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INNOVATION, KNOWLEDGE AND REGIONAL ECONOMIC PERFORMANCES: REGULARITIES AND DIFFERENCES IN THE EU

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Abstract

This paper examines how the recent economic performance – jointly measured by the level and growth rate of per capita GDP - of 151 developed European regions has been affected by their innovation and knowledge base. A regression analysis is carried out by using as a main explanatory variable a composite indicator extracted from a comprehensive set of innovation and education variables. The above relationship is controlled for structural characteristics and allowed to vary across EU countries. The results point to a highly significant economic impact of innovation and knowledge which, however, is not homogeneous among countries and regions.

Keywords: Regional economic performances; innovation and knowledge.

JEL codes: O18, O33, R11.

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1. Introduction

Among the reasons of the unsatisfactory economic performances of the EU during the second half of the 1990s and the early 2000s, a great emphasis has been put on its weak innovation and knowledge base, especially when compared to that of the US. Indeed, this was the main rationale of the Lisbon strategy aimed at transforming Europe in "the most competitive and dynamic knowledge-based economy in the world". In order to assess the potential benefits of this strategy, this paper examines some recent data concerned with European regions. Since the overall weakness of the EU is accompanied by remarkable regional differences in terms of R&D, patents and higher education, our aim is to test whether these disparities are significantly associated with regional economic performances.

The analysis refers to 151 developed regions of the EU where "developed" means with a level of per capita GDP equal or above 75% of the EU25 average. With respect to economic performances we employ a composite indicator that gives an equal weight to the level of per capita GDP in 2000-02 and its growth rate over the period 1995-2002. As a main explanatory variable of regional economic performances we use a composite indicator of innovation and knowledge which refers to the years 1995-96 and is obtained from a comprehensive set of measures: the intensity of R&D expenditures and EPO applications, the employment shares in high-tech manufacturing and services, the share of adults with tertiary education, and the percentage of turnover due to products new to the firms. The above relationship is controlled for the structural characteristics of the regions and allowed to vary among countries.

The results of a regression analysis shows that the recent economic performances of the EU developed regions have been positively and significantly affected by their innovation and knowledge base. However, the above relationship is far from being homogeneous across countries and regions. By controlling for the regional population density, the economic impact of innovation and knowledge is generally weaker and, for some countries, not significant. Secondly, the same impact is much higher within the EU countries endowed, on average, with a stronger innovation and knowledge base. Both findings suggest that, to allow a greater effect of innovation and knowledge on economic performances, traditional innovation policies need to be accompanied by other specific policies, tailored on the different features and actors of the national and regional innovation systems.

The paper is organised as follows. Section 2 reviews the main backgrounds of the present study while section 3 illustrates the aim and the geographical scope of the analysis. Sections 4 and 5 describe how the two composite indicators of, respectively, innovation & knowledge and economic performances are obtained and distributed across countries and regions. Section 6 presents the regression results and section 7 concludes with some reflections.

2. Backgrounds of the study

In contrast with the standard neoclassical framework, endogenous growth models contend that, in the long run, economic growth is influenced, rather than by exogenous changes in technology and population, by the intentional accumulation of knowledge or R&D (Romer, 1990), human capital (Lucas, 1988) as well as the effective introduction of innovations (Aghion and Howitt, 1998); all these activities are themselves determined by economic growth, giving rise to a process of cumulative causation. Albeit starting from quite different premises, neo-schumpeterian (or evolutionary) economists share many explanations based on endogenous growth theories: however, according to the "technology-gap theory" of economic growth (Fagerberg, 1987; Verspagen, 1991; Fagerberg and Verspagen, 2002), they argue that the successful introduction and assimilation of new technologies requires a broad range of enabling conditions (see also Abramovitz, 1986). Without a consistent socio-institutional setting, the efforts needed to introduce and absorb innovation might be sub-optimal, so that there are no deterministic mechanisms which ensures that, even in the long run, lagging economies will converge to the leaders.

A large body of empirical evidence across countries support the above arguments (see for a recent survey, European Commission, 2005). In terms of economic growth, the impact of R&D and education is substantial and provides permanent rather than transitory advantages to the most knowledge-based economies.

The above insights and evidences, feed the current debate on the EU economic prospects. The Sapir report, for instance, contends that the catching-up with the US, mainly based on imitation and accumulation of physical capital, was exhausted when the European countries moved closer to the technological frontier. In the new phase, "innovation at the frontier has become the main engine of growth" (Sapir at al., 2003, p. 29) and this justifies the need of extra-ordinary investment in R&D and education, as stressed by the Lisbon strategy.

It can be added that since the new technologies become more and more complex and knowledge-intensive, it is difficult to exploit them effectively without an adequate knowledge base. A high stock of human capital increases the capability to assimilate new technologies and this effect, stressed by Nelson and Phelps (1966) in their seminal contribution, is greater the more an economy is close to the technological frontier. Similarly, R&D activities are necessary not only to introduce innovation at the frontier but also to remain close to it, by maintaining an adequate absorption capacity (Cohen and Levinthal,1989).

All the above arguments have been at the basis of many recent studies on regional growth differentials. The increasing attention to the regional dimension of economic growth is due, among other reasons, to the fact that, even when developed nations converge, the differences within them appear persistent. In spite of its ongoing economic integration, this seems the case of the EU during the last two decades (Fagerberg and Verspagen, 1996; Sapir et al. 2003; Gardiner et al., 2004).

In the explanation of these enduring growth differentials among regions, the endogenous growth theory and the new economic geography display an interesting convergence. For instance, by combining a core-perifery model à la Krugman with endogenous growth à la Romer, Fujita and Thisse (2002) conclude that economic growth and agglomeration economies are mutual self-reinforcing phenomena pointing to increasing regional specialisation and concentration of economic activities and, then, no necessary convergence.

Although the importance of innovation and knowledge has been increasingly recognised, due to the lack of spatially disaggregated data, a few studies have used innovation and human capital variables as determinants of the growth differentials among EU regions.

By considering 106 European regions, Cappellen et al. (1999) show that the initial share of R&D personnel on total employment is positively associated to the changes of per capita GDP over the period 1980-94[1]. However, when the authors split the sample into two regional groups with high and low R&D intensity, only within the former group the innovation variable maintains a positive and significant coefficient. Being the measure of R&D intensity strongly correlated with the initial level of per capita GDP, the authors conclude that a high propensity to innovation is beneficial only for the regions that are above a certain threshold of development.

Mora et al. (2005) find that the initial regional specialisation in high-tech services affects positively and significantly the change of per capita GDP in 108 EU regions during the period 1985-2000.

Badinger and Tondl (2003) examine 128 European regions and use both innovation and human capital indicators as explanatory variables of the average growth rate of per capita Gross Valued Added over the period 1993-2000. Using a production function framework to test the “technology-gap” approach (see above), they show that the initial share of adults with tertiary education exerts a significant impact on regional growth and the same occurs to the intensity of patent application per employee. Moreover, the catching-up process is faster for the regions with greater shares of highly educated people.

Another strand of literature, focussed on innovation only, has examined the regional distributions of patents and R&D expenditures and the spatial correlation among the two measures. Acs et al. (2002) and Bottazzi and Peri (2003) have linked R&D to patent activities across, respectively, US metropolitan areas and EU regions. They find a patent/R&D elasticity close to unity also after controlling for spatial spillovers which are found to be remarkable but strongly localised. Similar results are attained by Moreno-Serrano et al. (2004) who analyse EPO applications across 175 European regions and over the period 1981-2001. First, they find that patent applications have been strongly concentrated in Northern and Central European countries. Secondly, patenting activities are correlated with the R&D performed in contiguous areas but this occurs mainly between regions within a country so that innovation or knowledge spillovers appear significantly constrained by national borders[2].

