KIT
Knowledge, Innovation, Territory

Applied Research 2013/1/13

Interim Report | Version 24/02/2011

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This report presents the interim results of an Applied Research Project conducted within the framework of the ESPON 2013 Programme, partly financed by the European Regional Development Fund.

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1. Executive summary

1.1 Aims and philosophy of the project

The aims of the KIT project are manifold:

i) to show the present spatial trends of the knowledge economy;
ii) to explain the territorial elements behind these spatial trends;
iii) to measure the impact of different forms/patterns of innovation on regional economic performance;
iv) to build ad-hoc innovation policy actions that go beyond the thematically and regionally neutral and generic orientation of R&D funding investments.

A specific definition of "knowledge economy" is behind the whole project. We are convinced that the knowledge economy has a multidimensional definition, something reflected also in the literature that probably explains the suggestion of OECD to use about sixty indicators - among which R&D and high technology activities play a dominant role - to measure a knowledge economy (OCSE, 2004). The EU territory was therefore analyzed according to the presence of "science-based" or high-technology sectors; regions hosting these sectors are considered as regions helping the transformation of the economy, and labelled **"Technologically advanced regions".** A second typology of regions is identified, based on a function-based approach, which stressed the importance of pervasive and horizontal functions like R&D and high education. "**Scientific regions"**, hosting large and well-known scientific institutions, are for this reason identified in the EU territory. This approach, equating knowledge and scientific research, is very important since it was the one re-launched by the European Commission Strategy defined in the Lisbon Agenda, and, more recently, in the EU2020. The third approach, based on a relational paradigm, concentrates on the identification of a "cognitive capability" (Foray, 2000): the ability to manage information in order to identify and solve problems, or, more precisely in the economic sphere, the ability to transform information and inventions into innovation and productivity increases, through co-operative or market interaction. Based on this approach, technologically advanced regions and scientific regions have to be complemented by "**Knowledge networking regions**".

This multidimensional definition (sectoral, functional, networking) is a first step to go away from the simplified idea that: i) R&D equates knowledge, that ii) a knowledge economy is a synonymous of a scientific (R&D-based) economy and iii) that R&D investments are the right and unique innovation policy measures to support a knowledge economy.

As the whole project will highlight, different territorial patterns of innovation exist in Europe, defined as different combinations of ***context conditions*** and of ***specific modes of performing the different phases*** of the innovation process. The identification of these innovation patterns is necessary **to develop regional innovation policies able to support the most productive use of local research and/or local innovation capabilities**.

In this sense, the general philosophy of the project is in line with the words of Danuta Hübner (2009), former Commissioner for Regional Policy: "Innovation is not considered as a linear process that starts with research, eventually leading to development, translated later into growth in the territories that have more capabilities. Instead, it is the product of a policy mix, including several bodies and stakeholders in which the territories, their specificities and conditions are paramount".

The spatial trends of the "Knowledge Economy" in Europe are studied empirically in this report, by highlighting, through a series of indicators, the location of technologically advanced, scientific and knowledge networking regions. The interim report replies therefore to the first aim of the project. The other three aims will be tackled in the next year of work.

1.2 Knowledge Economy in Europe

1.1.1. Technologically advanced regions

Technologically-Advanced Regions (TAR) are those regions which present simultaneous specialization in both medium high-tech manufacturing and knowledge intensive sectors. All over Europe, 62 regions are identified as TAR, all concentrated in Germany (21), in the UK

(17), and the others in Belgium, France, Switzerland, Finland, Denmark and Sweden. The geography of technology in Europe is indeed highly concentrated, although some peripheral regions do play a major role. Over time, the hierarchy of high tech manufacturing seems quite hysteretic, with more change taking place in the KIS industries, where in particular a strong specialization of capital city-regions seems to take place.

1.1.2. Scientific regions

"Scientific regions" are defined as those regions that show higher than average values both in research activities and in high level human capital. Scientific regions are concentrated in the centre and in the north of Europe, most of them in Western countries. All research activity indicators that are used for one of the two pillars that define scientific regions constantly show a high spatial concentration. In 2007, R&D spending on GDP, one of the Lisbon objectives for the achievement of a knowledge economy, interestingly shows a strong regional variation, from lower than 0.5% values to more than 6%. A very small number of regions in Europe reaches 3% of R&D expenditure on GDP, witnessing that a smart growth called for by the EU2020 Agenda with the achievement of 3% of the EU's GDP (public and private) invested in R&D/innovation is still an ambitious aim.

1.1.3. Knowledge networking regions

Knowledge networking regions can be understood as regions that rely on external sources of knowledge and on facilitating interactive learning and interaction in innovation. This knowledge diffusion can take place through diffusive patterns based on spatial proximity (henceforth "spatial linkages") and/or through intentional relations based on a-spatial networks or non-spatially mediated mechanisms ("a-spatial linkages"). To identify knowledge networking regions two synthetic indicators are built, a first one capturing "spatial knowledge linkages" and a second one measuring "a-spatial knowledge linkages"; knowledge networking regions are those regions that have values for both indicators higher than the average.

Results show that networking regions are concentrated in the centre of Europe as well as in the Scandinavian countries, whereas the Non-interactive regions are mainly those belonging to the New Member Countries and some specific regions in the South European countries (the whole of Portugal and Greece, most Spain except the North-East area, and the South of Italy). More curious is the fact that a higher number of regions belong to the category of Knowledge networking regions (123) with respect to TAR and scientific regions. This results is rather important, telling us that external sources of knowledge, in the form of spatial spillovers or scientific networking, is a very diffused channel for local knowledge accumulation, even more diffused than the internal production of knowledge.

1.1.4. Innovation activity

Innovation shows rather differentiated spatial patterns depending on the type of innovation analyzed. Product innovation only is characterized by a strong spatial concentration. This variable displays consistent concentration in strong countries, the core of product innovative activity in Europe being carried out in German, Scandinavian, Swiss and British regions, with a few notable exceptions outside these areas. Concentrated spatial patterns characterize product innovation trends not only across country, but also within countries; in fact, capital regions tend to display higher product innovation rates, with some notable exceptions of regions also registering consistent innovation performance despite not hosting the capital city (e.g. Rhone-Alps and Toulouse in France).

A completely different spatial trend is depicted for what concerns process innovation, which displays on average higher values in Southern European countries, namely, Cyprus, Spain, France, Greece, Italy, Malta, and Portugal than in the rest of the Europe, by about two percentage points. The variance associated with process innovation is much lower than the same measure associated with product innovation. This finding further strengthens the case for a more evenly distributed practice. In fact, this is also reflected in the case of NMS (New Member States), that are unexpectedly characterized by homogeneous spatial trends.

Finally, it is interesting to notice the synergic nature of product and process innovation rates. In fact, on average, regions with higher tendencies to innovate in product also innovate in process. However, the performance of top accomplishers in each category deviates from this trend and points at particular specializations either in product, or process innovation.

A quite different perspective on innovation is provided by the marketing and organizational innovation spatial trend. In this case, non-material forms of technological progress are surveyed – for instance, quality improvements, reductions of environmental damages stemming from firms' production, reductions of energy consumption, creation of new markets, reduced labour costs, reductions of amount of materials required for production, and conformance to regulations. Results show a significant concentration of marketing and organizational innovation in regions in the EU15 countries, with particularly high values in German and Austrian regions. However, the spatial distribution of this soft form of innovation seems much more even across the European space. The relatively even distribution is in particular remarkable when observed within countries, witnessing a similar innovative capability among regions.

Social innovation, proxied by the penetration rate of broadband network, displays evident signs of country effects, naturally introduced in the data by the country-wide infrastructure ICT projects that both public as well as private companies launch and manage. Also, broadband connections penetrated more – and most unlike other innovation indicators – in regions belonging to Nordic countries and in Netherlands, more than on continental Europe. Besides, everywhere capital regions show over-performance in this measure of innovation diffusion with respect to other regions belonging to the same Country. Peripheral regions (Italian, Romanian, Bulgarian and Spanish) present some consistent lag when confronted with frontier ones. However, a striking evidence can be also presented by comparing Polish and Baltic regions, with relatively lower standards of living, with richer regions such as the Irish and Northern Italian ones.

An increasingly relevant dimension of innovative technologies has a green side. A core of innovative activity in green technologies as defined by the OECD stands out in continental Europe, Scandinavian countries and the UK; of lesser, through relevant, importance regions in France, Greece and Italy also present some positive contribution to the activity of patenting in one of the IPC (International Patent Classification) classes above mentioned.

1.3 The geography of scientific activity in China, India and the United States of America

The past two decades have seen the globalisation of production and the globalisation of R&D. China and India have been at the forefront of these shifts. The empirical results on the geography of scientific activity in these emerging countries show that both India and China have spatially concentrated scientific activities. The USA has a smoother spatial distribution of patents by applicant than either China or India. In China patenting activity is concentrated along coastal regions, especially in the South. The overall system is highly agglomerated, with the top 3 regions accounting for 73%. In India, patent counts are highest in high-tech clusters such as Bangalore, Chennai, Delhi, Hyderabad, Mumbai and Pune. The spatial concentration of patenting activity is even more pronounced when patenting by technological fields is analyzed. Biotechnology and ICT patenting broadly follows the country-level patterns, although with significantly higher than average levels of concentration in China and India. In nanotechnology, India's sectoral system is more agglomerated than China's. In all three fields, innovation in India and China is much more spatially clustered than in the USA.

These trends remind us of two aspects: i) the competitiveness of emerging countries will in a few years be moving from low-tech goods to innovative high-value functions and Europe will soon have to compare its research activity performance not only with the US but also with these new economies; ii) the spatial concentration of R&D in order to exploit economies of scale seems to be the model followed by the emerging countries, once again re-launching strongly the debate of the importance of the identification of an European Research Area.

