage (between groups) cluster analysis with innovation composite indicators (SII, GIS, EXIS) and averages (2000-2005) of the benchmarks indicators.

The main problem with this grouping is the low number of countries that have data for all indicators. Only 17 countries are included in the analysis, and many new Member States are excluded. It is more interesting, therefore, to use fewer indicators and try to group more countries. To this end, a cluster analysis was conducted for the specific aspects of SII (without accounting for innovation drivers) and the educational benchmark indicators average in the last five years. Figure 14 shows the results of such analysis. Again, the cluster analysis identifies two relatively clear groups of countries, showing a differentiation between low and high performers. However, each of the groups is rather heterogeneous, showing, once more, that innovation and education have a complicated relationship. Portugal and Iceland are rather different than the rest of the groups. Iceland is similar to the “high performers”, while Portugal is more similar to the low performers.

Within the “high performers”, Finland, Denmark, Sweden and United Kingdom form a relatively homogeneous group, which could be called “leaders”, with good performance both on educational indicators and innovation aspects. In comparison with the other groups, one of its most prominent characteristics is the high level of lifelong learning participation. Austria, Belgium, The Netherlands, Germany, Luxembourg and Switzerland form another, rather heterogeneous, group within “high performers” that we could call “followers”. In general they just have lower levels than the leaders on innovation and educational indicators, with the exception of Intellectual Property where Luxembourg, Germany and Switzerland have higher levels. France and Ireland form a third sub-group that is mainly characterized by having high levels of MST graduates and youth educational attainment and lower levels that the group of “followers” on innovation aspects indicators, except in the case of innovation applications.

The “low performers” form an even more heterogeneous group. It has sub-groups of two members; Bulgaria and Romania, Spain and Italy, Greece and Latvia, and another heterogeneous group form by Hungary, Poland, Slovakia, Chez Republic and Norway. In general terms these countries have low performance in all indicators.

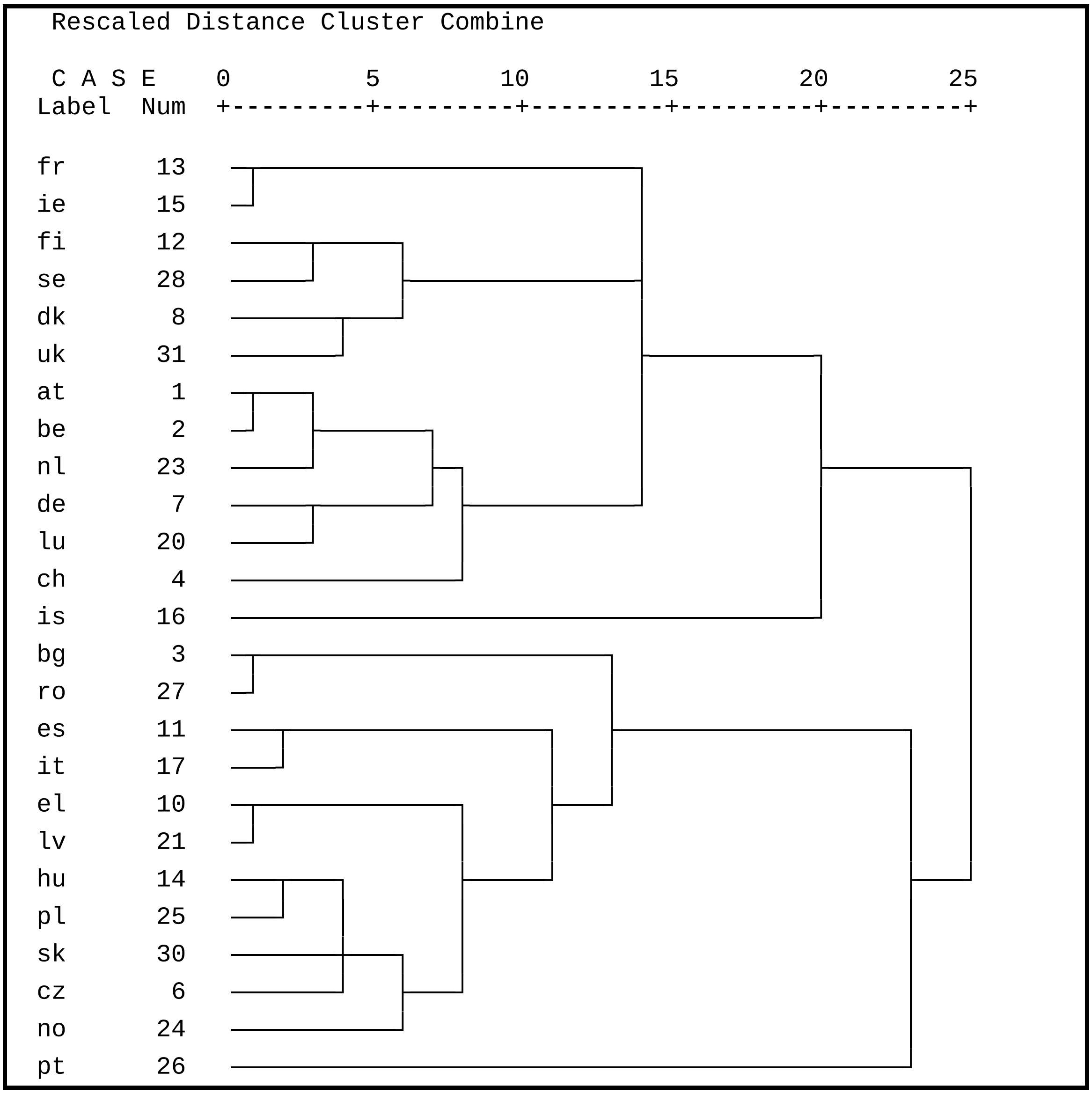

Figure 15: Dendrogram using average linkage (between groups) cluster analysis with SII components (except innovation drivers) and averages (2000-2005) of the benchmarks indicators.