To synthesise, both the uneven regional distribution of innovative activities and the presence of localised spillovers point to the key role played by the regional dimension (Frenz and Oughton, 2005; Todtling and Trippl, 2005). A further argument of support relies on the mounting importance of knowledge, especially in its tacit component. As stressed by Asheim and Gertler (2005) among others, tacit knowledge, which is naturally fostered by geographical proximity, is becoming crucial to be a “successful” region, not only in terms of production and absorption of innovations but also with respect to the learning ability of local organisations. The latter is obviously influenced by the extent and quality of local interactions between government, business and education. In this connection, the conceptual passage from national (Lundvall,1992; Nelson,1993) to regional systems of innovation (Howells, 2002; Asheim and Gertler, 2005) should be viewed as an important advancement, both for analytical and policy purposes.

Regional innovation systems are differentiated by a broad range of institutional, structural and technological features and, above all, by their inter-relationships[3] so that, across regions, an identical stock or increase of innovation and knowledge does not guarantee equal

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[1] A result confirmed by Cappellen et al. (2003) for a more recent period.

[2] This conclusion is shared by Maurseth and Verspagen (2002) who have examined, across 112 European regions, geographical spillovers of innovation or knowledge by using patent citations.

[3] By using this kind of information, Todtling and Trippl (2005) distinguish among peripheral, “old” industrial and metropolitan regions and identify different sets of innovation policies tailored on their idiosyncratic features.

improvements of economic performances. As Oughton et al. (2002) point out in the light of the European evidence, traditional innovation policies based on purely quantitative targets (such as the intensity of R&D expenditures) may not reduce and, actually, might increase regional disparities.

Thus, contrary to the assumptions of endogenous growth models, the relationship between knowledge and economic growth is not necessarily linear. Acs et al. (2004) contend that, between the two spheres, a filtering mechanism is needed and that such a role is played by entrepreneurship capital: the ability of a country (or a region) to convert public knowledge into "useful" economic knowledge relies on its availability of would-be and effective entrepreneurs which is fostered by a socio-economic environment favourable to new business activities. Audretsch and Keilbach (2006) test the above hypothesis across 440 German counties and find that their GDP growth is significantly and equally affected by the regional R&D intensity and a measure of entrepreneurship capital.

3. Aim and geographical scope

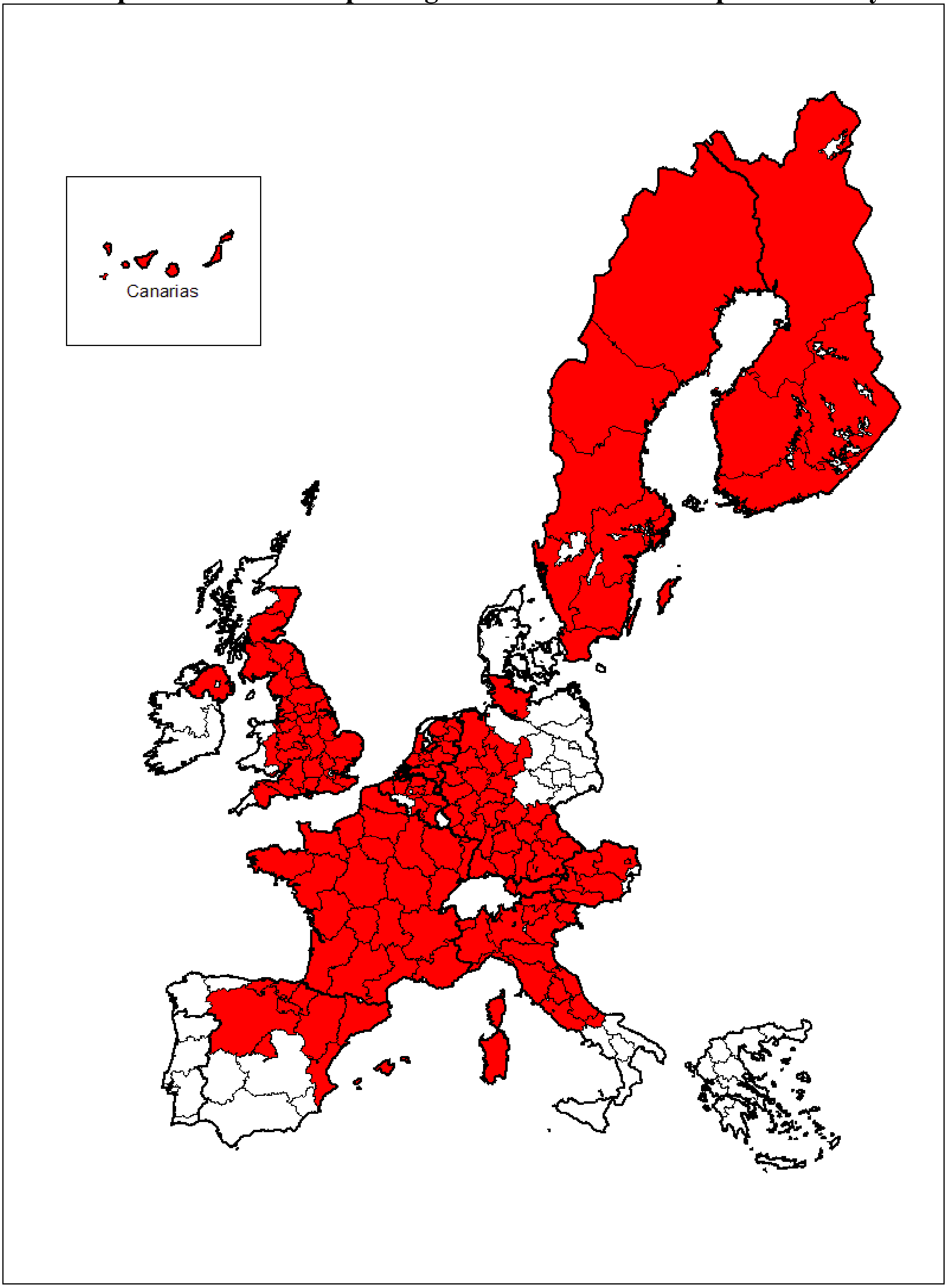
This paper employs a comprehensive set of innovation and knowledge indicators as determinants of the recent economic performances of European NUTSII regions. The latter are computed over the period 1995-2002 while innovation measures refer to the initial years. The reference period, shaped by the ICT revolution and the so called "knowledge economy", is particularly suitable for testing whether the economic impact of innovation and knowledge variables has been substantial also for the EU regions characterised by a relatively high level of development. We then consider the NUTSII regions of Europe which have recorded, in the early 2000s, a level of per capita GDP (in Purchasing Power Standards) equal to or above 75% of the EU25 average.

There are two main reasons for focussing on developed regions only.