1.4 Key findings

From the descriptive trends, a Decalogue of key messages emerges, namely:

1) the knowledge-economy shows a very differentiated and fragmented spatial pattern in Europe, with some regions highly specialised in advanced technology sectors and others playing the role of knowledge nodes;

2) a very high number of European regions, mainly in Eastern countries and in the Southern peripheral countries are below the EU average in any process of high-tech specialisation, of knowledge creation, and knowledge acquisition. This striking result witnesses that for many European regions the knowledge economy is still in its infancy. What to do in terms of innovation policy in such regions will be tackled in the draft final report;

3) "scientific regions", although registering a high innovation rate, innovate just slightly more than all other knowledge economy regions in Europe. This is true concerning both product innovation only, and product and/or process innovation. This result reminds us that the territorial factors that enhance the implementation of new knowledge can be quite different from the factors which stimulate invention and innovation, and therefore that invention, innovation and diffusion are not necessarily intertwined, and even more so at the local level. Firms and individuals which are leading an invention are not necessarily also leaders in innovation or in the widespread diffusion of new technologies. The real world is full of examples of this kind; the fax machine, first developed in Germany, was turned into a worldwide successful product by Japanese companies. Similarly, the anti-lock brake systems (ABS) was invented by US car makers but became prominent primarily due to German automotive suppliers;

4) process innovation rate is instead similar in all types of knowledge regions, being technologically advanced, scientific or networking regions. Process innovation is something that takes place with the same intensity in all sectors when the need for reorganisation and rejuvenation of production processes are called for by a competitive environment;

5) external sources of knowledge acquisitions are diffused all over Europe, and the number of regions acquiring knowledge from outside are in a higher number than those developing knowledge internally. "Islands of knowledge" exist in Europe. An open question is *if and how* these "islands of knowledge" have to be reinforced, moving to a European Research Area envisaged by the "Knowledge for Growth" expert group;

6) the way to a smart growth - calling for the achievement of 3% of the EU's GDP (public and private) to be invested in R&D/innovation - is still a long way. In 2007 regions that have reached 3% of R&D expenditures on GDP are in a number of 33 (11% of the European NUTS2 regions) and concentrated in a few countries in the North of Europe. Moreover, a very high number of regions belongs to the lowest class, the one that registers a R&D on GDP lower than 0.5%. This result calls also for a general reflection: in order to achieve a smart growth as rightly longed for by the Europe 2020 agenda, do we really need to have an innovation policy aim common for all countries/regions? Would it not be better to achieve the same goal by differentiating aims and policy tools at regional level? To these questions the project will respond in the draft final report;

7) innovation shows rather differentiated spatial patterns depending on the type of innovation analyzed. Process and product innovation follow completely different spatial patterns, the first more typical of Southern European countries, the latter more of Northern countries. These results might find an explanation in the difference between institutional, cognitive and cultural elements associated to the two kinds of innovation processes;

8) innovation in everyday life, proxied by the broadband network penetration rate, clearly evidences a consistent adoption lag of peripheral regions (Italian, Romanian, Bulgarian and Spanish) when compared with regions in Northern countries of Europe. Moroever, this kind of innovation displays evident signs of country effects, naturally introduced in the data by the country-wide ICT infrastructure projects that both public and private companies launch and manage. Furthermore, broadband connections penetrated more –unlike other innovation indicators – in regions belonging to Nordic countries and in Netherlands, more than on continental Europe. Besides, everywhere capital regions

show over-performance in this measure of innovation diffusion with respect to other regions belonging to the same country;

9) the competitiveness of emerging countries will in a few years be moving from low-tech goods to innovative high-value functions and Europe will soon have to compare its research activity performance not only with the US but also with the emerging economies;

10) the spatial concentration of R&D in order to exploit economies of scale seems to be the model followed by emerging countries, re-launching in a decisive way the debate of the importance of the identification of an European Research Area.

All these results tell us that at present *different innovation patterns characterise* Europe. Some regions are able to produce their internal knowledge, translate knowledge into innovation, and obtain the maximum efficiency and effectiveness from innovation adoption in terms of growth (the so called "linear model"). Other regions exist that are able to innovate getting the knowledge required from other regions; finally, regions exist that are able to innovate through a creative imitation of already existing innovation. These different patterns of innovation are supported by different local conditions. There is therefore a need to link context conditions to the single phases of the innovation process. Once this is done, *territorial patterns of innovation will be identified*, and this is one of the main aims of the next research steps.

1.5 Future research directions

The next future research directions are threefold, in line with the general structure of the project:

- the empirical identification of territorial patterns of innovation;
- the measurement of their efficiency in terms of R&D investments/ regional growth link. Our impression is that there is no pattern that is by definition superior to the other in terms of efficiency and effectiveness of innovation on growth; on the contrary, each territorial pattern may provide an efficient use of research and innovation activities generating growth. The true issue in this context will probably be a different one, concerning the evolutionary path of the different "territorial patterns" under changing economic conditions, especially in regions that today rely too much on external limits and knowledge transfer. But this impression has to be proved empirically;
- the policy implications that stem from the analysis. We are mostly sure that policies targeted on each regional innovation pattern have to be implemented.

These research directions will be supported by a case study approach, whose results will reinforce our quantitative results, giving in-depth support to our conceptual expectations and our policy design.

2. Outline of methodology

2.1 Aims and state of the art of the project

The general aim of the KIT project is to contribute to our understanding of the creation and diffusion processes of innovation and knowledge in space. In particular, the project focuses on:

a) the present spatial diffusion of the knowledge economy in the EU regions (WP2.1 and 2.2);
b) the territorial elements that are behind the different patterns of knowledge and innovation creation and diffusion (WP 2.3.1);
c) the impact of the different territorial patterns of innovation on regional performance (WP 2.3.2).

These aims are achieved through a quantitative analysis and a case study approach (the latter contained in WP 2.4.1 and 2.4.2). Besides, a comparison with development stage of the knowledge economy and with its impact on regional growth in different countries is presented (WP 2.5). In particular, the countries in which a similar analysis is run are US, China and India. The structure of the project is presented in Figure 2.1.1, where the different aims and steps of the project are summarised. The present interim report contains:

- the **whole results on the spatial trends of the knowledge economy** (point a. above), only partially due for this interim report according to the timetable of the inception report;
- the **conceptual philosophy with which we tackle point b**), which is much more developed than in the inception report;
- the **whole results of the comparison between India, China and US for what concerns patent activities**;
- an **in-depth thinking on the interview protocol for the case studies and the final choice of the case study areas**.

The project is therefore **ahead of schedule** with the previewed timetable.

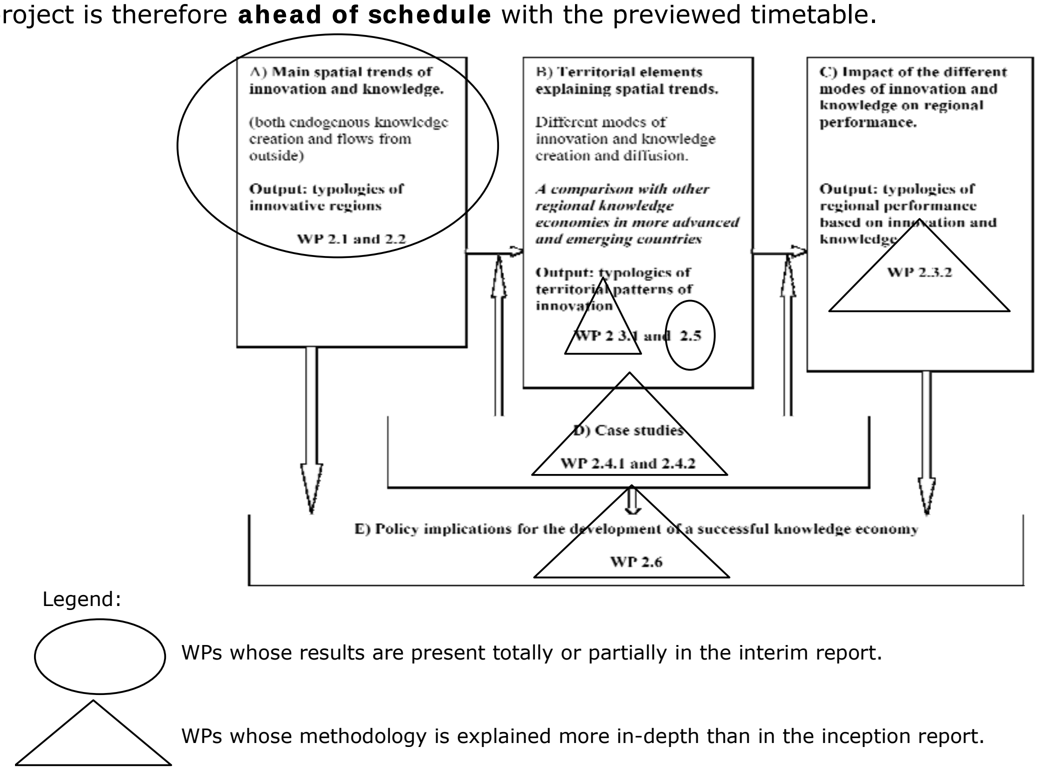


Figure 2.1.1. Structure and state of the art of the project.

2.2 Definition of the knowledge economy: the philosophy of the project

A specific definition of "knowledge economy" is behind the empirical analysis whose aim is to show the present development stage of innovation and knowledge. We are convinced that the knowledge economy has a multidimensional definition, something reflected also in the literature that probably explains the suggestion of OECD to use about sixty indicators - among which R&D and high technology activities play a dominant role - to measure a knowledge economy (OECD, 2004).

We adopted a historical approach to the interpretation of the concept, finding interesting ideas in all three main conceptual paradigms with which knowledge economy was interpreted; a sector-based paradigm, a function-based paradigm, and a networking paradigm. All these were successively proposed and held for long times.

We therefore analysed the EU territory according to the presence of "science-based" or high-technology sectors; regions hosting these sectors are considered as regions helping the transformation of the economy, and labelled **"technologically advanced regions".** However, this approach is far too simplistic, since it does not explain many knowledge-based advances that were (and are) possible and are actually introduced by "traditional" sectors – such as textiles and car production - in their path towards rejuvenation in the eighties. A second typology of regions is therefore identified, based on a function-based approach, which stressed the importance of pervasive and horizontal functions like R&D and high education. "**Scientific regions"**, hosting large and well-known scientific institutions, are for this reason identified in the EU territory. This approach, equating knowledge and scientific research, is very important since it was the one launched again by the European Commission Strategy defined in the Lisbon Agenda, and, more recently, in the EU2020.

It is difficult to escape the impression that both the sector-based and the function-based paradigms to the knowledge-based economy, both driven by the need to measure and quantify, result in a simplified picture of the complex nature of knowledge creation and its relation to inventive and innovative capability. The presence of advanced sectors and advanced functions like R&D and higher education are special features of only some of the possible innovation paths and, though relevant, cannot be considered as necessary or sufficient preconditions for innovation.

The third stage of reflection, typical of the present in which a relation-based paradigm emerges, concentrates on the identification of a "cognitive capability" (Foray, 2000): the ability to manage information in order to identify and solve problems, or, more precisely in the economic sphere, the ability to transform information and inventions into innovation and productivity increases, through co-operative or market interaction. Based on these paradigms, technologically advanced regions and scientific regions have to be complemented by "**knowledge networking regions**".

The knowledge economy can manifest itself in these three different forms on the territory, forms that sometimes complement each-other and sometimes substitute each-other. This multidimensional definition (sector, function networking) is a first step **to go away from the simplified idea that: i) R&D equates knowledge, that ii) a knowledge economy is a synonymous of a scientific (R&D-based) economy and iii) that R&D investments are the right and unique innovation policy measures to support a knowledge economy**.

As the whole project will highlight, different territorial patterns of innovation exist in Europe, based on different context conditions. The identification of these context conditions is necessary **to develop regional innovation policies able to support the most productive use of local research and innovation capabilities**.