Conclusions from the cluster analysis

The different groups presented in the above figures (from figure 7 to figure 14) are useful to understand the results of the correlations found in the previous section. The clusters have shown that the relationship between education and innovation is far from simple and that linear relationships cannot be easily assumed. Table 17 summarizes the different cluster carried out and indicates which countries belong where. It is relatively clear, and it is constant through the different clusters, that there are two groups of countries: Low and high achievers, both in education and in innovation. Within these two groups, depending on the variables taken into account for the analysis, there are different subgroups that tend to repeat themselves over the different clusters. The colouring of the cells attempts to show high and low achievers in each of the clusters carried out. Green represents the countries in each cluster that have highest levels in most of the indicators, while red indicated the opposite. It is important to note that numbering does not represent high and lows, but just membership to the same cluster.

It seems clear that there is a group of leaders, both in innovation and in education compounded of Sweden, Denmark and Finland. A very distinctive feature of these countries is the high level of lifelong learning participation, which would explain partially the high correlation that this educational indicator presents with most of the innovation indicators. Also seems clear to some extent that Romania, Portugal, Bulgaria are among the countries with major challenges ahead in their educational and innovation systems. Spain and Italy are relatively similar, both usually with low performance.

Table 17: Group Membership by cluster analysis results

	Cluster using EXIS, SII and GIS	Cluster from JRC, MERIT, 2007	Cluster using SII aspects without Innovation drivers	Cluster using educational benchmarks indicators averages	Cluster using Composite indexes for innovation and educational benchmarks indicators averages	Cluster using aspects of SII (exepct innovation drivers) and educational benchmarks indicators averages
Referring to:						
	Figures 7, 8	Figure 9	Figures 10, 11	Figure 12	Figure 13	Figure 14
dk	high	Leader	GroupH1	3	3	3
fi	high	Leader	GroupH1	3	3	3
se	high	Leader	GroupH1	3	3	3
de	high	Leader	GroupH1	1	1	1
ch		Leader	GroupH1	1		1
jp		Leader		.	.	.
ie		Follower	GroupH2	5	.	3
is		Follower	GroupH2	6	.	4
uk		Follower	GroupH2	3	.	3
us		Follower		.		
at	high	Follower	GroupH2	1	1	1
be	high	Follower	GroupH2	1	1	1
fr	high	Follower	GroupH2	5	5	3
nl	high	Follower	GroupH2	1	1	1
cy		Other		.	.	.
lu	high	Other	GroupH1	2	1	1
no	high	Other	GroupL2	1	1	2
bg		Catching up	GroupL2	2	.	2
lv		Catching up	GroupL1	1	.	2
pl		Catching up	GroupL2	1	.	2
cz	low	Catching up	GroupL2	1	2	2
si	low	Catching up	GroupL2	.	.	.
ro	low	Other	GroupL2	2	6	2
ee		Trailing	GroupL1	.	.	.
mt		Trailing	GroupL2	.	.	.
sk		Trailing	GroupL2	1	.	2
el	low	Catching up	GroupL1	1	2	2
lt	low	Catching up	GroupL1	.	.	.
pt	low	Catching up	GroupL1	4	4	5
es	low	Trailing	GroupL2	4	4	2
hu	low	Trailing	GroupL2	1	2	2
it	low	Trailing	GroupL2	4	4	2

Since the paper is only looking at relationships, it is problematic to draw conclusions in terms of political actions, since many factors are not being accounted for. However, the results (specially in figure 14) show that certain countries are at a similar starting point in terms of education and innovation; exploring their evolution together might be more fruitful than comparing these countries with other group of countries.

3.4 Relationship between educational indicators and specific output indicators

This section look into the relationship between the averages in the last five years of the educational indicators and specific output variables derived from CIS4. The objective in this section is to explore to what extent educational indicators are contributing as inputs for the innovation outputs. To this end, correlations between specific output indicators and averages of the educational benchmarks are used. Table 18 shows the variables derived from CIS4 used in the analysis.

Table 18: CIS4 variables used for the correlations on output indicators

Variable code	Explanation	Measure
inno	*Innovation active enterprises*	*% of total number of enterprises*
newfrm_turn	*Share of newly introduced product*	*% of total turnover*
newmar_turn	*Share of products new to the market*	*% of total turnover*
rexp04	*Total innovation expenditures*	*% of total turnover*
funpub	*Share of enterprises that increased range of goods and services*	*% of innovative enterprises*
co_all	*Share of enterprises that entered new markets or increased market share as result of innovation*	*% of innovative enterprises*
orginno_yes	*Share of enterprises that improved quality in goods or services*	*% of innovative enterprises*
mktinno_yes	*Share of enterprises that improved flexibility of production or service provision*	*% of innovative enterprises*
erange	*Share of enterprises that increased capacity of production or service provision*	*% of innovative enterprises*
emar	*Share of enterprises that reduced labour costs per unit output*	*% of innovative enterprises*
equa	*Share of enterprises that reduced materials and energy per unit output*	*% of innovative enterprises*
eflex	*Share of enterprises that reduced environmental impacts or improved health and safety*	*% of innovative enterprises*
ecap	*Share of enterprises that met regulation requirements*	*% of innovative enterprises*
elbr	*Share of enterprises that received any public funding*	*% of innovative enterprises*
emat	*Share of enterprises that have engaged in any type of innovation cooperation*	*% of innovative enterprises*
eenv	*Share of enterprises that applied for a patent*	*% of innovative enterprises*
ereg	*Share of enterprises that that registered a trademark*	*% of innovative enterprises*
propat	*Share of enterprises that that registered an industrial design*	*% of innovative enterprises*
prodsg	*Enterprise introduced organisational innovation*	*% of total number of enterprises*
protm	*Enterprise introduced marketing innovation*	*% of total number of enterprises*
efored_high	*Share of enterprises that reduced time to respond to customer or supplier needs*	*% of total enterprises that introduced organizational innovations*
eoqua_high	*Share of enterprises that improved quality of goods or services*	*% of total enterprises that introduced organizational innovations*
eored_high	*Share of enterprises that reduced costs per unit output*	*% of total enterprises that introduced organizational innovations*
eosat_high	*Share of enterprises that improved employee satisfaction and/or reduced rates of employee turnover*	*% of total enterprises that introduced organizational innovations*