First, in the new regulation of the EU regional policy for the period 2007-13 (see European Commission, 2004) the regions with the above level of GDP per capita will be eligible to a new "competitiveness and employment objective" while the remaining low-income regions to a "convergence objective" (which will be in place of the current "Objective 1"). For the former group of regions, the EC guidelines identify " innovation & knowledge" as one of the key policy areas, also with a view to provide a further contribution to the attainment of the Lisbon goals. As a consequence, to assess whether this strategy is likely to produce the

expected outcomes, an inspection to the recent performances of the relatively developed areas of the EU is useful.
Secondly, within the broad geographical area composed by European developed regions a sufficient knowledge base already exists so that, in contrast with low income regions (see the previous section), it is likely that the effects of innovation, knowledge and education on the level and growth of economic performances are already substantial and could increase further if sustained by adequate policy measures. This does not imply that the less developed regions of the EU should be left behind (on the contrary, they will continue to receive the bulk of regional development funds) but that to speed-up their process of convergence a broader and more variegate mix of policy interventions, tailored on their peculiar features, is needed.
Since our focus is on regional rather than country differences, the European countries containing only one or two NUTSII regions of the first type (i.e. those eligible to the new competitiveness objective) are not taken into account. Thus, five countries of the former EU15 are excluded: Denmark (1 region corresponding to the whole country), Greece (2 regions), Ireland (2), Luxembourg (1) and Portugal (2). The same applies to four New Member States containing only one developed region (Czech Republic, Cyprus, Hungary and Slovakia). Moreover, other four regions with abnormal indicators of economic performances are excluded. Specifically, the big capital cities of Brussels and Inner London coincide with two NUTSII regions with a per capita GDP more than double with respect to the average of the EU developed regions. On the other hand, the German region coinciding with the city of Berlin records a GDP per capita 20% lower than the reference average coupled with a negative rate of GDP growth over the period 1995-2002. Finally, another peculiar case is that of Åland in Finland, a small highland of only 26 thousands inhabitants recording a GDP per capita 50% higher than the above mentioned average (along with an excellent GDP growth rate). To avoid the possible biases due to the inclusion of relevant outliers, these four regions are not included in our empirical analysis. Thus, at the end, our study refers to 151 regions.
Map 1 illustrates their geographical location in the EU15 space while the complete list of them is provided in appendix A.1.

Map 1 - EU-15 developed regions considered in the present study



4. The composite indicator of innovation and knowledge

For the purposes of our study we collected six indicators of the regional innovation and knowledge base, all included in the *European Innovation Scoreboard* (European Commission, 2006). Since our aim is to use these measures as explanatory variables of the regional growth of per capita GDP over the period 1995-2002 and its regional level during 2000-02, the following indicators refer, with only one exception, to the years 1995 or 1996:

1) share of total (private and public) R&D expenditures on GVA (Gross Value Added);
2) log of patent applications to the European Patent Office (EPO) per million inhabitants;
3) share of employment in high-tech manufacturing (Office machinery, Radio & telecommunications equipment, Scientific instruments, Aerospace);
4) share of employment in high-tech (or knowledge-intensive) services (Post & communications, Computer, Software and R&D services);
5) share of adult population (aged from 25 to 65) who attained a tertiary level of education; this variable is available for EU NUTSII regions only since 1999;
6) share of turnover due to products that are new to the firm, a variable obtained from the second Community Innovation Survey (CIS2) and referring to the year 1996; contrary to the previous variables, this indicator is provided as a value re-scaled across all the EU15 NUTSII regions (ranging from 0 – ascribed to the region with the lowest share – to 100[4]).

Apart from the last measure which derives from a specific study carried out for the EU regions (see European Commission, 2003), all the other variables are taken from the regional statistics provided by Eurostat (see Appendix A.2 for technical and computational details). The first two indicators denote the traditional inputs (or intermediate outputs in the case of patents) of the innovation process; the third and four variables measure the high-tech specialisation of the region and the distinction between manufacturing and services is particularly useful when the most recent years, shaped by the ICT revolution, are taken into account; the fifth indicator is a proxy for the highest level of human capital available in the region; finally, the sixth variable is the only measure of innovation output considered in the present study and can be taken as a proxy of the regional capability to assimilate innovations which are not necessarily produced in the local context .

According to the survey provided in section 2, not all the above indicators have been extensively used in the empirical literature and, to our knowledge, there have been no

[4] The region with the lowest share of turnover attributable to new-to-the-firm products was Åland in Finland (a region excluded from our analysis) while that with the highest share was Braunschweig in Germany. See European Commission (2003, Annex Table F: Re-scaled European indicator values).

attempts to considered all of them together either to shape the innovation capabilities or explain the regional economic performances across Europe.

Table 1 – Indicators of innovation and knowledge across 151 EU developed regions

	No. of NUTSII regions	R&D expenditures on GVA		Ln EPO application per million inhabitants		Share of employment in high-tech manufacturing	
		Mean	Stand. Dev.	Mean	Stand. Dev.	Mean	Stand. Dev.
Austria	8	1.491	0.923	4.622	0.325	1.717	0.639
Belgium	9	1.710	1.142	4.383	0.655	1.246	0.650
Germany	29	1.952	1.350	5.081	0.573	1.944	0.861
Spain	11	0.686	0.415	2.205	0.958	0.702	0.409
Finland	4	3.048	1.390	4.858	0.621	2.075	0.992
France	22	1.267	0.822	4.041	0.671	1.418	0.768
Italy	15	0.829	0.514	3.587	0.923	1.214	0.529
Netherlands	12	1.751	0.746	4.568	0.413	1.410	0.964
Sweden	8	2.476	1.661	5.090	0.444	1.703	0.676
UK	33	1.936	1.307	4.261	0.561	1.805	0.843
Total	151	1.647	1.199	4.280	0.971	1.568	0.830
Between country dispersion			20%		59%		19%
Within country dispersion			80%		41%		81%

	Share of employment in high-tech services		Share of adults with tertiary education		Share of turnover due to products new to the firm (*)		Composite indicator of innovation & knowledge	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Austria	2.304	0.566	19.511	2.010	46.250	9.794	-0.107	0.510
Belgium	3.054	1.042	31.723	5.745	19.111	1.054	0.141	0.706
Germany	2.824	0.513	22.781	3.099	59.069	22.290	0.547	0.846
Spain	1.743	0.878	27.858	6.043	36.727	21.804	-1.224	0.874
Finland	3.604	1.275	24.823	2.349	29.375	10.144	0.824	1.058
France	3.084	0.899	20.675	4.117	23.636	11.919	-0.370	0.787
Italy	2.374	0.837	12.912	1.770	36.067	22.607	-1.015	0.721
Netherlands	2.991	0.937	24.424	5.168	34.583	8.836	0.103	0.501
Sweden	4.009	1.208	26.589	4.696	40.375	9.516	0.887	1.088
UK	3.278	1.116	26.151	4.096	31.364	4.872	0.271	0.909
Total	2.920	1.022	23.346	6.037	37.156	19.169	0.000	1.000
Between country dispersion		25%		57%		42%		37%
Within country dispersion		74%		43%		58%		63%

(*) Value re-scaled across all the NUTSII regions of the EU15 (range 0-100).

Table 1 shows that, in line with the findings of other recent studies for the EU regions (Oughton et al., 2002; Frenz and Oughton, 2005), the regional dispersion of the R&D intensity is mainly due to within country differences (accounting for 80% of the total variance). The same conclusion arises for the employment share in high-tech manufacturing and, albeit to a lower extent, for the share of turnover due to new products[5]. The intensity of EPO applications and the share of adults with tertiary education across regions are instead significantly influenced by country effects: respectively, 59% and 57% of their total variance is due to between country dispersion.