In this sense, the general philosophy of the project is in line with the words of Danuta Hübner (2009): "Innovation is not considered as a linear process that starts with research, eventually leading to development, translated later into growth **in the territories that have more capabilities**. Instead, it is the product of a policy mix, including several bodies and stakeholders in which **the territories, their specificities and conditions are paramount**".

The state of the art of the Knowledge Economy in Europe is studied empirically in this interim report, by highlighting, through a series of indicators, the location of technologically advanced, scientific and knowledge networking regions (see section 3).

3. Presentation of the main results achieved so far

3.1 Technologically advanced regions

3.1.1. A definition

Following the logic outlined before, this project adopts a sectoral approach in the definition of *Technologically Advanced Regions*. Because of the deep technological content of both manufacturing as well as service activities, neither are ex ante excluded from the definition. In fact, regions are classified as Technologically Advanced if both technologically advanced manufacturing and services characterize the region.

The definition of high tech industries is also arbitrary; therefore, we decided to choose a broad one, encompassing industries with medium-high and high-tech content (henceforth, MHHT)so to capture a wide range of industries characterized by consistent high-tech creation and deployment. High-tech industries are classified according to the OECD methodology (OECD, 2005). Such industries include manufacturing of aircraft and spacecraft, pharmaceuticals, office, accounting and computing machinery, radio, TV and communications equipment, and medical, precision and optical instruments.[1] High-tech services follow the OECD classification too, labeled "Knowledge-Intensive Service Activities ". Specialization is here defined with a location quotient calculated with respect to the EU27 average value; regional data include industry-specific employment in MHHT manufacturing and Knowledge Intensive Services (henceforth, KIS).[2] Specialization is calculated for two years (2002 and 2007), in order to identify time trends, along with its spatial distribution.

3.1.2 Regional sectoral specialization

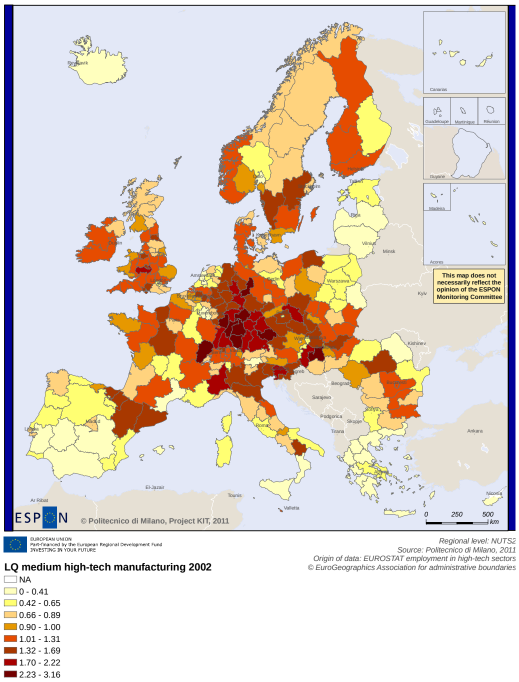
In Maps 3.1.3 and 3.1.4 the most recent (2007) Location Quotients for both MHHT manufacturing and KIS, employment are shown. In order to provide time comparisons, Maps 3.1.1 and 3.1.2 represent the same indicators for the year 2002. Although regions characterized by an urbanized, agglomerated settlement structure do not display remarkably higher specialization levels in the MHHT industry, they do so in terms of KIS. In time, however, a loss of high-tech manufacturing has taken place in the EU27, with rural regions showing over the period 2002-2007 an increasing specialization in the MHHT industry, which is mirrored by a simultaneous decrease in more urbanized areas.

Data confirm the slight decrease of MHHT manufacturing activities that has taken place in major industrial countries in the last decade. Regional specialization in the MHHT industry markedly declined between 2002 and 2007 in most French, Polish, British, Bulgarian and Greek regions; at the same time, a relative positive shift occurred in most regions belonging to two belts, one running North-Southwards and the other stretching West-Eastwards of the continent. On average, the location quotient for the MHHT industries declined by 0.02 in the EU15 regions and increased by 0.09 in New Member States (henceforth, NMS) ones.

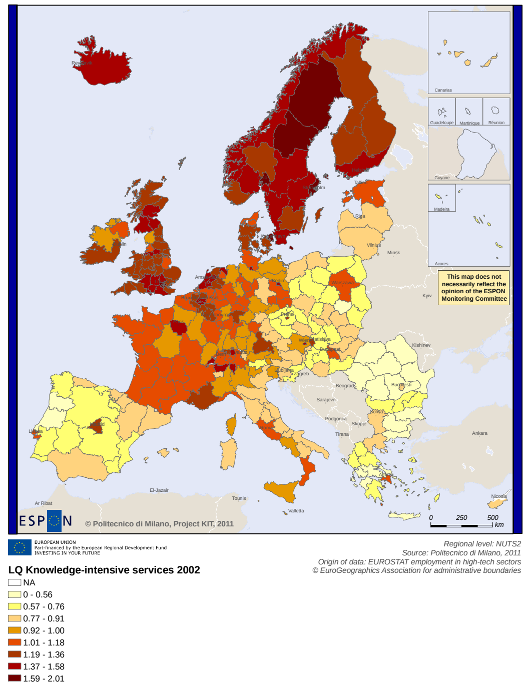
Not necessarily the loss of high-tech manufacturing is matched by a simultaneous process of increasing specialization in advanced services. In fact, on average EU15 regions show zero variation in the KIS location quotients, whilst NMS show a slight increase (0.01). Remarkable country effects characterize the data, with three countries registering significant correlations between the change in MHHT and the change in KIS specializations (Table 3.1.1). Negative correlation can be found only for Greece, Italy, and Sweden, where regions apparently

[1] Medium-high and high-tech manufacturing industries correspond to employment in chemicals (NACE24), machinery (NACE29), office equipment (NACE30), electrical equipment (NACE31), telecommunications and related equipment (NACE32), precision instruments (NACE33), automobiles (NACE34) and aerospace and other transport (NACE35); KIS include water transport (NACE 61), air transport (NACE 62), post and telecommunications (NACE64), financial intermediation (NACE 65), insurance and pension funding (NACE 66), activities auxiliary to financial intermediation (NACE 67), real estate activities (NACE 70), renting of machinery and equipment (NACE 71), computer and related activities (NACE72), research and development (NACE73) and other business activities (NACE 74).
[2] Source of the data is EUROSTAT.

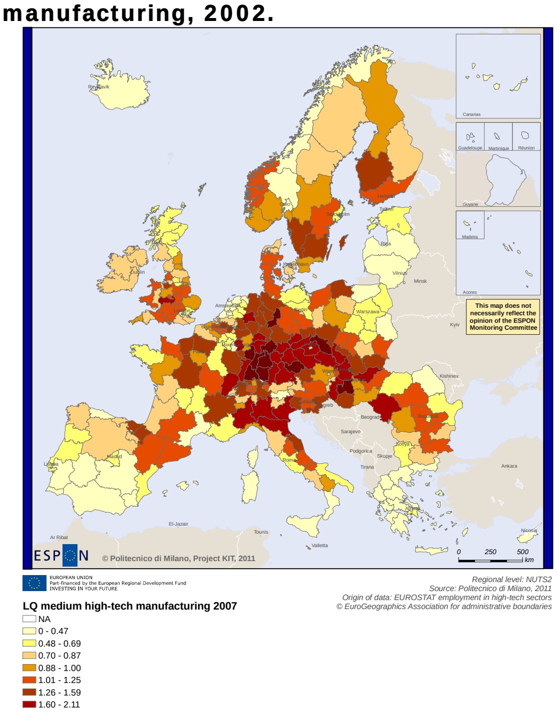
switched regime swapping a focus on advanced manufacturing with a specialization in advanced services. Elsewhere, insignificant relations suggest that not necessarily manufacturing jobs flowing to NMS or outside Europe are replaced with similarly advanced functions.



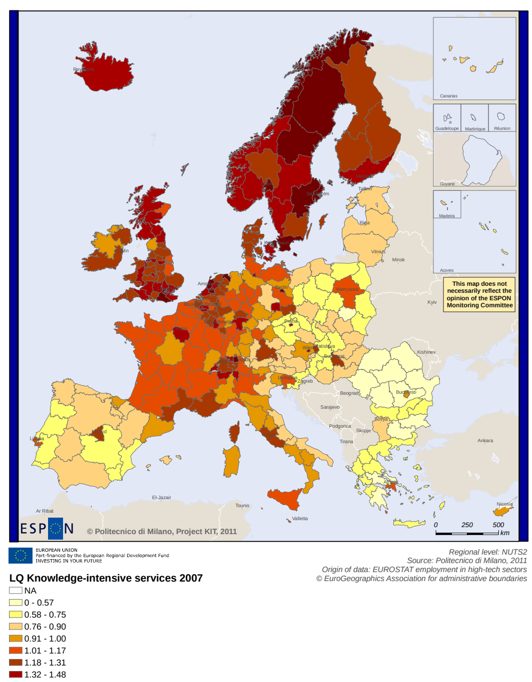
Map 3.1.1. LQ medium high-tech manufacturing, 2002.



Map 3.1.2. LQ KIS, 2002.



Map 3.1.3. LQ medium high-tech manufacturing, 2007.



Map 3.1.4 LQ KIS, 2007.

Source of raw data: EUROSTAT, own elaboration.

Table 3.1.1. Within-country correlations between changes in medium-high tech and KIS specializations, 2002-2007.

Country	Correlation	p-value
Greece	-0.61	0.03
Italy	-0.41	0.06
Sweden	-0.70	0.06

Source of raw data: EUROSTAT, own elaboration.

By examining top 10 performers over the analyzed time span (Table 3.1.2), the picture displays a less dynamic behaviour. In fact, from this perspective the situation seems much more stable, with only one change taking place between 2002 and 2007 for MHHT (Franche-Comté being substituted by Severovýchod), while more changes take place in the KIS case (five out of ten regions in the 2007 top ten table would not be listed in 2002). The hierarchy of high tech manufacturing seems therefore quite hysteretic, with more change taking place in the KIS industries, where in particular a strong specialization of capital city-regions seems to take place.

Table 3.1.2. Top 10 regions in terms of Location Quotients, 2002-2007.

Location quotient	Medium and high tech manufacturing 2002	Medium and high tech manufacturing 2007	Knowledge intensive services 2002	Knowledge intensive services 2007
Region #1	Stuttgart	Stuttgart	Inner London	Inner London
Region #2	Tübingen	Braunschweig	Stockholm	Stockholm
Region #3	Braunschweig	Karlsruhe	Oslo og Akershus	Oslo og Akershus
Region #4	Franche-Comté	Tübingen	Outer London	Hovedstaden
Region #5	Közép-Dunántúl	Rheinhessen-Pfalz	Brussels	Åland
Region #6	Karlsruhe	Unterfranken	Hovedstaden	Zürich
Region #7	Niederbayern	Freiburg	Övre Norrland	Berlin
Region #8	Unterfranken	Severovýchod	Mellersta Norrland	Noord-Holland
Region #9	Rheinhessen-Pfalz	Közép-Dunántúl	Île de France	Utrecht
Region #10	Freiburg	Niederbayern	Surrey and Sussex	Övre Norrland

Source of raw data: EUROSTAT, own elaboration.