From section 3.2 it was possible to see that in general terms, educational indicators did not relate very much with innovation output indicators. Table 27 in the annex shows clearer the lack of relationship between educational and innovation outputs indicators. In this way, very few significant relationships (at 0.05 level) appear. Percentage of innovative companies

(companies that in the reference period have introduced at least one innovation) presents a significant and weak correlation with lifelong learning participation (.38) and negative, moderate relationship with the low results in the literacy scale for PISA (-.50). These correlations are very much driven by Romania and Bulgaria. Taking away these two countries the correlations become not significant for any of the indicators. This is showing that there is a weak relationship between educational and output innovation indicators.

The number of enterprises that report entering new markets as a result of innovation (as a percentage of innovative enterprises) seems associated with countries that have higher levels of young educational attainment, low early school leaving and low percentage of pupils with low literacy level. This seems to confirm the relationship between innovation friendly markets and education. Countries that have younger and better educated youth seem to have companies that entered new markets or increased market shares as a result of innovation.

The percentage of innovative companies that have registered and industrial designs is significantly related (at 0.05 level) with participation in lifelong learning, number of MST graduates and with having low levels of students with low literacy level in PISA. This confirms, also the correlations found before. Countries with higher number of MSTs tend to have higher levels of production in terms of know-how as is the case if they have high levels of lifelong learning and low levels of low literacy skills. In general, these correlations can be explain because the Nordic countries present high levels in this indicators, while countries in the south present lower levels. In the case of MST, France and Ireland (as seen from the clustering) have high levels of MST graduates and in general higher levels of patent registration.

3.5 Other educational indicators and its relationship to innovation composite indexes

The present section explores the relationship between other educational indicators with EIS, GIS and EXIS. In order to simplify the reading, only the most relevant (and significant) correlations are commented here. The list of educational indicators comes from a set of indicators chosen from the Progress report, “towards the Lisbon objectives in education and training” for 2006 and the forthcoming 2007.

Investment in education is probably the other indicator generally considered as an important benchmark for educational policies. This indicator, measuring the percentage of GDP invested in education, correlates moderately and significantly (at 0.05 level) with SII for the four years of data available (from 2000 to 2003). It correlates significantly (at 0.05 level) with innovation drivers. This suggests that investment in education is associated with the structural conditions required for innovation. It also correlates in the four years with innovation and entrepreneurship. The correlation is higher in the year 2000, probably due to the lower number of countries to calculate the Pearson correlation. Investment in education correlates with Intellectual property outputs in the year 2000. These results are showing that countries that put major efforts in education are countries where the structural conditions for innovation (in terms of human capital and skills) and in terms of efforts towards innovation at the firm level are stronger.

In relation to GIS, the investment in education presents weak to moderate associations. While in the case of EXIS, investment in education presents positive, moderate significant correlations at 0.05 level with the overall EXIS index, with innovation friendly markets, with innovation skills and with innovation governance. Investment in education is therefore, moderately related to having more friendly innovation markets.

An interesting association appears between the indicators in vocational education and training (VET) and certain specific characteristics of EIS and EXIS. The VET indicator refers to the percentage of students in a vocational route at ISCED level 3 as percentage of the all student at ISCED 3 level. While the VET indicator does not correlate significantly with the overall EIS index, it correlates moderately and significantly (at 0.05 level) in all the years available with on of the output components, innovation applications. This is significant, because in general, the other educational indicators tend to not correlate much with this indicator. It seems, therefore, that in countries where there is higher interest in VET, there are better performance in terms of labour and business activities in innovative sectors. VET also correlates significant (at 0.05 level) and moderately with the thematic indexes "innovation friendly markets" and Innovation governance of EXIS; but it does not correlate significantly with the overall scale. This suggests that countries where there is an interest for VET, there is a better market for innovation, and companies seem to provide more innovative governance.

Mobility, measured as the percentage of the total tertiary students (levels ISCED 5 and 6) studying in another EU25/EEA/CC, presents low levels of association with almost all indicators except with EIS growth. Countries where there has been higher level of growth in EIS, have had higher number of students abroad. This is probably the case, because countries that send more students abroad are Candidates countries, and countries with lower levels of innovation, that have grown more in the last years. These correlations are bias to certain degree by Malta, Luxemburg and Cyprus that have high levels of growth and are clearly outsiders in this way.

ICT skills are usually associated with innovation. The ICT skills indicator measures the percentage of students in formal education with low level of e-skills as a % of ICT users aged 16-74. Unfortunately, the correlation can be only done for 14 countries, and only in the year 2005. Due to the low number of cases significant correlations will be difficult to find. In general, low levels of e-skills correlate negatively and moderately with most of the innovation indicators. The only significant associations are with intellectual property and the average of output indicators of EIS. To some degree this results question the importance of e-skills for innovation. However, the number of countries is limited and an association of .5 with 14 countries is not too small. The correlations show, in any case, that countries where young people have higher e-skills are countries that produce more outputs in innovation. This is mainly driven by the Nordic countries.