All the selected indicators are significantly correlated – albeit not to the same extent - across the 151 European regions under examination. The R&D intensity is particularly associated with the log of EPO applications per million inhabitants[6] followed by the shares of employment in high-tech manufacturing and services. Lower correlation coefficients, although significant, arise for the intensity of tertiary education and the share of turnover due to product innovations.

In any case, the significant correlation coefficients between the six measures of innovation and knowledge suggest that a composite or synthetic indicator can be computed. For this purpose we run a factor analysis to identify what components capture the maximum possible variance among the original variables.

Table 2 - Factor analysis for innovation and knowledge indicators

Factor weight	2.814
Percentage of total correlation explained	46.908
Correlation with the original variables:	
R&D expenditures on GVA	0.871
Ln EPO application per million inhabitants	0.808
Share of employment in high-tech manufacturing	0.639
Share of employment in high-tech services	0.682
Share of adults with tertiary education	0.593
Share of turnover due to products new to the firm	0.422

[5] It must be reminded that for this indicator the mean values reported in table 1 do not refer to the original shares of turnover due to new products but are re-scaled across all the European regions. Thus, for instance, the mean of 19.1 attached to Belgian regions indicates that, on average, their share of innovative turnover amounts to 19% of that recorded by the best NUTSII region of the EU15. Moreover, the relatively low standard deviations arising for Belgium and UK are due to the fact that, for these two countries, CIS2 data are available only for NUTSI regions.

[6] This high correlation could be partially due to the way in which R&D intensities are attributed to some NUTSII regions. In fact, when only R&D data at the level of NUTSI (UK) or NUTS0 (Belgium and Sweden) were available, the R&D intensities were imputed to NUTSII regions in line with the differences arising from the EPO applications per million inhabitants. This procedure was chosen after verifying that, across the EU NUTSII or

From this analysis only one important factor emerges (where "important" means with an eigenvalue greater than one). Table 2 shows that this factor is quite informative accounting for 47 per cent of the total correlation among the basic indicators; moreover, it appears strongly associated with the intensities of R&D and EPO applications while the correlation with the share of innovative turnover is much lower. On the basis of these results, a factor score (synthesising the information contained in the six basic variables) can be attached to each region and taken as a composite indicator of innovation and knowledge.

The country means of this composite indicator are reported in the last column of the bottom part of table 1 and confirm the well known "technological" divide between Northern and Southern European countries: positive scores[7] arise for the former (which are, in decreasing order, Sweden, Finland, Germany, UK, Belgium, and the Netherlands) while the latter record negative scores (Spain, Italy, France, and Austria). Moreover, the decomposition of variance shows that between country differences explain a substantial share (37%) of the regional dispersion.

According to the above findings and since our aim is that of emphasising idiosyncratic regional differences, the country effects should be removed from our data. Then, in the remaining of this paper, all regional variables of innovation and knowledge shall be expressed as deviations from national un-weighted means, where "national" stands for all the developed regions belonging to each country (cf. the first column of table 1).

Table 3 - Factor analysis for innovation and knowledge indicators expressed as deviations from national means

Factor weight	2.916
Percentage of total correlation explained	48.594
Correlation with the original variables:	
R&D expenditures on GVA	0.843
Ln EPO application per million inhabitants	0.786
Share of employment in high-tech manufacturing	0.511
Share of employment in high-tech services	0.638
Share of adults with tertiary education	0.813
Share of turnover due to products new to the firm	0.508

Table 3 reports the results of the factor analysis applied to the six variables computed as deviations from country means. Once again, only one relevant factor emerges which,

NUTSI regions for which both R&D and patent data were available in 1995, the correlation coefficient was highly significant and equal to 0.6.

however, is now particularly correlated with the intensity of R&D and the share of adults with tertiary education, while the role of EPO applications is reduced as compared to the previous results. Moreover, along with the share of innovative turnover, also the employment share in high-tech manufacturing plays a secondary role. In conclusion, by removing country effects, the composite indicator of regional innovation and knowledge that can be computed from the scores of the factor analysis is mainly shaped by within country differences in terms of R&D and higher education.

Table 4 illustrates the distribution of this composite indicator by showing, for each country, the minimum and maximum values and the corresponding regions.

Table 4 – Composite indicator of innovation and knowledge*

	Number of NUTSII regions	Minimum value (region)	Maximum value (region)	Interval
Austria	8	-0.570 (Salzburg)	1.381 (Wien)	1.950
Belgium	9	-0.978 (Limburg)	1.760 (Brabant Wallon)	2.315
Germany	29	-1.636 (Weser-Ems)	2.370 (Oberbayern)	4.005
Spain	11	-1.532 (Illes Balears)	2.252 (Comunitad de Madrid)	3.784
Finland	4	-1.648 (Itä-Suomi)	1.324 (Etelä-Suomi)	2.972
France	22	-1.924 (Corse)	3.194 (Île de France)	5.118
Italy	15	-1.521 (Sardegna)	1.794 (Lazio)	3.315
Netherlands	12	-1.334 (Zeeland)	0.881 (Noord-Brabant)	2.215
Sweden	8	-1.582 (Småland med öarna)	2.783 (Stockholm)	4.366
UK	33	-1.515 (South Yorkshire)	3.168 (Berkshire, Buckinghamshire, Oxfordshire)	4.683

*= Computed on the basis of the scores arising from the factor analysis for the innovation and knowledge indicators expressed as deviations from national means (cf. table 3).

[7] The mean of the scores arising from the factor analysis is, by definition, equal to zero so that the positive values identify the regions and, then, the countries with above average innovation and knowledge performances.

There are remarkable regional differences within countries, no matter their average performance in terms of innovation and knowledge. Less technology-oriented countries contain some regions that score largely above the national mean (which is centred, by definition, around zero): a notorious example is that of Ile de France but also in Spain and Italy the interval between the best and worst region is substantial. Strong regional differences are also displayed by the more technology-oriented countries and this is particularly the case of UK, Sweden and Germany.

In all the countries in which they are included (i.e. apart from Belgium, Germany and UK), the regions hosting the country capital attain the highest scores, confirming that highly urbanised or metropolitan areas act as strong centres of attraction for (private and public) R&D activities, advanced business services and highly educated workers.

As a consequence, to avoid a spurious correlation between innovation & knowledge variables and economic performances, it is highly advisable to control for the role played by agglomeration economies which can be proxied by the density of population.

5. The composite indicator of regional economic performances

The economic performance variables used in this study are the log of GDP per capita in PPS (Purchasing Power Standards) averaged over the years 2000-02 and the rate of growth of per capita GDP at constant prices during the period 1995-2002. In principle, other indicators could have been used such as the growth of labour productivity or the employment rate but they are, on the one hand, less general measures of economic performance and, on the other, strongly correlated with the level and growth rate of per capita GDP. Thus, for the sake of parsimony and the purposes of the present study, the two selected indicators are sufficiently informative.

As mentioned in section 3, the level of per capita GDP represents the crucial variable used by the EC to distinguish between "developed" and "less developed" regions. Moreover, it can be taken as a broad measure of the regional competitiveness reflecting the cumulative outcome of past growth performance (Gardiner et al., 2004; Frenz and Oughton, 2005). As depicted by table 5, in spite of having a level of GDP per capita equal or above 75 per cent of the EU25 average, the 151 developed regions considered in this study are characterised by significant differences which, moreover, are marginally influenced by country effects. In fact, 87% of the total variance is explained by the regional (within countries) dispersion. The countries recording a regional dispersion significantly above the average are Finland, Germany, Italy and Austria.