Country-wise, however, the negative correlation between specialization levels in the MHHT and KIS industries is remarkable although slightly not significant (Figure 3.1.1).[3] At the country level, therefore, the shift of modern EU27 economies towards advanced services seems to characterize countries previously specialized in high-tech manufacturing.

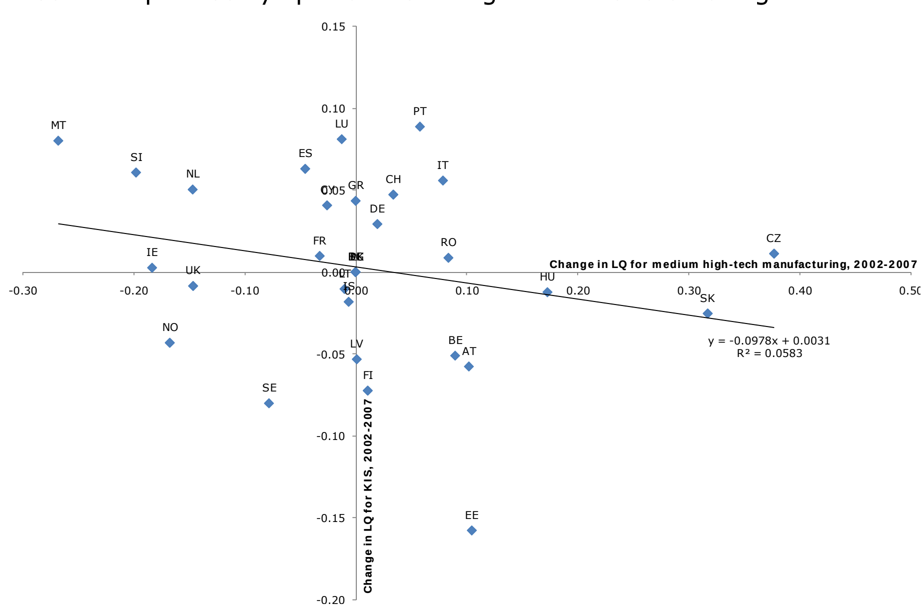


Figure 3.1.1. Country average change in Location Quotients for medium high-tech and KIS industries, 2002-2007.

[3] Pearson's Index equals 0.24, with p-value equal to 0.19.

3.1.2 Technologically advanced regions in Europe

The definition of Technologically-Advanced Regions (henceforth, TAR) is summarized in Figure 3.1.2; TAR are those regions which present simultaneous specialization in both MHHT and KIS industries. In Map 3.1.5, regions are classified according to classes and colours of Figure 3.1.2. Twenty-one regions identified as TAR with our methodology are German, thirteen British, eight French, five Belgian, four Swiss, three Swedish, two Finnish and Danish, and one each for Italy, Norway, Slovenia, and Slovakia. The geography of technology in Europe is indeed highly concentrated, although peripheral regions and regions with capital cities in NMS do play a major role. Over time (although the time span considered may be too short to draw safe conclusions), no region acquired or lost the status of Technologically-Advanced Regions.

The productive fabric of Europe shows therefore a remarkable concentration of technology,[4] either related to the advanced manufacturing or services activities.

This statement needs however qualification. In fact, while specialization in manufacturing high-tech seems to be much more diffused on the European space, specialization in KIS displays impressive concentration rates. It is finally worth stressing that some countries present no specialization type – neither in MHHT, nor in KIS industries.

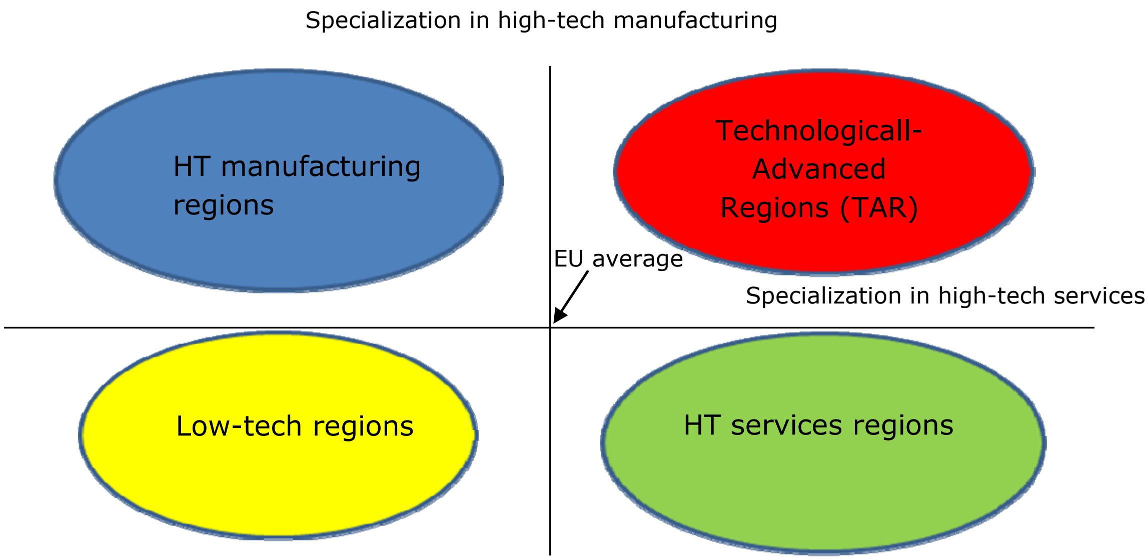
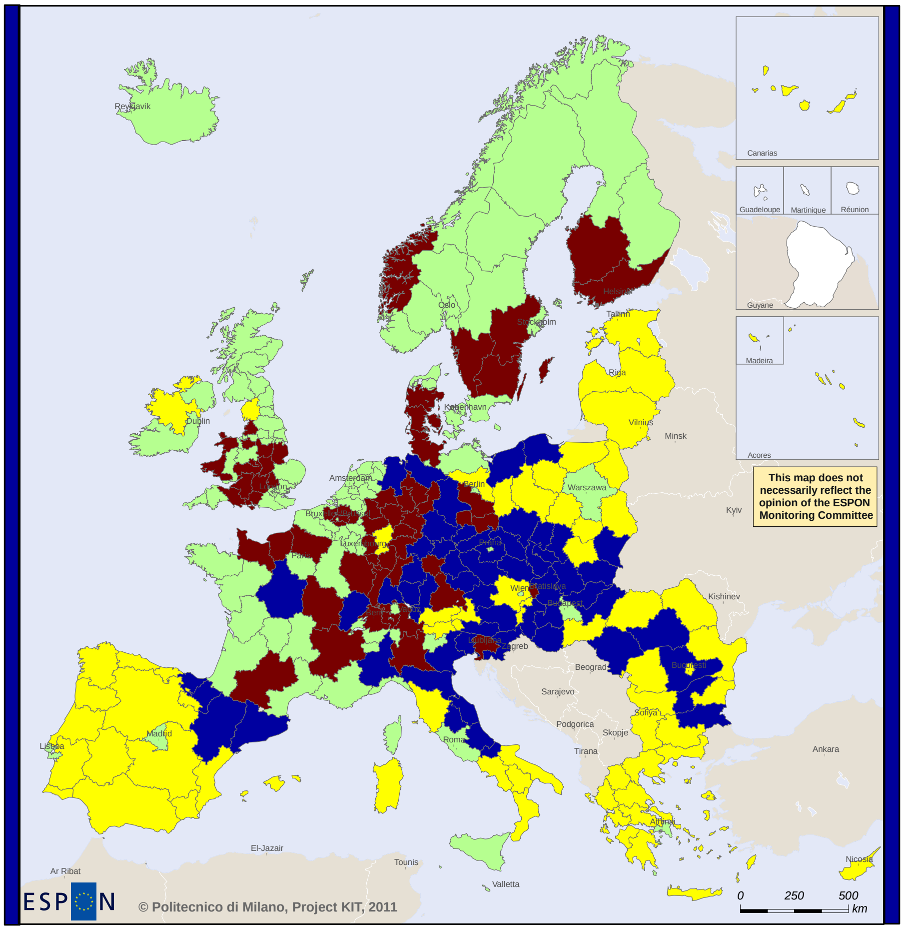


Figure 3.1.2. Definition of Technologically Advanced Regions.

Table 3.1.3. Count of TAR by typology of region.

	ESPON whole sample	**Countries**			**EU Regions**		
		EU 15	EU 12, NMS	EFTA 4	Convergence	Transition	Competitive
Technologically advanced regions	62	55	2	5	3	2	52
High-tech manufacturing regions	58	31	27	0	30	1	27
High-tech services regions	93	79	4	10	5	8	70
Low-tech regions	69	46	23	0	42	17	10

[4] Moran's I index, measuring the degree of spatial autocorrelation among regions and calculated on the basis of a rook contiguity matrix of second order, is equal to 0.18, and significant at all conventional levels, for the categorical variable "Technologically-Advanced Region" depicted in Map 3.1.5.



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Regional level: NUTS2
Source: Politecnico di Milano, 2011
Origin of data: EUROSTAT employment in high-tech sectors
© EuroGeographics Association for administrative boundaries

Technologically-advanced regions
2007
- NA
- Low tech regions
- Advanced manufacturing regions
- Advanced services regions
- Technologically-advanced regions

Map 3.1.5. Technologically-advanced regions in Europe (2007).

3.2 Scientific regions

3.2.1. A definition

The functional approach emphasizes the importance of pervasive and horizontal functions like high education and research and development efforts and the role of these advanced functions in creating and diffusing knowledge is grounded in the economics of knowledge literature.

Following this approach the definition of scientific regions is based on two fundamental pillars that are human capital and research activities. It is important to remark that these two elements are able to capture both the production of knowledge carried out within the region and the capacity of the local firm to absorb knowledge spilling from the external economies.

Scientific regions are defined as those regions showing at the same time a higher than average scientific activity and a higher than average high-quality human capital.