4 Discussion and Conclusions

In general terms, the different results presented above show that there is moderate association between higher levels in the educational benchmarks indicators and higher levels of innovation measured by the EIS, GIS and EXIS. The overall scale of EIS correlates significantly in all the available years with all of the five benchmarks, except in the case of Youth educational attainment. It is not surprising that the educational benchmark indicators correlate with EIS, since three of them are used to calculate it. They are part of the innovation driver component of EIS. In this way, all the five benchmarks correlate significantly (at least at 0.05 level). However, it is surprising that youth educational attainment does not present stronger association, since it is one of the indicators used to calculate EIS. One possible explanation is that EIS, within five years, is not noticing the effects of low levels of skills in youth, or that young people have other ways of acquiring the skills needed to build innovation. The fact that early school leavers present stronger but negative correlation than "youth educational attainment" with the overall EIS suggests that school failure is more associated with lower levels of innovation than school input (as measured by educational attainment of the youth). This is also the case when looking at correlation results with EXIS, where "early school leaving" correlates stronger (and negatively) with more thematic areas than the youth educational attainment indicator.

In general one could say that youth educational attainment is the less related of the benchmark indicators with innovation. In a similar way, participation in lifelong learning is the indicator more directly related to innovation. As mentioned above, educational benchmark indicators tend to correlate mainly with input indicators, especially with innovation skills in EIS, since they are actually part of it. They also correlate normally with the innovation skill component of EXIS.

To certain extent educational benchmark indicators relate to output indicators of EIS. In general terms, they are more associated with performance in intellectual property than with applications. It seems that education has more impact on the production of know-how than on the labour structure. This might be connected with the fact that countries that have strong tradition on patenting, are countries probably more R&D intensive. However, only few of the benchmark indicators are associated with the knowledge creation component of EIS (mainly measuring R&D efforts).

Lifelong learning, MST graduates and PISA results are also associated with innovation governance in the EXIS index. This seems to show that countries where firms promote innovation are countries where there are higher levels of lifelong learning participation. They are also countries where there is a good supply of MSTs, and they probably have a student population with high level of literacy skills. This creates a workforce, which seems to be prepared for innovation. Also interesting to note is that all the educational benchmark indicators where related to innovation friendly markets. Countries that perform better in education, have more innovation friendly markets. This seems to confirm that countries with better educated population are better prepared to receive innovation.

Lifelong learning is the benchmark indicator that relates the most to all the different aspects of innovation. This goes in line with the correlations found between CVTS statistics and innovation indexes. Countries with higher levels of supply and demand of training are performing better in innovation. It is impossible, with the data available, to know if innovative firms are those that provide more training to their employees, but it seems clear that at a country level, higher demand and supply of training is associated with better innovation performance.

To certain extent, many of these results can be explained based on country differences. Nordic countries tend to perform well both in innovation and education. In this way, the correlations are driven in many ways for the scores of Finland, Sweden and Denmark; and the low scores of Romania, Portugal or Malta. In general terms, however, the correlations remain similar when outliers are taken away. In addition, cluster analysis indicates that the relationship between education and innovation is far from simple. In general terms, there are two groups of countries: Low and high achievers, both in education and in innovation. Within these two groups, depending on the variables taken into account for the analysis, there are different subgroups that appear in different clusters. It seems clear that there is a group of leaders, both in innovation and in education compounded of Sweden, Denmark and Finland. A very distinctive feature of these countries is the high level of lifelong learning participation. Also seems clear to some extent that Romania, Portugal, Bulgaria are among the countries with major challenges ahead in their educational and innovation systems. Spain and Italy are relatively similar, both usually with low performance. France and Ireland seem similar in terms of MST graduates and innovation outputs.

Since the paper is only looking at relationships, it is problematic to draw conclusions in terms of political actions, since many factors are not being accounted for, as for example, sector distributions. However, the results show that certain countries are at a similar starting point in terms of education and innovation; exploring their evolution together might be more fruitful than comparing these countries with other countries at a different innovation stage.

It is important to note also, that the correlations tend to be lower when data for new Member States is considered. Old Member States (EU15) tend to present higher correlations with innovation indicators than the New Member States. In other words, the association between education and innovation seems to be a characteristic of old Member States, but not of the new Member States.

One could ask, if the type of measurements that are taken, both in education and innovation, are to some degree some kind of "Nordic model", where countries in the Mediterranean ring or new Member States are not fully represented. As an example, most of the firm level surveys are carried out for companies with more than 10 employees. In Southern European Countries, such as Italy or Spain, the vast majority of companies are micro-companies with less than ten employees. It is not clear in what way these small businesses are using or not innovation.

Searching for innovation related indicators in education

Finally, it is important to mention that there is a necessity to create educational indicators that relate specifically to innovation. This paper has shown relationships between innovation and education at a general level, mainly exploring how education might contribute to innovation. However, there is a necessity of investigating how and to what extent innovation is taking place within educational systems.

The Continuous Innovation Survey is only carried out in the so-called main business activities that do not include education or other important services. Innovation in services such as education or health-care might be difficult to measure, but it is a necessary step in order to monitor and understand changes in the system. In addition, there is a growing importance of organizational and marketing innovation and education cannot remain apart from it. Product and process innovation might be difficult to apply to an educational context, but organizational and marketing innovation might play a major role, especially if education is becoming more demand driven and a larger variety of educational providers appear.

Educational related surveys exist and could be used as a tool to explore innovation within schools. PISA, for example, has one question in the school questionnaire related to innovative practices of mathematic teachers. Questions on this direction could be used to assess innovation at the school level. But questions to the head-masters specifically directed towards organizational innovation could be of use to assess school innovation. However, PISA questionnaire is already crowded and it might be difficult to include new questions.

Another survey that is being carried out by OECD, a survey on teachers, teaching and learning (TALIS) has many questions on school practices. To some extent it could be possible to ask if new practices have been carried out within the reference period. It is, however, complicated to determine to what extent such questions will work in an educational context.