For the second, dynamic measure of economic performance we compute GDP per capita at constant (1995) prices for each NUTSII region according to the sectoral composition of its economy. For this purpose, we take the 6 macro branches of the NACE classification[8] for which national data on Gross Value Added at constant prices are available; then, after allocating the GDP-GVA difference pro-rata among the branches, each national branch is broken down by NUTSII regions using as weights the regional shares of GVA at current prices; finally, the resulting regional values at constant price for each branch are summed-up. The growth rate of real GDP per capita over the period 1995-2002 is expressed as the log difference between the initial and final year.

Table 5 – Indicators of economic performance across 151 EU developed regions

	No. of NUTSII regions	Ln GDP per capita in PPS 2000-02		ΔLn GDP per capita at constant prices 1995-2002	
		Mean	Stand. Dev.	Mean	Stand. Dev.
Austria	8	10.136	0.179	0.152	0.023
Belgium	9	9.947	0.174	0.141	0.045
Germany	29	10.057	0.180	0.081	0.037
Spain	11	9.938	0.126	0.187	0.040
Finland	4	9.945	0.198	0.219	0.047
France	22	9.942	0.148	0.157	0.027
Italy	15	10.084	0.180	0.108	0.035
Netherlands	12	10.064	0.175	0.142	0.042
Sweden	8	10.025	0.157	0.155	0.052
UK	33	9.976	0.165	0.168	0.064
Total	151	10.010	0.173	0.141	0.057
Between country dispersion			13%		41%
Within country dispersion			87%		59%

Sources: for the level of GDP: Eurostat; for the growth of GDP: own computations from Eurostat data.

[8] NACE A+B = Agriculture, hunting and forestry, fishing; C+D+E = Mining and quarrying, manufacturing, electricity, gas and water supply; F = Construction; G+H+I = Wholesale and retail trade, hotels and restaurants, transport, storage and communications; J+K = Financial intermediation, real estate, renting and business activities; L to P = Other services (public administration and defence, compulsory social security, education, health and social work, other community, social and personal service activities, private households).

Table 5 shows that, in contrast with the final level of per capita GDP, its growth rate is significantly affected by country differences as displayed by the fact that only 59% of the total variance is due to within country dispersion.

The final level and the growth rate of per capita GDP could be positively correlated as far as the richest (poorest) regions have grown faster (slower). However, this is not the case, since the coefficient of simple correlation between the two variables is very low (0.09) and not statistical significant. This low correlation could be due, among other factors, to the different role played by country effects which is much more pronounced in the growth rather than the level of per capita GDP. Since our aim is to stress regional differences, as done for the innovation and knowledge indicators in the previous section, the two measures of economic performance have been transformed into deviations from country means (again, only the developed regions of each country are considered). Computed in this way, the level and growth of per capita GDP are significantly correlated although with a not particularly strong coefficient (0.32).

Table 6 – Composite indicator of economic performance *

	Minimum score (region)	Maximum score (region)	Interval
Austria	-0.771 (Niederösterreich)	0.903 (Wien)	1.674
Belgium	-1.625 (Luxembourg)	1.531 (Brabant Wallon)	3.156
Germany	-1.668 (Trier)	2.467 (Hamburg)	4.135
Spain	-1.175 (Canarias)	1.453 (País Vasco)	2.628
Finland	-1.632 (Itä-Suomi)	1.625 (Etelä-Suomi)	3.256
France	-1.100 (Lorraine)	1.972 (Île de France)	3.072
Italy	-0.919 (Valle d'Aosta)	0.892 (Prov. Trento-Bolzano)	1.812
Netherlands	-1.735 (Drenthe)	1.998 (Utrecht)	3.733
Sweden	-1.412 (Övre Norrland)	2.148 (Stockholm)	3.560
UK	-3.257 (Cumbria)	3.204 (Berkshire, Buckinghamshire, Oxfordshire)	6.461

*= Computed from the scores of the factor analysis for the level and growth of per capita GDP expressed as deviations from national means.

In order to find a composite indicator of economic performance, ascribing an equal weight to the level and the growth rate of per capita GDP, we use again a factor analysis. Across the EU developed regions, the extracted factor accounts for 66 per cent of the total variance among the two variables and is associated to them with an identical correlation coefficient of 0.81. Then, a factor score denoting the composite indicator of economic performance can be attached to each region.

The value of this composite indicator is positive for the regions which perform above the national mean and negative otherwise. The width of the interval between the lowest and highest value depends on the extent of regional disparities within each country. Thus, as table 6 shows, UK and Germany are characterised by the strongest regional differences in terms of economic performances while lower regional disparities arise for Austria and Italy.

Another interesting feature revealed by table 6 is that, although the best scores are in general obtained by urban regions (often hosting the capital city of the country), there are some relevant exceptions to this rule. In Spain the best performing region is the Basque Country rather than the region of Madrid. In Italy the provinces of Trento and Bolzano (bordering on Austria) rather than Lazio or Lombardia (the most urbanised region of Italy which hosts Milan, recognised as the "business capital" of the country). In the Netherlands, the region of Utrecht which scores much higher than Noord-Holland. The top position attained by these three regions is due to their very good performance in terms of GDP growth. The above examples (among many other intermediate cases that could be mentioned) are useful for stressing that the joint employment of recent regional data for the level and growth of GDP gives rise to a non obvious ranking of the EU developed regions.

6. Linking economic performance to innovation & knowledge

In this section a regression analysis is carried out across EU developed regions. The dependent variable is the composite indicator of economic performance described in the previous section (*ECPERF*) which is assumed to be mainly explained by the composite indicator of innovation and knowledge computed in section 4 (*INKNOW*). As argued at the end of the same section, the above relationship must be controlled for the structural features of the regions and, in this respect, the population density – being a proxy for agglomeration economies - should play a crucial role. Accordingly, the equation to be estimated becomes:

$ECPERF_i = \alpha\ INKNOW_i + \beta\ LnPOPDENS_i + \varepsilon_i$ [1]

where i=1,…,151 denotes the EU developed regions, the population density is expressed in natural logs and ε is the error term. To be free from country effects, all the variables are computed as deviations from national means so that the constant term of the regression is omitted because, by definition, it is equal to zero. It must be added that, to control for other structural characteristics of the regions, additional explanatory variables were used[9]; they are not displayed because did not exert a significant impact on economic performances.

To test the stability of the innovation parameter (α) across EU countries, an alternative specification that shall be used is the following:

$ECPERF_i = \Sigma_j\ \alpha_j\ (INKNOW_i * COUNTRY_j) + \beta\ LnPOPDENS_i + u_i$ [2]

where the innovation and knowledge variable is interacted with j country dummies (with j=1, …,10).

The nature of available data allows one to run a cross-sectional regression only[10] so that the issues of regional heterogeneity and endogeneity between dependent and independent variables cannot be properly addressed. In any case, the fact that the dependent variable is extracted from the level of GDP per capita in 2000-02 and its growth rate over the period 1995-2002 while the innovation and knowledge variable refers to the beginning of the period (1995-96) alleviates the problem of endogeneity. Similarly, by adding the population density as a control variable, an important source of regional heterogeneity is taken into account. Finally, it must be stressed that our regression exercise has nothing to do with a standard convergence analysis since the dependent variable is not limited to the growth of per capita GDP but it is also affected by its level at the end of the period; as a consequence, the inclusion of the initial level of GDP in the right-hand side of equation [1] or [2] is redundant.