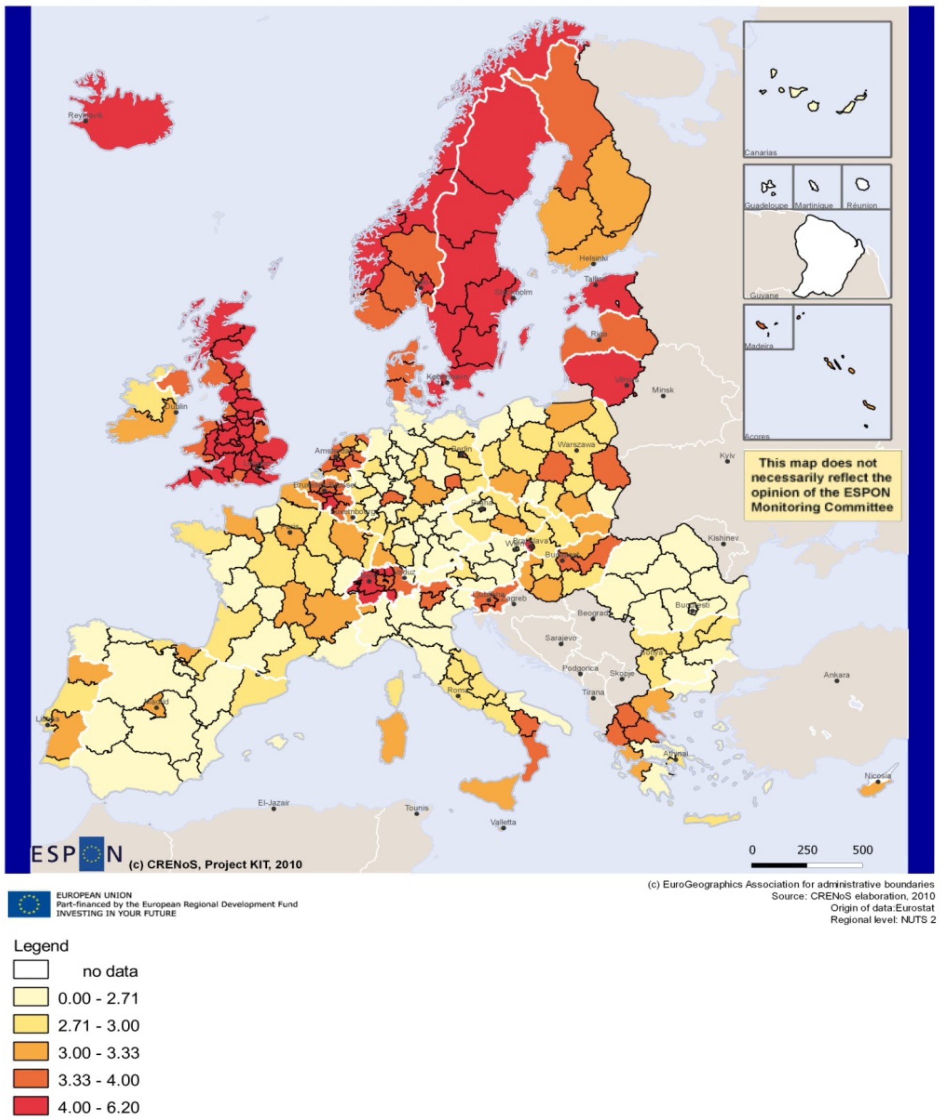
We measure the level of human capital stock in a region by means of the following indicators:
- the percentage of population employed in the education sector;
- the share of population that has attained at least a university degree;
- funding per capita in the activities of the 5th Framework Programmes;

Similarly, the level of research activities is measured by:
- the R&D expenditures per capita
- the percentage of employees in R&D
- the number of patent per capita for all economic sectors
- the number of patent per capita for the subsample of high-tech sectors.

A description of the spatial trends of these indicators is reported in the next sub-sections.

3.2.2. Human capital in European regions

Map 3.2.1 presents the map of the percentage of population employed in the education sector (average 2005-2007) which is assumed to be the input indicator in the process of human capital formation in the region.



Map 3.2.1. Employment in education (% POP), average 2005-2007.

If we consider the whole sample of regions, we observe that on average the 3.24% of population is employed in the education sector. The minimum value is presented by a Romanian region, Sud Muntenia (1.53%) and the maximum by a Swedish region, Övre Norrland (6.20%). By comparing the minimum and the maximum value we can observe that the range of variation is small in absolute terms and it can be also seen by the coefficient of variation value equal to 0.26, which measures the dispersion of values around the mean regardless of the unit of measurement.

As the figure clearly shows, regions characterized by the highest values are concentrated in the northern countries: Iceland, United Kingdom (29 out of 37 regions), Sweden (all regions), Norway (4 out of 7) and Denmark (2 out of 5 regions). The first highest class includes also 2 Belgian regions (Prov. Brabant Wallon and Prov. Namur) and a Dutch region (Utrecht) where important universities are located and this is true also for the two British regions like Oxfordshire and Essex. Moreover, most of the Swiss regions (5 out of 7) are also included in the top class together with few regions belonging to NMS: Estonia, Lithuania, Zahodna Slovenija (Slovenia) and Bratislavský kraj (Slovakia). The sample of regions included in the second and third class are less geographically concentrated and they belong to 25 out of 31 countries. Finally, the lowest values class includes regions belonging mainly to central and southern countries. Countries more represented are Austria (7 out of 9 regions are included), Germany with 22 regions (out of 39), Spain with 12 (out of 19), France (11 out of 26), Greece (6 out of 13), Italy (8 out of 21) and Romania (with all regions). Looking at the map, it appears a well defined geographical pattern of the values distribution and the presence of spatial association of the values is confirmed by the Moran Index value (0.144) that is highly statistically significant.

Summing up, the highest average value is presented by regions belonging to Efta countries (4.27%) and competitive regions (3.37%). Lower values are shown by transition regions (3.10%), convergence regions (2.84%) and regions belonging to NMS (2.87%).

In Map 3.2.2 we can observe the spatial distribution of the human capital endowment output indicator, the percentage of population (aged 15 and over) that has attained a university degree (average 2005-2007). The average value for the whole sample is equal to 12.37% and the region characterized by the minimum sample variable is an overseas Portuguese region, Região Autónoma dos Açores, with a percentage of graduates equal to 4.09. On the opposite side of the ranking there is a UK region, Highlands and Islands with a third of population that has attained a university degree (33.19%). In this case the coefficient of variation is equal to 0.36, slightly higher than for the previous variable and it indicates greater dispersion around the mean variable.

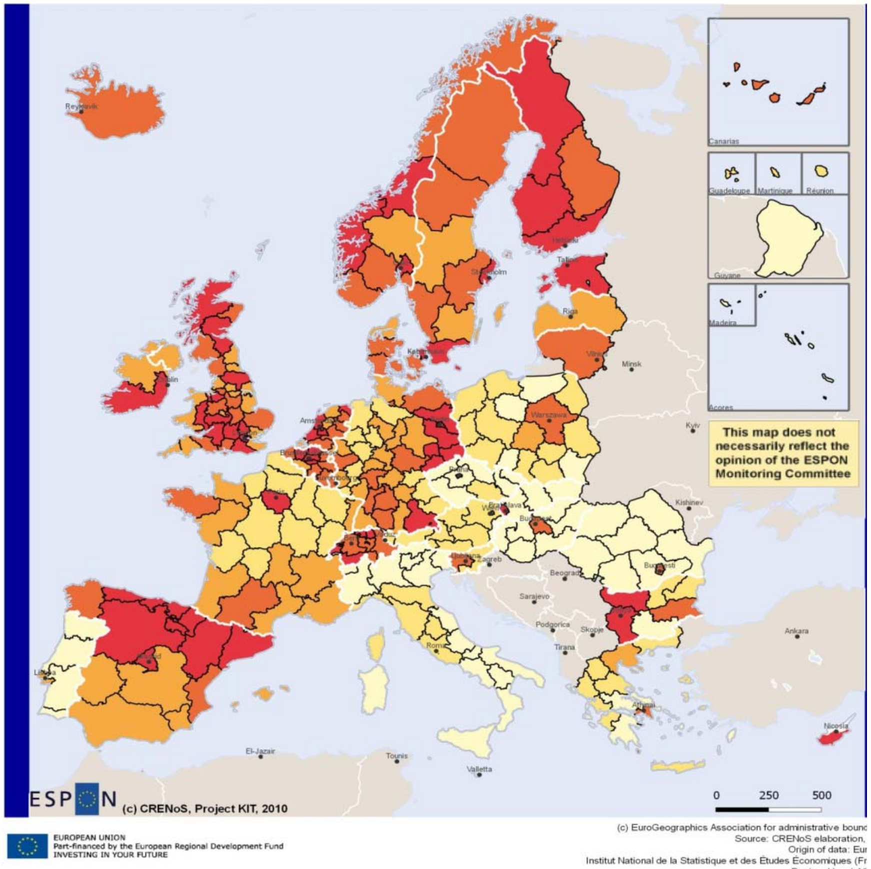
The Map presents some interesting features of spatial clustering of values. In fact, as for map 3.2.1, regions with high values are mainly concentrated in Nordic countries, but few exceptions can be noticed. Among them, Spanish regions in the north (9 out of 19), Swiss regions (3 out of 7), 2 Bulgarian regions (out of 6), and Cyprus. The top class comprises several capital regions including Brussels, Sofia, Madrid, Paris, London, Stockholm, Helsinki, Amsterdam, and Praha. This statement clearly confirms the theoretical expectation that human capital tends to concentrate in urban environments, where it pays more off to complete formal education.

In the second and third highest classes, ranging between 16% and 11%, there are again regions belonging to Nordic countries like Belgium (6 out of 11), Switzerland (4 out of 7), Germany (23 out of 39), almost all Danish regions (4 out of 5), Spain (9 out of 19), France (10 out of 13), Iceland (1 out of 1), Netherlands (8 out of 12), Norway (4 out of 9), Sweden (6 out of 8) and UK (25 out of 37). But also some important administrative regions belonging to NMS countries are included, for instance Közép Magyarország where Budapest is located, Lithuania, Latvia and regions there Warsaw and Bucharest are located.

In the lowest 2 classes, where the percentage of graduates is lower than 10.66%, 71 out 113 regions belong to EU 15 countries. A high percentage of national samples is represented in Portugal, Italy, Greece, France, Austria, and Germany. Conversely, most regions belonging to the lowest two classes (62 out of 113) are convergence regions and in fact the subsample showing the lowest average value is this group with a percentage of graduates equal to 9.21%. As for the previous variable, the highest average value is presented by regions that belong to the Efta countries (16.41%), followed by the competitive regions (13.61%) and regions that belong to the EU 15 countries (12.88%).

Map 3.2.3 shows the spatial distribution of values for the variable which proxies the quality of the human capital and research activities conducted in the region and the diffusion of knowledge through cooperation: the involvement of each region in the activities of the 5th Framework Programmes, measured by funding per 1000 population. On average regions receive 22.27 thousands euro for 1000 population. The Belgian region of Brussels shows the maximum value equal to 207,000. Sud Muntenia (Romania), Ciudad Autónoma de Ceuta and Ciudad Autónoma de Melilla, Spanish overseas territories, show the minimum value which is equal to zero. As a consequence of the distance between minimum and maximum value, the coefficient of variation value is higher than for the previous variables and equal to 1.19.