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ANNEX: Additional Tables

Table 19: Adult educational attainment with SII

		eaa00	eaa01	eaa02	eaa03	eaa04	eaa05lst
SII	Pearson Correlation	.199	.223	.214	.167	.214	.136
	Sig. (2-tailed)	.291	.235	.255	.386	.257	.489
	N	30	30	30	29	30	28
GrowthSII	Pearson Correlation	-.084	-.107	-.100	-.086	-.117	-.079
	Sig. (2-tailed)	.658	.572	.598	.657	.539	.690
	N	30	30	30	29	30	28
inidrv	Pearson Correlation	.389(*)	.410(*)	.404(*)	.386(*)	.411(*)	.408(*)
	Sig. (2-tailed)	.034	.024	.027	.039	.024	.031
	N	30	30	30	29	30	28
iniKC	Pearson Correlation	.150	.164	.159	.114	.164	.084
	Sig. (2-tailed)	.430	.386	.402	.557	.387	.671
	N	30	30	30	29	30	28
inientrep	Pearson Correlation	.189	.198	.202	.144	.198	.117
	Sig. (2-tailed)	.326	.304	.294	.465	.304	.562
	N	29	29	29	28	29	27
inoapp	Pearson Correlation	-.024	.002	-.017	-.042	-.011	-.083
	Sig. (2-tailed)	.898	.990	.930	.828	.952	.674
	N	30	30	30	29	30	28
inoip	Pearson Correlation	.118	.142	.131	.085	.124	.034
	Sig. (2-tailed)	.534	.454	.490	.662	.515	.863
	N	30	30	30	29	30	28
inoav	Pearson Correlation	.074	.103	.087	.043	.084	-.011
	Sig. (2-tailed)	.696	.588	.648	.825	.659	.955
	N	30	30	30	29	30	28

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 20: Bivariate correlations of EYA and SII components without outliers: TR, PT, MT, IS

		eay00	eay01	eay02	eay03	eay04	eay05lst
SII	Pearson Correlation	-.065	-.004	-.047	-.107	-.124	-.117
	Sig. (2-tailed)	.747	.983	.813	.586	.531	.569
	N	27	27	28	28	28	26
GrowthSII	Pearson Correlation	.139	-.009	.028	.058	.020	.035
	Sig. (2-tailed)	.491	.965	.888	.771	.921	.865
	N	27	27	28	28	28	26
inidrv	Pearson Correlation	.049	.190	.144	.087	.098	.070
	Sig. (2-tailed)	.809	.344	.465	.660	.621	.736
	N	27	27	28	28	28	26
iniKC	Pearson Correlation	-.076	-.037	-.017	-.062	-.060	-.033
	Sig. (2-tailed)	.707	.855	.933	.759	.765	.875
	N	27	27	27	27	27	25
inientrep	Pearson Correlation	.018	.002	.048	.008	.026	.056
	Sig. (2-tailed)	.930	.992	.816	.968	.900	.796
	N	26	26	26	26	26	24
inoapp	Pearson Correlation	.121	.130	.118	.101	.012	.012
	Sig. (2-tailed)	.549	.520	.557	.617	.955	.953
	N	27	27	27	27	27	25
inoip	Pearson Correlation	-.260	-.198	-.233	-.298	-.296	-.323
	Sig. (2-tailed)	.191	.323	.232	.124	.126	.108
	N	27	27	28	28	28	26
inoav	Pearson Correlation	-.140	-.092	-.164	-.218	-.256	-.278
	Sig. (2-tailed)	.485	.647	.405	.265	.189	.169
	N	27	27	28	28	28	26

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 21: Bivariate Pearson correlations of EYA and SII components by Old vs. New Member States

		NEW MEMBER STATES						Old Member States					
		eay00	eay01	eay02	eay03	eay04	eay05lst	eay00	eay01	eay02	eay03	eay04	eay05lst
SII	Pearson Correlation	.003	-.047	.024	.063	.071	-.009	.576(*)	.592(*)	.598(*)	.534(*)	.520(*)	.541(*)
	Sig. (2-tailed)	.992	.885	.940	.846	.827	.977	.025	.020	.018	.040	.047	.046
	N	12	12	12	12	12	12	15	15	15	15	15	14
GrowthSII	Pearson Correlation	-.468	-.458	-.424	-.421	-.425	-.458	.171	.050	.082	.106	.107	.116
	Sig. (2-tailed)	.125	.135	.169	.173	.168	.134	.542	.860	.772	.707	.704	.693
	N	12	12	12	12	12	12	15	15	15	15	15	14
inidrv	Pearson Correlation	.502	.466	.496	.531	.580(*)	.585(*)	.554(*)	.673(**)	.665(**)	.600(*)	.558(*)	.560(*)
	Sig. (2-tailed)	.096	.126	.101	.076	.048	.046	.032	.006	.007	.018	.030	.037
	N	12	12	12	12	12	12	15	15	15	15	15	14
iniKC	Pearson Correlation	-.006	.022	.081	.096	.099	.062	.685(**)	.661(**)	.669(**)	.624(*)	.625(*)	.649(*)
	Sig. (2-tailed)	.986	.946	.803	.767	.759	.848	.005	.007	.006	.013	.013	.012
	N	12	12	12	12	12	12	15	15	15	15	15	14
inientrep	Pearson Correlation	.035	-.092	-.037	.012	.064	.047	.340	.376	.393	.351	.350	.358
	Sig. (2-tailed)	.919	.789	.915	.973	.851	.890	.215	.167	.147	.199	.202	.208
	N	11	11	11	11	11	11	15	15	15	15	15	14
inoapp	Pearson Correlation	-.245	-.237	-.253	-.209	-.221	-.359	.544(*)	.511	.496	.459	.420	.498
	Sig. (2-tailed)	.442	.459	.428	.515	.489	.252	.036	.051	.060	.085	.119	.070
	N	12	12	12	12	12	12	15	15	15	15	15	14
inoip	Pearson Correlation	-.261	-.257	-.176	-.220	-.273	-.251	.427	.375	.390	.313	.325	.363
	Sig. (2-tailed)	.413	.421	.584	.492	.390	.431	.113	.169	.151	.257	.237	.203
	N	12	12	12	12	12	12	15	15	15	15	15	14
inoav	Pearson Correlation	-.296	-.287	-.282	-.251	-.276	-.401	.502	.455	.459	.393	.385	.447
	Sig. (2-tailed)	.350	.367	.374	.431	.385	.196	.056	.088	.085	.147	.156	.109
	N	12	12	12	12	12	12	15	15	15	15	15	14