Table 7 presents four regression specifications estimated by means of OLS. The first uses as explanatory variable only the composite indicator of innovation and knowledge. The second, instead, includes ten variables obtained by interacting the innovation indicator with country dummies. The third specification adds the log of population density as a control variable while the fourth also includes the ten interaction variables.

[9] Namely, the employment share in total manufacturing (useful to identify "industrial" regions) and the employment share in total business services. The former was always not significant while the latter did not provide additional explanatory power when inserted together with the population density.

[10] A panel analysis was precluded by the lack of complete annual series (from 1995 on) for most of the innovation and knowledge variables.

Table 7 – OLS regression results for the composite indicator of economic performance

	Specification 1 Coeff.	St. Err.	Specification 2 Coeff.	St. Err.	Specification 3 Coeff.	St. Err.	Specification 4 Coeff.	St. Err.
α	0.623	0.064**			0.532	0.065**		
β					0.298	0.073**	0.384	0.077 **
α_1 (Austria)			0.589	0.495			-0.257	0.489
α_2 (Belgium)			0.911	0.272**			0.774	0.253**
α_3 (Germany)			0.507	0.139**			0.472	0.129**
α_4 (Spain)			0.421	0.197**			0.328	0.183*
α_5 (Finland))			1.020	0.357**			0.848	0.332**
α_6 (France)			0.322	0.165*			0.154	0.156
α_7 (Italy)			0.403	0.226*			0.193	0.213
α_8 (Netherland)			1.270	0.332 **			1.011	0.312**
α_9 (Sweden)			0.663	0.217**			0.340	0.211
α_{10} (UK)			0.827	0.126**			0.839	0.116**
Adjusted R^2	0.384		0.407		0.443		0.493	
		P-value(°)		P-value(°)		P-value(°)		P-value(°)
Breusch-Pagan test (heteroskedasticity)	2.16	0.142	5.39	0.864	0.30	0.861	2.03	0.998
LM test for spatial error dependence	1.763	0.184	1.790	0.181	0.853	0.356	0.247	0.619
LM test for spatial lag	0.826	0.364	0.574	0.448	0.301	0.583	0.033	0.856
F test for the equality of parameters α_j			1.65	0.107			2.63**	0.007

*= significant at 0.05 **=significant at 0.01.
(°) = Relative to the null hypothesis of, respectively, no heteroskedasticity, no spatial error, no spatial lag dependence and equality of the parameters α_j (with j=1,…,10).

Along with the usual test for heteroskedasticity (which does not appear to be a problem), a test for the equality of interaction parameters is presented when applicable and, in order to verify whether the OLS estimates are affected by the presence of spatial correlation in regional economic performances, two Lagrange Multiplier (LM) tests for spatial error and spatial lag dependence are used (Anselin, 1988; see, for an application to regional data, Acs et al., 2002). In fact, OLS estimators are inefficient in presence of spatially auto-correlated residuals and biased and inconsistent when there is spatial interdependence in the dependent variable. By exploiting OLS residuals, the two LM tests control for these potential miss-specifications. The latter do not affect our OLS estimates since, in all the regressions, both tests – performed by means of a row-normalised binary contiguity matrix for the 151 regions - accept the null hypothesis of no spatial correlation.

In the first specification, the innovation variable turns out to be highly significant in explaining the recent economic performances of the EU developed regions. By introducing country interaction variables (specification 2) the goodness of fit of the regression increases and a differentiated impact of the innovation and knowledge base seems to arise among countries: however, the F test indicates that the parameter α is not statistically different across countries.

The results change when also the log of population density is included in the regression. The third specification, as opposed to the first one, displays a remarkable increase of the adjusted R squared suggesting that, ceteris paribus, the most urbanised regions record better economic performance; in addition, although the innovation coefficient remains substantial and very significant, its size is reduced. When the innovation parameter is allowed to vary among EU countries (specification 4), the estimated coefficients appear very different and, in this case, the F test refuses the hypothesis of equality. In fact, once the estimates are controlled for the regional population density, in four countries out of ten – namely, Austria, France, Italy and Sweden – the impact of innovation and knowledge on economic performances is not statistically significant. Moreover, also in the case of Spain the same impact is significant only at 10% and the size of the innovation coefficient is lower than that arising for all the north European countries but Sweden.

The non significant impact of innovation arising for Sweden is surprising but can be explained by the fact that the region of Stockholm is largely above all the other Swedish regions, either in terms of innovation and economic performance; being the most urbanised region, agglomeration economies - proxied by the population density - emerge as the most significant explanatory variable outperforming that related to innovation and knowledge.

Apart from Sweden, for the countries located in north and central Europe - which, according to the descriptive analysis of section 4, can be defined as "highly innovative"- the relationship between innovation & knowledge and economic performance seems much stronger than that displayed by the "low innovative countries" of Southern Europe. To test the statistical significance of the above difference, we run two separate regressions, one for the regions of the latter group (56) which includes those belonging to Austria, Spain, France and Italy and a second one for the remaining regions (95) located in highly innovative countries. Two specifications are used: one with the innovation variable only and another which also includes the log of population density. The results reported in table 8 show that, for both specifications, the Chow tests refuse the hypothesis of equality between the α parameters of the two separate regressions. Secondly, the innovation parameter arising for highly innovative countries is at least two times higher than that estimated for low innovative countries. Lastly, only for the former group of regions the density of population does play a significant role.

Table 8 – Separate OLS regressions for the composite indicator of economic performance

	Low innovative countries		Highly innovative countries		Low innovative countries		Highly innovative countries	
	Coeff.	St. Err.	Coeff.	St. Err.	Coeff.	St. Err.	Coeff.	St. Err.
α	0.383	0.070**	0.747	0.090**	0.326	0.082**	0.656	0.084**
β					0.117	0.091	0.430	0.095**
No. of observations	56		95		56		95	
Adjusted R^2	0.346		0.422		0.354		0.522	
		P-value(°)		P-value(°)		P-value(°)		P-value(°)
Breusch-Pagan test (heteroskedasticity)	0.03	0.866	2.64	0.104	0.43	0.806	0.47	0.789
Chow test for the equality of innovation parameters (α)			3.77**	0.025			5.64**	0.019

**=significant at 0.01.
(°) = Relative to the null hypothesis of, respectively, no heteroskedasticity and equality of the innovation parameters (α) arising from the two sub-samples of low and highly innovative countries.