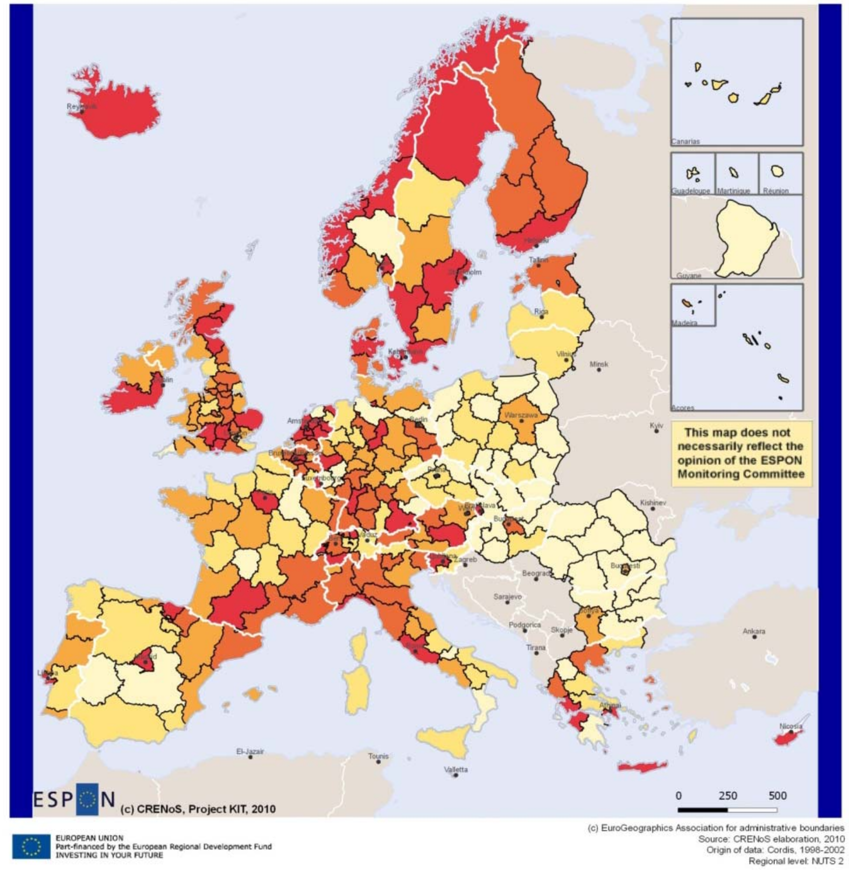
Once again, capital city regions enjoy higher than average values; this result, however, may be deeply influenced by the political nature of FP contracting, as well as by the sheer size effect that most EU capitals enjoy, also with regard to the academia.



Legend

- no data
- 0.00 - 7.94
- 7.94 - 10.66
- 10.66 - 13.67
- 13.67 - 15.99
- 15.99 - 33.19

Map 3.2.2.Tertiary education (% over population), 2005-2007.



Legend

- no data
- 0.0 - 3.6
- 3.6 - 9.1
- 9.1 - 18.0
- 18.0 - 37.4
- 37.4 - 207.8

Map 3.2.3. Funding in the 5FP per 1000 population, 1998-2002, th. Euros.

Again, regions characterized by the highest values are mainly localized in Nordic and core countries. In the highest 2 classes, ranging between 207 and 18 thousands of euro per 1000 population, are included regions that belong to Austria (4 out of 9), Belgium (7 out of 11), Switzerland (5 out of 7), Germany (16 out of 39), Denmark (5 out of 5), Finland (4 out of 5), France (6 out of 26), Iceland, Liechtenstein, Luxemburg, Netherland (9 out of 12), Norway (5 out of 7), Sweden (5 out of 8), and United Kingdom (19 out of 37). Furthermore within these samples are also included southern, eastern and western regions where the most important administrative cities are located and most of them are characterized by a high population density. For instance Praha in Czech Republic, Estonia, 4 Spanish regions including the Madrid region, the Hungarian region of Közép Magyarország where Budapest is located, the most important Italian regions (8 of 21). Among dark red coloured regions there are also 6 out of 7 Greek regions.

Regions included in the third and fourth class, ranging between 13.67 and 7.94 thousands of euro, are not so spatially concentrated as regions in the first two classes. However, we can see that they mainly belong to EU15 (99 out of 117) and most of them are competitive regions (66 out of 117). A difference between the previous subsample is that most of them are rural regions, where population density is lower.

Among regions included in the lowest class, most belong to NMS (34 out of 55) and are facing a convergence process (43 out of 55): Czech Republic (1 out of 8), Bulgaria (5 out of 6), Czech Republic (3 out of 8), Poland (10 out of 16), Romania (7 out of 8) and Slovakia (3 out of 4) but also an Austrian region, 3 regions from Germany, 3 from Spain, 6 from France, 3 from Greece, 2 from Italy, 1 from Netherlands, 1 from Norway and a UK region.

Summing up, Map 3.2.3 reveals strong spatial concentration of high and low values that is confirmed by the Moran index equalling 0.065, not high in absolute terms but highly statistically significant. Competitive regions, regions belonging to Efta countries and the EU15 show the highest average values (respectively 29, 47.9 and 24.31 thousands euro per 1000 population) while lowest average values are shown by convergence regions and regions belonging to NMS (respectively 6.94 and 7.13 thousands euro per 1000 population). The geography of research quality as evidenced by FP5 presents therefore further evidence of a persisting dichotomy within the EU27.

3.2.3. Research activity in European regions

Turning to the research activity measures, in Map 3.2.4 we can observe the spatial distribution of R&D expenditure on GDP which is considered as an input indicator for research activities in order to analyse its regional distribution. This indicator is rather important since it has been used as a benchmark for the knowledge-economy development policies in official Ministerial documents like the Lisbon Agenda and Europe2020. The first comment is that there is a large difference between minimum and maximum value, ranging from less than 0.5% to more than 6%.

By observing the map, the first impression is that the number of regions that reach the Lisbon objective is very limited (32 regions all over Europe), with a strong geographical concentration: dark red colored regions are concentrated on the Scandinavian regions, southern UK regions and territories located on the centre of Europe, with the exception of the French region of Toulouse. Nine European countries host the 32 virtuous regions (Austria, Belgium, Germany, Switzerland, Denmark, Finland, France, The Netherlands, Sweden and the UK), and within these countries, the spatial concentration is evident from the Map.

Furthermore, most of them are competitive regions. Moreover, there is a clear Eastern-Western dichotomy, where Eastern regions show a very limited capacity of R%D spending with respect to Western countries.

The same spatial concentration is shown when R&D is divided by population. The concentration is confirmed in this variable by the spatial association Moran Index equal to 0.091 and highly statistically significant. From the analysis of the map we can also deduce that the average value for competitive regions and regions that belong to Efta countries is again higher than the same value for convergence and transition regions and regions that belong to NMS (respectively 0.60, 1.09 and 0.09, 0.18 and 0.07 millions of euro per 1000 population).

Map 3.2.5 shows the spatial distribution of values for the second research activity input variable, that is the percentage of employees in the R&D sectors over total employment (average 2006-2007). By considering the whole sample of European regions, on average the

0.65% of employees works in the R&D sectors but there are large differences among single regional values. The region characterized by the highest percentage of R&D personnel is North Eastern Scotland (UK) (5.71%). Also the region showing the minimum value belongs to UK and it is Highlands and Islands (0.18%). For this indicator the variation interval between minimum and maximum is not so large and it is confirmed by the coefficient of variation equal to 0.65, which is lower than previously.

The map shows a less marked spatial pattern than for the previous indicators. Although regions belonging to the lowest classes are mainly localized on the eastern part of the continent, there are some light yellow territory also on the north, for example UK regions (6 out of 37), 3 Dutch regions (out of 12) and 3 German regions (out of 39).

Map 3.2.5 shows a relatively lower spatial concentration with respect to other variables above described. All capital cities and major agglomerated regions show a high share of R&D personnel, and this applies also to agglomerated areas in some NMS (viz., Poland, Hungary and Czech Republic). The same positive spatial trend characterizes Spain and Greece. The share of personnel does not fully reflect the share of R&D expenditure on GDP (map 3.2.4); in fact, some capital (Lazio, Madrid, Attiki, Warsaw) and agglomerated (Basque Countries, Rhone-Alpes, Emilia-Romagna) regions present a high share of R&D personnel, notwithstanding relatively lower shares of R&D expenditure on GDP.

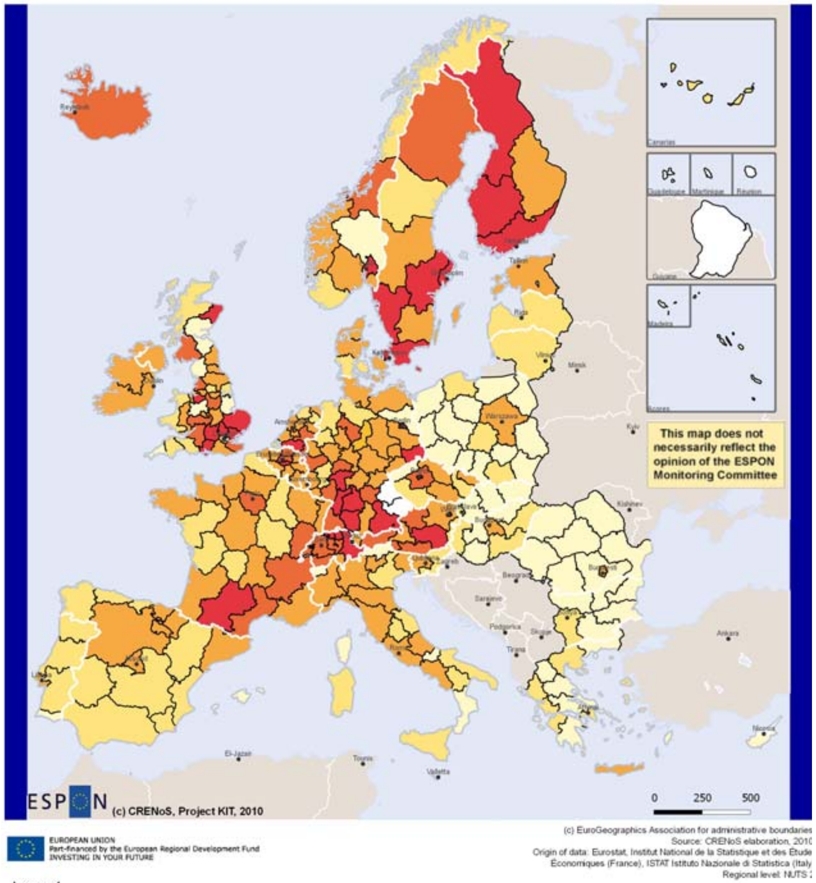
To conclude, although the spatial pattern is not so strong as for the previous variables, the Moran index is statistically significant suggesting, once again, spatial concentration of similar values and then the presence of spatial association. As for the previous variables, the highest average value is shown by regions belonging to Efta countries and competitive regions (respectively 2.35% and 1.76%). Lowest average value is presented by regions belonging to NMS (0.86%).