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 22: Bivariate Pearson correlations of EAY and EXIS without PT

		eay00	eay01	eay02	eay03	eay04	eay05lst
GSII	Pearson Correlation	.120	.119	.107	.090	.089	.101
	Sig. (2-tailed)	.536	.539	.572	.636	.642	.603
	N	29	29	30	30	30	29
EXIS	Pearson Correlation	.208	.113	.136	.103	.091	.113
	Sig. (2-tailed)	.407	.655	.589	.685	.719	.666
	N	18	18	18	18	18	17
EXISserv	Pearson Correlation	.083	.104	.101	.066	.050	.078
	Sig. (2-tailed)	.735	.671	.681	.789	.838	.760
	N	19	19	19	19	19	18
EXdiverse	Pearson Correlation	.024	-.088	-.099	-.114	-.105	-.061
	Sig. (2-tailed)	.917	.696	.661	.613	.641	.793
	N	22	22	22	22	22	21
EXinnfri	Pearson Correlation	.288	.326	.332	.262	.263	.247
	Sig. (2-tailed)	.218	.160	.153	.264	.263	.323
	N	20	20	20	20	20	18
EXkflow	Pearson Correlation	.287	.260	.298	.347	.342	.294
	Sig. (2-tailed)	.207	.255	.189	.123	.129	.208
	N	21	21	21	21	21	20
EXinnoinv	Pearson Correlation	.036	.031	.040	.039	.015	-.010
	Sig. (2-tailed)	.872	.890	.855	.860	.947	.965
	N	23	23	23	23	23	22
EXinnskills	Pearson Correlation	.489	.510	.516(*)	.447	.403	.383
	Sig. (2-tailed)	.064	.052	.049	.095	.137	.177
	N	15	15	15	15	15	14
EXinngov	Pearson Correlation	-.150	-.087	-.086	-.149	-.143	-.141
	Sig. (2-tailed)	.496	.692	.698	.497	.516	.541
	N	23	23	23	23	23	21

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 23: Bivariate Pearson correlations of ESL and SII, without PT and MT

		esl00	esl01	esl02	esl03	esl04	esl05lst
SII	Pearson Correlation	-.550(**)	-.348	-.288	-.265	-.256	-.161
	Sig. (2-tailed)	.008	.095	.137	.173	.189	.433
	N	22	24	28	28	28	26
GrowthSII	Pearson Correlation	.211	.085	-.061	-.143	-.105	-.182
	Sig. (2-tailed)	.345	.693	.760	.469	.593	.375
	N	22	24	28	28	28	26
inidrv	Pearson Correlation	-.491(*)	-.378	-.215	-.250	-.264	-.197
	Sig. (2-tailed)	.020	.069	.272	.199	.175	.335
	N	22	24	28	28	28	26
iniKC	Pearson Correlation	-.413	-.235	-.172	-.170	-.171	-.082
	Sig. (2-tailed)	.056	.268	.382	.386	.385	.692
	N	22	24	28	28	28	26
inientrep	Pearson Correlation	-.507(*)	-.298	-.260	-.275	-.253	-.198
	Sig. (2-tailed)	.019	.168	.190	.165	.203	.344
	N	21	23	27	27	27	25
inoapp	Pearson Correlation	-.358	-.238	-.368	-.313	-.271	-.194
	Sig. (2-tailed)	.102	.263	.054	.105	.162	.343
	N	22	24	28	28	28	26
inoip	Pearson Correlation	-.495(*)	-.299	-.204	-.143	-.153	-.032
	Sig. (2-tailed)	.019	.156	.297	.468	.436	.878
	N	22	24	28	28	28	26
inoav	Pearson Correlation	-.477(*)	-.298	-.290	-.224	-.215	-.105
	Sig. (2-tailed)	.025	.158	.135	.252	.271	.610
	N	22	24	28	28	28	26

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 24: Bivariate Pearson correlations of ESL and SII, with countries that have data from 2000 to 2005

		esl00	esl01	esl02	esl03	esl04	esl05lst
SII	Pearson Correlation	-.503(*)	-.473(*)	-.505(*)	-.501(*)	-.509(*)	-.439(*)
	Sig. (2-tailed)	.012	.020	.012	.013	.011	.041
	N	24	24	24	24	24	22
GrowthSII	Pearson Correlation	.344	.346	.310	.261	.234	.213
	Sig. (2-tailed)	.100	.097	.140	.218	.270	.341
	N	24	24	24	24	24	22
inidrv	Pearson Correlation	-.640(**)	-.636(**)	-.629(**)	-.652(**)	-.648(**)	-.636(**)
	Sig. (2-tailed)	.001	.001	.001	.001	.001	.001
	N	24	24	24	24	24	22
iniKC	Pearson Correlation	-.477(*)	-.437(*)	-.473(*)	-.478(*)	-.479(*)	-.423
	Sig. (2-tailed)	.018	.033	.020	.018	.018	.050
	N	24	24	24	24	24	22
inientrep	Pearson Correlation	-.374	-.330	-.379	-.405	-.385	-.332
	Sig. (2-tailed)	.079	.125	.075	.055	.070	.142
	N	23	23	23	23	23	21
inoapp	Pearson Correlation	-.016	.003	-.027	-.001	-.063	.062
	Sig. (2-tailed)	.941	.988	.899	.997	.771	.784
	N	24	24	24	24	24	22
inoip	Pearson Correlation	-.471(*)	-.452(*)	-.477(*)	-.443(*)	-.453(*)	-.384
	Sig. (2-tailed)	.020	.027	.018	.030	.026	.078
	N	24	24	24	24	24	22
inoav	Pearson Correlation	-.341	-.320	-.350	-.315	-.347	-.239
	Sig. (2-tailed)	.103	.127	.094	.133	.097	.285
	N	24	24	24	24	24	22