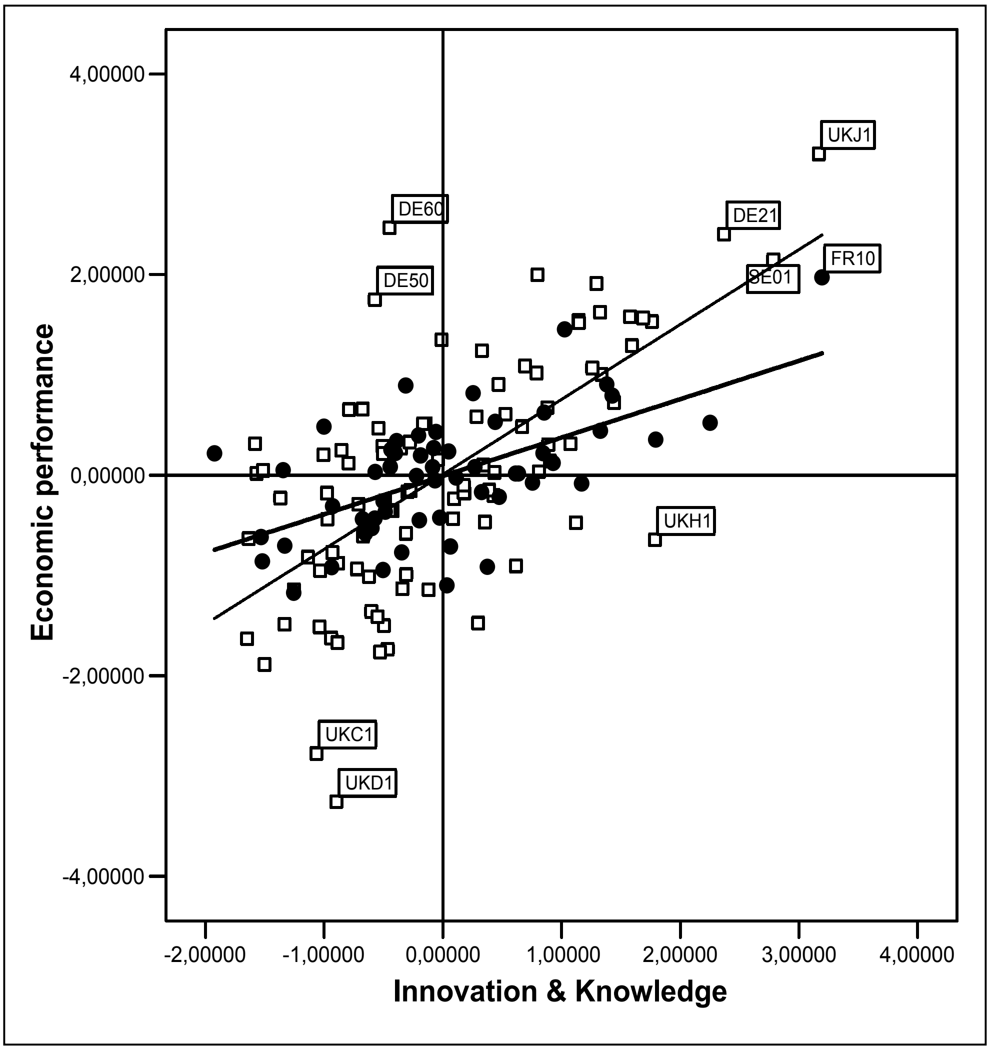
A graphical representation of the results arising from the first specification, useful to introduce further considerations, is provided by figure 1 in which the regions belonging to highly innovative countries are identified by squares, while those of low innovative countries by (full dark) circles.

First of all, according to the regression results (cf. specification 1 in table 8), the interpolation line for the former group of regions (the thin one) displays a greater slope. Secondly, there are four regions, located in top right of the diagram, which patently outperform all the others: three of them belong to highly innovative countries (Berkshire, Buckinghamshire and Oxfordshire-UKJ1, Stockholm-SE01 and Oberbayern-DE21) and one to low innovative countries (Ile de France-FR10).

The worst performing regions (bottom left) are those of Cumbria (UKD1) and Tees Valley and Durham (UKC1) which, due to their extremely low level of economic performance (much lower than that concerned with innovation and knowledge), are by far below the interpolation line. An opposite location (top-left) characterises, instead, the German regions of Hamburg (DE60) and Bremen (DE50) which perform much better in terms of economic performances than with respect to innovation and knowledge. Finally, in the bottom right quadrant, the region of East Anglia (UKH1) displays a very good innovation and knowledge base which, however, is coupled with a negative indicator of economic performances.

These nine regions share the common feature of being, for different reasons, anomalous with respect to the others. However, by excluding them from the regression analysis, the overall impact of the innovation variable is reduced only by a small percentage[11]; in addition, the impact recorded by the regions belonging to highly innovative countries remains more than two times higher than that arising for the other group of regions[12]. In short, the exclusion of the above anomalous cases do not significantly change our findings.

Figure 1: Innovation & knowledge and economic performance indicators (*)



(*) Squares and (full dark) circles identify the regions belonging to, respectively, highly and low innovative countries. The thin interpolation line refers to the former group of regions.

Figure 1 allows one to identify the relative position of each single region and this can be useful to derive different policy implications at regional level. For instance, in order to improve their economic performances, the regions located in the bottom-right quadrant should

[11] From 9 to 5% as compared with the estimates arising from, respectively, the first and third specification reported in table 7.

[12] In the specification with the innovation variable only, the estimated parameter for the regions belonging to highly innovative countries is 0.71 against a 0.32 parameter for the other regions; in the specification including

not need a substantial expansion of their innovation and knowledge base since the latter appears already developed (in relative terms); in these cases, the policy priority could be that of strengthening technological spillovers or transfers between private and public research centres and local firms. Moving to the regions placed in the opposite quadrant (top-left), their good economic outcomes are instead not associated with their innovation potential; obviously, as far as the reduced innovation and knowledge base is interpreted as a threat for their future economic prospects, this does not imply that, in these regions, innovation policies are useless.

7. Concluding remarks

This paper has shown that the recent economic performances of the EU developed regions have been positively and significantly affected by their innovation and knowledge base, as measured by a comprehensive set of indicators. Thus, the growth enhancing policies grouped under the "Lisbon strategy" label are supported by our empirical analysis and the lack of progresses made in pursuing this strategy - stressed by the European Commission (2005) - is particularly worrying.

Having saying that, the other message of the paper is that a mere additional effort in terms of innovation, knowledge and education does not guarantee equal growth opportunities among EU countries and regions.

Although the analysis has been confined to the most developed regions of the EU, it has been shown that their structural features affect the economic impact of innovation capabilities: by controlling for the population density (taken as a proxy for the degree of urbanisation), the above effect turns out to be generally weaker and, for some countries, not statistically significant. Moreover, we found that the impact of innovation and knowledge on economic performances is almost twice as higher for the regions of the north and central European countries characterised by a higher average intensity of R&D, patents and highly educated people (Belgium, Finland, Germany, Netherland, Sweden and UK) as opposed to those of southern Europe (Austria, France, Italy and Spain).

The above findings suggest that, albeit innovation and knowledge remain important drivers of regional competitiveness, their effectiveness cannot be taken for granted. As a general policy implication it can be said that to convert innovation capabilities and knowledge endowments

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also the population density the innovation parameter is 0.64 for the former group and 0.28 for the regions belonging to low innovative countries.

into better economic performances, traditional public supports for R&D and education need to be accompanied by other specific measures, tailored on the different features and actors of the national and regional innovation systems.

In this connection, a crucial role should be played by entrepreneurship capital, that is the socio-economic attitude towards new business activities, especially in high-tech manufacturing and services. This kind of entrepreneurship can be sustained by different policy measures focussed upon, for instance, the availability of financial resources for high-tech start-ups and spin-offs from universities and R&D laboratories, the presence of effective channels of technology transfer from research centres to business firms, and the design of regulatory frameworks more favourable to the introduction of new products and services. In this way, the relationship between innovation & knowledge and economic performances could be strengthened also for the European countries and regions in which, at present, investing in R&D, knowledge and education is less rewarding than expected.