In Maps 3.2.6 and 3.2.7 we can observe maps of variables used to measure inventive activities. We rely upon patent counts including two complementary measures: the total number of per capita patents released in the region in all economic sectors (Map 3.2.6) and the number of per capita patents for the subsample of high-tech sectors (Map 3.2.7). These output indicators are expected to measure the value resulting from technological knowledge generated by firms and can be used as a proxy for research and development effectiveness.

Map 3.2.6 represents the spatial distribution of the number of patents per 1000 population (average 2005-2006) whose average values is equal to 0.103. Maximum value is reached by a Dutch region, Noord Brabant, and it is equal to 0.728 patents for 1000 population. The minimum distribution value is 0 and it is assumed by 12 regions belonging to Romania (4 regions), Greece (3 regions), Spain (2 regions), Iceland and the Portuguese overseas territories (2 regions). Because of the large difference between maximum and minimum value, the variation interval is consistent and it is confirmed by the coefficient of variation value equal to 1.25, higher than for the previous variables.

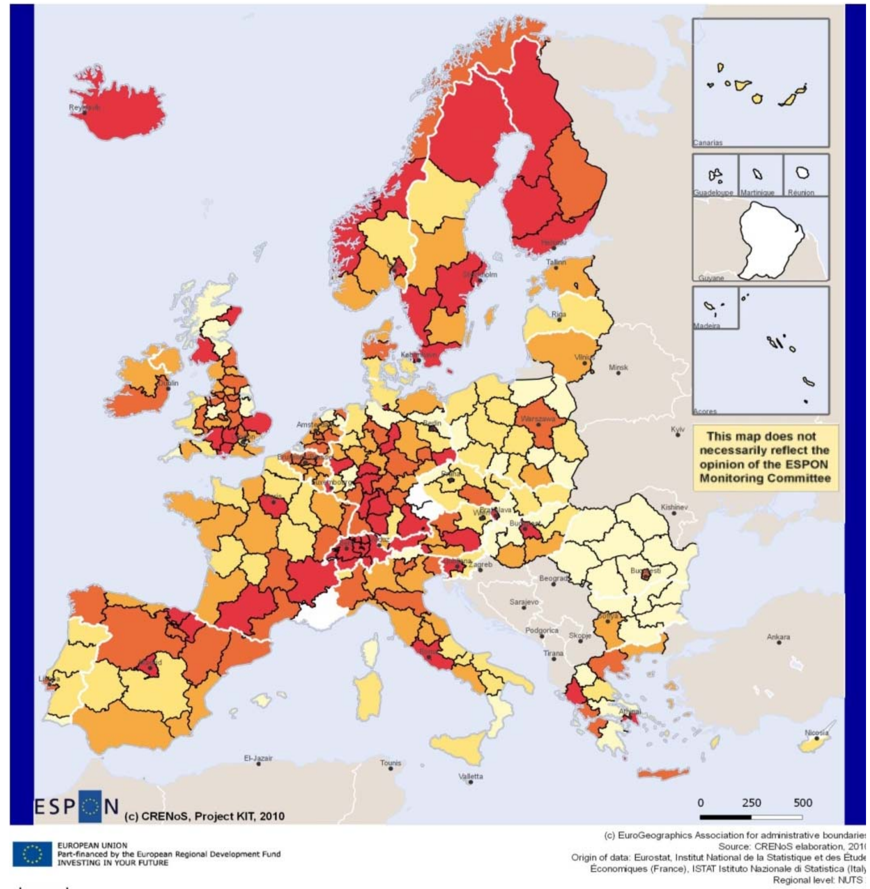
Spatial concentration does not prevent the map from presenting interesting features. In fact, Map 3.2.6 shows policentricity characteristics, whereas different macro regions with a consistent concentration of dark colours can be detected. In fact, the highest two classes (ranging between 0.728 and 0.089), include regions belonging to Austria, Belgium, Switzerland, Luxemburg, and Germany (core of continental Europe); Denmark, Finland, Sweden, and Norway (Scandinavian regions); Spain, France, and Italy (Southern Europe); and Netherlands and the United Kingdom (North-Western Europe). Within this group, only 2 transition and 2 convergence regions are included, with no region belonging to NMS. This suggests a relatively stable polycentric system of innovation in EU15 countries, and a relatively lagging situation in NMS, almost with two separate systems co-existing.

If we distinguish among rural, urban, agglomerated regions and regions where large cities are located, a large number of territories included in the first two classes are urban regions.



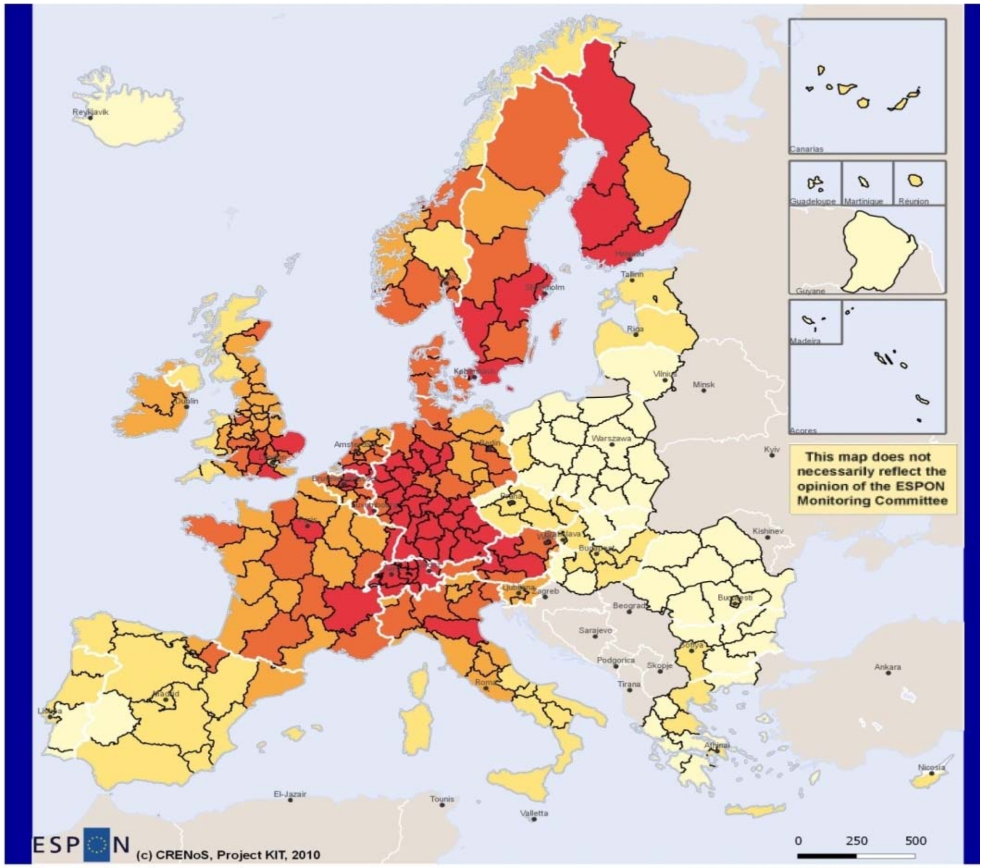
Legend
- no data
- 0.00 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- 2.00 - 3.00
- 3.00 - 6.77

Map 3.2.4. RD Expenditure on GDP, average 2006-2007.



Legend
- no data
- 0.000 - 0.615
- 0.615 - 1.052
- 1.052 - 1.490
- 1.490 - 2.105
- 2.105 - 5.710

Map 3.2.5. RD Personnel % of total employment, Average 2006-2007.



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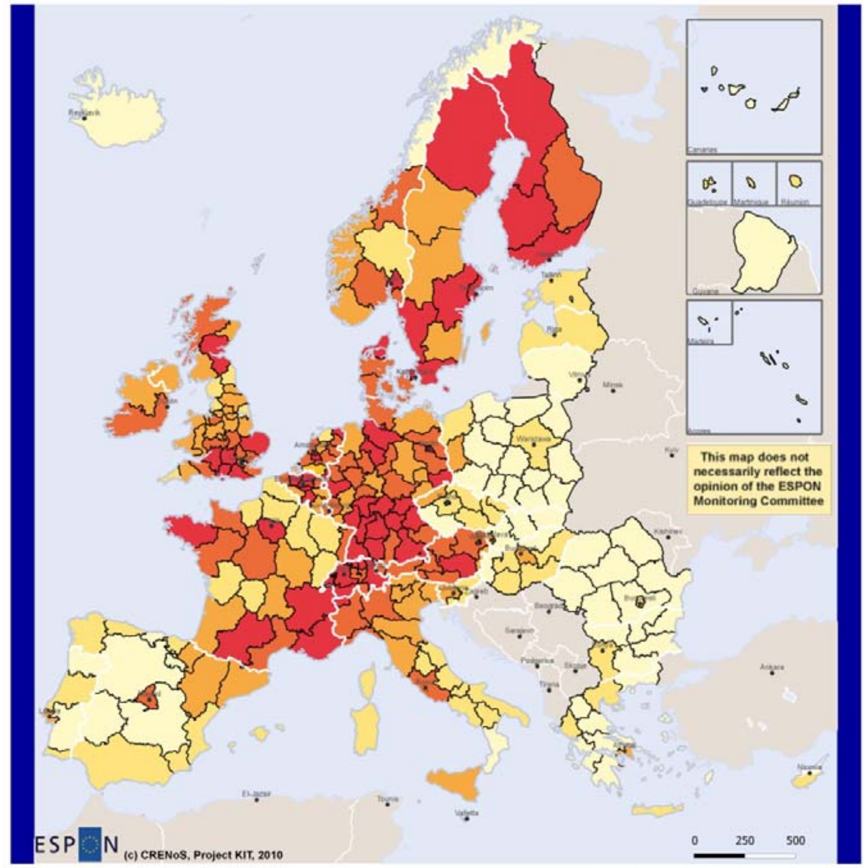
(c) EuroGeographics Association for administrative boundari
Source: CRENoS elaboration, 20
Origin of data: OECD REGPAT Database, 20
Regional level: NUTS

Legend

- no data
- 0.000 - 0.005
- 0.005 - 0.042
- 0.042 - 0.089
- 0.089 - 0.160
- 0.160 - 0.728

Map 3.2.6. Number of patents per 1000 POP, average 2005-2006.



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(c) EuroGeographics Association for administrative boundaries
Source: CRENoS elaboration, 2010
Origin of data: OECD REGPAT database 2010
Regional level: NUTS 2

Legend

- no data
- 0.00 - 0.45
- 0.45 - 2.44
- 2.44 - 6.74
- 6.74 - 17.90
- 17.90 - 181.51

Map 3.2.7. Number of patents in high-technology fields per million POP, average 2005-2006.