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 25: Bivariate Pearson correlations of ESL and SII components by Old vs. New Member States

		NEW MEMBER STATES						Old Member States					
		esl00	esl01	esl02	esl03	esl04	esl05lst	esl00	esl01	esl02	esl03	esl04	esl05lst
SII	Pearson Correlation	.180	.059	-.101	-.107	-.108	-.018	-.764(**)	-.747(**)	-.731(**)	-.736(**)	-.742(**)	-.720(**)
	Sig. (2-tailed)	.699	.881	.756	.742	.738	.956	.001	.002	.002	.002	.002	.004
	N	7	9	12	12	12	12	14	14	15	15	15	14
GrowthSII	Pearson Correlation	.764(*)	.569	.431	.424	.389	.456	-.200	-.209	-.232	-.327	-.328	-.339
	Sig. (2-tailed)	.046	.110	.161	.170	.212	.136	.493	.473	.405	.234	.233	.236
	N	7	9	12	12	12	12	14	14	15	15	15	14
inidrv	Pearson Correlation	-.719	-.708(*)	-.596(*)	-.615(*)	-.623(*)	-.612(*)	-.688(**)	-.677(**)	-.662(**)	-.623(*)	-.626(*)	-.657(*)
	Sig. (2-tailed)	.069	.033	.041	.033	.031	.034	.007	.008	.007	.013	.013	.011
	N	7	9	12	12	12	12	14	14	15	15	15	14
iniKC	Pearson Correlation	.163	-.105	-.102	-.102	-.157	-.093	-.801(**)	-.768(**)	-.765(**)	-.763(**)	-.756(**)	-.738(**)
	Sig. (2-tailed)	.727	.789	.752	.753	.625	.775	.001	.001	.001	.001	.001	.003
	N	7	9	12	12	12	12	14	14	15	15	15	14
inientrep	Pearson Correlation	-.128	-.079	-.098	-.115	-.136	-.098	-.551(*)	-.520	-.494	-.550(*)	-.570(*)	-.549(*)
	Sig. (2-tailed)	.810	.853	.775	.737	.690	.774	.041	.057	.061	.034	.026	.042
	N	6	8	11	11	11	11	14	14	15	15	15	14
inoapp	Pearson Correlation	.808(*)	.669(*)	.272	.253	.236	.333	-.614(*)	-.618(*)	-.611(*)	-.608(*)	-.606(*)	-.612(*)
	Sig. (2-tailed)	.028	.049	.392	.428	.460	.290	.020	.018	.016	.016	.017	.020
	N	7	9	12	12	12	12	14	14	15	15	15	14
inoip	Pearson Correlation	.310	.264	.191	.229	.287	.291	-.666(**)	-.666(**)	-.636(*)	-.637(*)	-.640(*)	-.617(*)
	Sig. (2-tailed)	.498	.493	.551	.475	.367	.358	.009	.009	.011	.011	.010	.019
	N	7	9	12	12	12	12	14	14	15	15	15	14
inoav	Pearson Correlation	.858(*)	.702(*)	.304	.295	.294	.387	-.679(**)	-.680(**)	-.666(**)	-.665(**)	-.667(**)	-.662(**)
	Sig. (2-tailed)	.014	.035	.336	.352	.354	.214	.008	.007	.007	.007	.007	.010
	N	7	9	12	12	12	12	14	14	15	15	15	14

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 26: Bivariate Pearson correlations of MST graduates and SII components by Old vs. New Member States

		NEW MEMBER STATES					Old Member States				
		mst00	mst01	mst02	mst03	mst04lst	mst00	mst01	mst02	mst03	mst04lst
SII	Pearson Correlation	.023	-.119	-.224	-.293	-.212	.231	.321	.372	.252	.331
	Sig. (2-tailed)	.943	.713	.484	.355	.531	.427	.285	.233	.407	.293
	N	12	12	12	12	11	14	13	12	13	12
GrowthSII	Pearson Correlation	-.314	-.328	-.261	-.499	-.321	-.222	.222	.086	.212	.071
	Sig. (2-tailed)	.320	.297	.412	.099	.336	.445	.466	.790	.486	.827
	N	12	12	12	12	11	14	13	12	13	12
inidrv	Pearson Correlation	.759(**)	.717(**)	.624(*)	.611(*)	.488	.564(*)	.565(*)	.601(*)	.511	.523
	Sig. (2-tailed)	.004	.009	.030	.035	.128	.036	.044	.039	.075	.081
	N	12	12	12	12	11	14	13	12	13	12
iniKC	Pearson Correlation	.006	-.193	-.126	-.292	-.251	.177	.212	.234	.171	.196
	Sig. (2-tailed)	.986	.547	.696	.357	.457	.545	.486	.464	.577	.541
	N	12	12	12	12	11	14	13	12	13	12
inientrep	Pearson Correlation	.304	.203	.027	.075	.082	.122	.243	.318	.181	.333
	Sig. (2-tailed)	.364	.550	.936	.825	.823	.677	.424	.313	.554	.290
	N	11	11	11	11	10	14	13	12	13	12
inoapp	Pearson Correlation	-.400	-.433	-.415	-.412	-.223	.402	.536	.546	.484	.470
	Sig. (2-tailed)	.197	.160	.180	.184	.510	.154	.059	.066	.094	.123
	N	12	12	12	12	11	14	13	12	13	12
inoip	Pearson Correlation	-.410	-.496	-.567	-.639(*)	-.549	-.233	-.123	-.067	-.200	-.047
	Sig. (2-tailed)	.186	.101	.055	.025	.080	.424	.689	.837	.513	.885
	N	12	12	12	12	11	14	13	12	13	12
inoav	Pearson Correlation	-.479	-.531	-.531	-.545	-.386	.015	.152	.193	.079	.168
	Sig. (2-tailed)	.115	.076	.076	.067	.241	.959	.620	.548	.798	.602
	N	12	12	12	12	11	14	13	12	13	12