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Appendix A.1 – List of the EU developed regions considered in the present study by country

COUNTRY (number of regions)	NUTSII	NAME
AUSTRIA (8)		
	AT12	Niederösterreich
	AT13	Wien
	AT21	Kärnten
	AT22	Steiermark
	AT31	Oberösterreich
	AT32	Salzburg
	AT33	Tirol
	AT34	Vorarlberg
BELGIUM (9)		
	BE21	Antwerpen
	BE22	Limburg
	BE23	Oost-Vlaanderen
	BE24	Vlaams-Brabant
	BE25	.West-Vlaanderen
	BE31	Brabant Wallon
	BE33	Liège
	BE34	Luxembourg
	BE35	Namur
GERMANY (29)		
	DE11	Stuttgart
	DE12	Karlsruhe
	DE13	Freiburg
	DE14	Tübingen
	DE21	Oberbayern
	DE22	Niederbayern
	DE23	Oberpfalz
	DE24	Oberfranken
	DE25	Mittelfranken
	DE26	Unterfranken
	DE27	Schwaben
	DE50	Bremen
	DE60	Hamburg
	DE71	Darmstadt
	DE72	Gießen
	DE73	Kassel
	DE91	Braunschweig
	DE92	Hannover
	DE94	Weser-Ems
	DEA1	Düsseldorf
	DEA2	Köln
	DEA3	Münster
	DEA4	Detmold
	DEA5	Arnsberg
	DEB1	Koblenz
	DEB2	Trier
	DEB3	Rheinhessen-Pfalz
	DEC0	Saarland
	DEF0	Schleswig-Holstein
SPAIN (11)		
	ES13	Cantabria
	ES21	País Vasco
	ES22	Comunidad Foral de Navarra
	ES23	La Rioja

	ES24	Aragón
	ES30	Comunidad de Madrid
	ES41	Castilla y León
	ES51	Cataluña
	ES52	Comunidad Valenciana
	ES53	Illes Balears
	ES70	Canarias
FINLAND (4)		
	FI13	Itä-Suomi
	FI18	Etelä-Suomi
	FI19	Länsi-Suomi
	FI1A	Pohjois-Suomi
FRANCE (22)		
	FR10	Île de France
	FR21	Champagne-Ardenne
	FR22	Picardie
	FR23	Haute-Normandie
	FR24	Centre
	FR25	Basse-Normandie
	FR26	Bourgogne
	FR30	Nord - Pas-de-Calais
	FR41	Lorraine
	FR42	Alsace
	FR43	Franche-Comté
	FR51	Pays de la Loire
	FR52	Bretagne
	FR53	Poitou-Charentes
	FR61	Aquitaine
	FR62	Midi-Pyrénées
	FR63	Limousin
	FR71	Rhône-Alpes
	FR72	Auvergne
	FR81	Languedoc-Roussillon
	FR82	Provence-Alpes-Côte d'Azur
	FR83	Corse
ITALY (15)		
	ITC1	Piemonte
	ITC2	Valle d'Aosta
	ITC3	Liguria
	ITC4	Lombardia
	ITD1+2	Province Autonome di Bolzano e Trento
	ITD3	Veneto
	ITD4	Friuli-Venezia Giulia
	ITD5	Emilia-Romagna
	ITE1	Toscana
	ITE2	Umbria
	ITE3	Marche
	ITE4	Lazio
	ITF1	Abruzzo
	ITF2	Molise
	ITG2	Sardegna
NETHERLANDS (12)		
	NL11	Groningen
	NL12	Friesland
	NL13	Drenthe
	NL21	Overijssel
	NL22	Gelderland
	NL23	Flevoland
	NL31	Utrecht

	NL32	Noord-Holland
	NL33	Zuid-Holland
	NL34	Zeeland
	NL41	Noord-Brabant
	NL42	Limburg
SWEDEN (8)		
	SE01	Stockholm
	SE02	Östra Mellansverige
	SE04	Sydsverige
	SE06	Norra Mellansverige
	SE07	Mellersta Norrland
	SE08	Övre Norrland
	SE09	Småland med öarna
	SE0A	Västsverige
UNITED KINGDOM (32)		
	UKC1	Tees Valley and Durham
	UKC2	Northumberland and Tyne and Wear
	UKD1	Cumbria
	UKD2	Cheshire
	UKD3	Greater Manchester
	UKD4	Lancashire
	UKD5	Merseyside
	UKE1	East Riding and North Lincolnshire
	UKE2	North Yorkshire
	UKE3	South Yorkshire
	UKE4	West Yorkshire
	UKF1	Derbyshire and Nottinghamshire
	UKF2	Leicestershire, Rutland and Northamptonshire
	UKF3	Lincolnshire
	UKG1	Herefordshire, Worcestershire and Warwicks
	UKG2	Shropshire and Staffordshire
	UKG3	West Midlands
	UKH1	East Anglia
	UKH2	Bedfordshire and Hertfordshire
	UKH3	Essex
	UKI2	Outer London
	UKJ1	Berkshire, Buckinghamshire and Oxfordshire
	UKJ2	Surrey, East and West Sussex
	UKJ3	Hampshire and Isle of Wight
	UKJ4	Kent
	UKK1	Gloucestershire, Wiltshire and North Somerset
	UKK4	Devon
	UKL2	East Wales
	UKM1	North Eastern Scotland
	UKM2	Eastern Scotland
	UKM3	South Western Scotland
	UKN0	Northern Ireland

Appendix A.2 – Innovation and knowledge variables: definition, data sources and computations

R&D EXPENDITURES ON GVA: Percentage of total intramural R&D expenditure on Gross Value Added. Year: 1995 (with the exclusion of Austrian regions for which only 1999 data are available). Source: Eurostat. Level: NUTSII apart from UK (NUTSI), Belgium (NUTS0) and Sweden (NUTS0). In these cases, the R&D intensities are imputed to NUTSII regions according to the differences in terms of EPO applications per million inhabitants.

EPO APPLICATIONS PER MILLION INHABITANTS: Total patent applications to the European Patent Office/ Population in millions. Year: 1995. Source: Eurostat. Level: NUTSII.

SHARE OF EMPLOYMENT IN HIGH-TECH MANUFACTURING: Employment in high-tech manufacturing (NACE Rev. 1.1 codes 30, 32 and 33) / Total employment. Year: 1995. Source: Eurostat. Level: NUTSII. In some cases, NUTSI (in a few cases NUTS0) figures are imputed to NUTSII regions or, in place of the 1995 employment shares, the averages of the following years are used The above adjustments were necessary for all the NUTSII regions of Finland and the UK, some belonging to Belgium, Spain and Sweden and a few located in France, Germany and the Netherlands.

SHARE OF EMPLOYMENT IN HIGH-TECH SERVICES: Employment in high technology and knowledge-intensive services (NACE Rev. 1.1 codes: 64, 72 and 73) / Total employment. Year: 1995. Source: Eurostat. Level: NUTSII.

SHARE OF ADULTS WITH TERTIARY EDUCATION: Population aged 25-64 with tertiary education (ISCE97 codes 5 and 6) / Total population aged 25-64. Year: 1999. Source: Eurostat. Level: NUTSII.

SHARE OF TURNOVER DUE TO PRODUCTS NEW TO THE FIRM: Year: 1996. Source European Commission (2003) which reports regional data taken from the second Community Innovation Survey; values are re-scaled in a range going from 0 (ascribed to the region with the lowest share of innovative turnover, Åland in Finland) to 100 (attributed to the region with the highest share, Braunschweig in Germany). Level: NUTSII. In the cases of Belgium and UK NUTSI values are imputed to NUTSII regions.