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 27: Bivariate Pearson correlation between specific CIS4 indicators and benchmark educational indicators averages

		average of EAY	average of ESL	average of LLL	average of MST	average of PISArL
inno	Pearson Correlation	-.049	-.157	.381(*)	.216	-.496(*)
	Sig. (2-tailed)	.802	.416	.041	.260	.014
	N	29	29	29	29	24
newfrm_turn	Pearson Correlation	-.201	.201	-.055	-.082	.194
	Sig. (2-tailed)	.296	.295	.775	.673	.364
	N	29	29	29	29	24
newmar_turn	Pearson Correlation	-.044	.093	-.006	-.032	.126
	Sig. (2-tailed)	.820	.633	.974	.869	.558
	N	29	29	29	29	24
rexp04	Pearson Correlation	.264	-.358	.260	.150	-.281
	Sig. (2-tailed)	.224	.094	.231	.494	.243
	N	23	23	23	23	19
funpub	Pearson Correlation	.057	-.116	.250	-.252	-.254
	Sig. (2-tailed)	.795	.599	.250	.247	.293
	N	23	23	23	23	19
coall	Pearson Correlation	.425(*)	-.483(**)	.293	.252	-.493(*)
	Sig. (2-tailed)	.022	.008	.123	.187	.014
	N	29	29	29	29	24
orginno_yes	Pearson Correlation	-.193	-.027	.257	.120	-.396
	Sig. (2-tailed)	.379	.903	.236	.586	.094
	N	23	23	23	23	19
mktinno_yes	Pearson Correlation	.040	-.124	.153	-.059	-.459(*)
	Sig. (2-tailed)	.858	.574	.485	.791	.048
	N	23	23	23	23	19
erange	Pearson Correlation	.255	-.334	-.042	.104	.023
	Sig. (2-tailed)	.182	.077	.828	.593	.913
	N	29	29	29	29	24
emar	Pearson Correlation	.141	-.181	-.127	.216	.112
	Sig. (2-tailed)	.466	.347	.512	.260	.604
	N	29	29	29	29	24
equa	Pearson Correlation	.300	-.329	-.211	-.075	.261
	Sig. (2-tailed)	.114	.082	.271	.700	.217
	N	29	29	29	29	24
eflex	Pearson Correlation	.138	-.131	-.252	-.245	.235
	Sig. (2-tailed)	.474	.498	.188	.200	.269
	N	29	29	29	29	24
ecap	Pearson Correlation	.174	-.127	-.248	-.147	.220
	Sig. (2-tailed)	.367	.510	.194	.446	.301
	N	29	29	29	29	24
elbr	Pearson Correlation	.019	-.058	-.014	.138	.044
	Sig. (2-tailed)	.922	.769	.945	.483	.841
	N	28	28	28	28	23
emat	Pearson Correlation	-.074	.062	-.171	-.026	.274
	Sig. (2-tailed)	.715	.759	.395	.896	.218
	N	27	27	27	27	22
eenv	Pearson Correlation	.080	.020	-.362	-.192	.384
	Sig. (2-tailed)	.678	.917	.054	.318	.064

		average of EAY	average of ESL	average of LLL	average of MST	average of PISArL
	N	29	29	29	29	24
ereg	Pearson Correlation	-.014	.071	-.257	-.160	.285
	Sig. (2-tailed)	.944	.715	.179	.408	.177
	N	29	29	29	29	24
propat	Pearson Correlation	-.008	-.135	.592(**)	.614(**)	-.534(*)
	Sig. (2-tailed)	.971	.538	.003	.002	.019
	N	23	23	23	23	19
prodsg	Pearson Correlation	-.075	-.047	.481(*)	.370	-.257
	Sig. (2-tailed)	.733	.831	.020	.083	.288
	N	23	23	23	23	19
protm	Pearson Correlation	.379	-.399	-.315	.280	.124
	Sig. (2-tailed)	.074	.059	.143	.196	.614
	N	23	23	23	23	19
efored_high	Pearson Correlation	.018	.046	-.323	-.193	.160
	Sig. (2-tailed)	.941	.846	.165	.414	.553
	N	20	20	20	20	16
eoqua_high	Pearson Correlation	.022	.085	-.358	-.173	.269
	Sig. (2-tailed)	.926	.721	.121	.465	.314
	N	20	20	20	20	16
eored_high	Pearson Correlation	-.034	.107	-.258	-.091	.094
	Sig. (2-tailed)	.888	.653	.273	.703	.728
	N	20	20	20	20	16
eosat_high	Pearson Correlation	-.090	.179	-.277	-.170	.123
	Sig. (2-tailed)	.706	.450	.237	.473	.650
	N	20	20	20	20	16

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

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Abstract
The present paper explores the relationship between education and innovation. Specifically, the paper explores the relationship between educational benchmarks indicators and innovation composite indexes. The relationships found are relatively weak and differ considerably depending on which countries are taken into account for the analysis. Old Member States (15 Members, before 2004) tend to have stronger correlations between innovation and educational indicators. Lifelong learning seems to be the factor most commonly associated with innovative countries.

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