The third and fourth class, ranging between 0.089 and 0.005, encompasses in particular rural areas, belonging to the EU core (Austria, Belgium, Germany) but also to several other countries outside the Pentagon. The lowest class, finally, includes mainly convergence and rural regions. These territories are located above all on the eastern part of Europe and belong to Bulgaria (out of 6 regions), Spain (3 out of 19), France (3 out of 26 that are the overseas territories), Greece (6 out of 13), Hungary (3 out of 7), (1 out of 1), Lichtenstein and Lithuania (1 out of 1), Poland (15 out of 16), Portugal (4 out of 7), Romania (7 out of 8) and Slovakia (2 out of 4).

The spatial pattern stressed by the map is confirmed by the highly significant Moran Index equal to 0.156 (p-value equal to 0.00). The geographical distribution of values explains also large differences in average values for macro areas. If we rank the sub-samples of regions, on the top we find regions that belong to Efta countries with an average value equal to 0.21, followed by competitive regions with 0.15. On the bottom of the rank there are regions that belong to NMS.

In Map 3.2.7 we represent the number of high-technology fields patents per million population (average 2005-2006) whose mean value equals 13.12. The maximum value, 181.51 patents per million population, is reached by the same regions as for the previous variable, the Dutch region Noord Brabant and also the minimum value is the same as for the total amount of patents and equal to zero. 33 out of 287 regions show a zero value and they belong to Bulgaria, Spain, Greece, Iceland, Liechtenstein, Poland, Portugal, and Romania. Among them there are overseas territories, for instance Ciudad Autónoma de Ceuta, Ciudad Autónoma de Melilla, Canarias, Região Autónoma dos Açores, and rural territories. Again the range variation of values is confirmed by a coefficient of variation equal to 1.74, higher than for all the previous variables.

As the map shows, the spatial distribution of values is quite similar to that observed for the previous variable; nevertheless, spatial concentration seems to be even higher, with a clear West-East divide and a consistent concentration in some innovation-prone regions, such as the Rhone-Alpes (France), South-East England, South Germany, and most Finnish regions. Regions included in the two highest classes, ranging between 181.51 and 6.74, are mainly competitive regions, belonging to EU 15 and Efta countries. Furthermore, they are urban regions and belong to Austria (8 out of 9), Belgium (8 out of 11), Switzerland (all regions), Germany (31 out of 39), Denmark (all regions), Spain (1 out of 19), Finland (all regions), France (10 out of 26), Ireland (1 out of 2), Italy (5 out of 21), Luxemburg, Netherland (9 out of 12), Norway (3 out of 7), Sweden (5 out of 8) and United Kingdom (16 out of 37).

Regions included in the third and fourth class, ranging between 6.74 and 0.45, are mainly rural areas that are not geographically concentrated. Conversely, regions included in lowest class, ranging between 2.71 and 0, are mainly concentrated in the eastern countries like Bulgaria (5 out of 6 regions), Czech Republic (1 out of 8 regions), Greece (9 out of 13), Hungary (2 out of 7), Lithuania (1 out of 1), Poland (13 out of 16), Romania (7 out of 8 and Slovakia (3 out of 4). There are also some exceptions as 7 Spain regions (out of 19) including overseas territories, the French Guyane, Iceland, the Italian Calabria, Liechtenstein, Nord Norge that belongs to Norway, 4 Portuguese regions (out of 7).

Again the strong geographical trend emerges and it is confirmed by the significance of spatial dependence Moran Index. The spatial pattern stresses also differences for macro areas average values: competitive regions show the highest average value (20.40), followed by Efta countries' regions (18.61), EU 15 countries' regions (15.90), transition regions (3.46), convergence regions (1.52) and finally EU NMS regions (0.85).

3.2.4. Scientific Regions in Europe

The aim of this section is to identify the subsample of scientific regions under the two main perspectives of research activities and human capital. On the basis of the previous indicators, we develop two synthetic measures by standardizing all simple indicators around the European average imposed equal to zero and by constraining the distribution within the range -1 and 1. Following the methodology used in the Community innovation scoreboard, re-scaled values are calculated by first subtracting the minimum sample value and then dividing by the difference between the maximum and minimum value. The maximum re-scaled value is thus equal to 1 and the minimum re-scaled score is equal to -1. For positive and negative outliers and small countries where the relative value is above the maximum score or below the minimum score, the re-scaled value is thus set equal to 1 and -1, respectively.[5] Thus we no longer have the problem of different units of measurement (and this allows us to add the various indicators) also solving the problem of outliers.

We construct the two synthetic measures by imposing the same weight to each simple indicator: 1/3 for each human capital indicator and 1/4 for each research activity indicator.[6]

We detect "Scientific regions" as a subsample of the total number of European regions showing for both indicators values greater than zero. Regions showing values greater than zero for human capital indicator but less than zero for research activity are labelled Human capital intensive regions. On the contrary, regions characterized by values greater than zero for research activity and less than zero for the human capital indicator are indicated as Research intensive regions. Finally, regions showing values less than zero for both indicators are defined as Regions with no specialisations in knowledge activities (Figure 3.2.1).

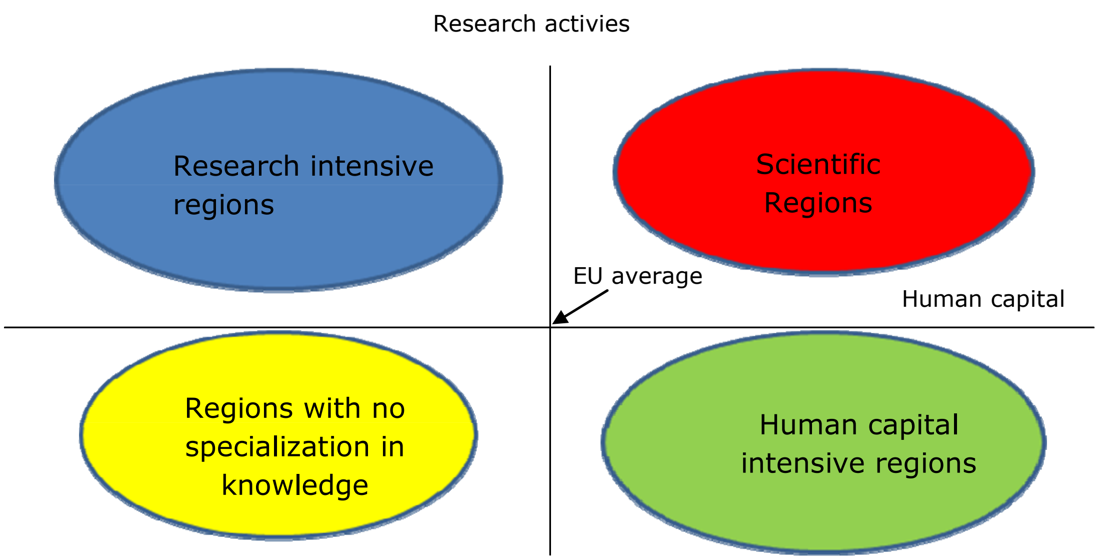


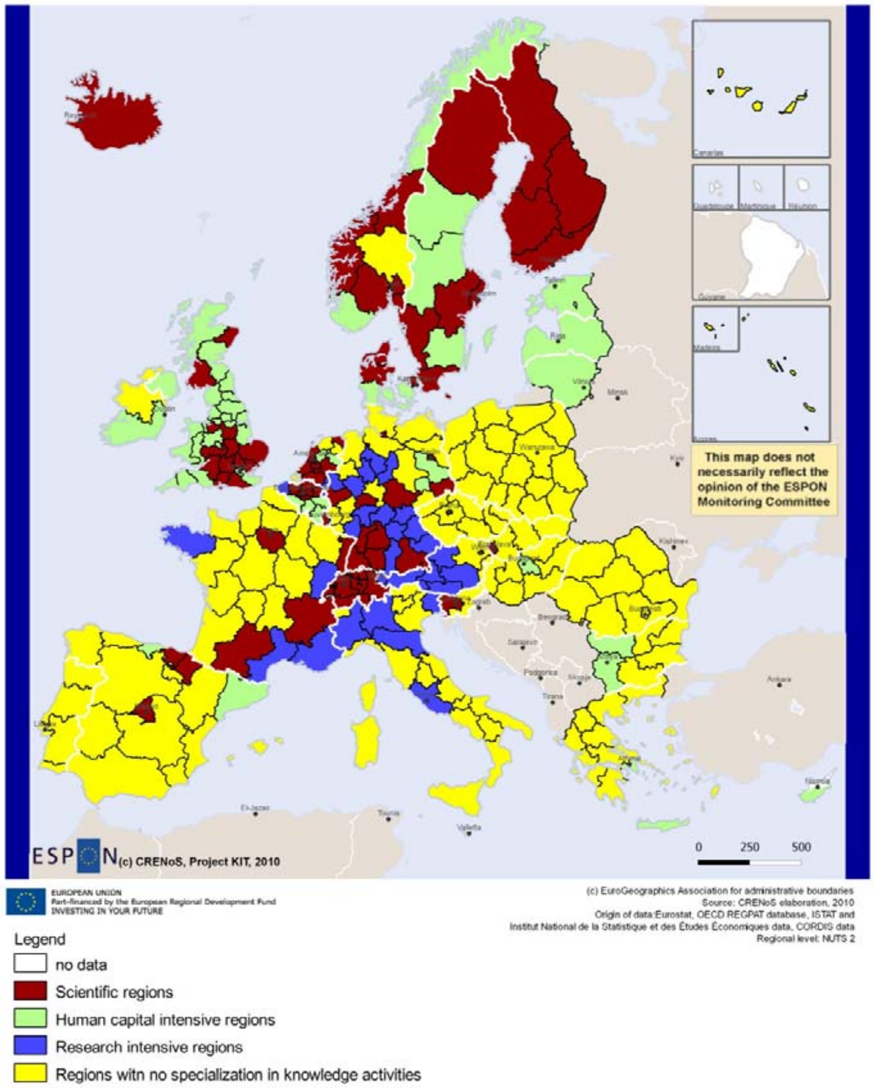
Figure 3.2.1. Definition of Scientific Regions.

In order to classify territories with respect to a single dimension, we build a synthetic indicator as the sum of the human capital and research activity composite indicators. Among the top ten scientific regions, Scandinavian countries are largely represented, together with Swiss and most Belgian regions: for Denmark 3 out of 5, for Finland 4 out of 5, for Norway 4 out of 7 and for Sweden 5 out of 8. All are represented. Among Scientific regions there are also 12 (out of 39) German regions, 6 regions belonging to Netherlands and 14 (out of 37) British regions. Moreover there are regions where important administrative towns are located: the Wien region for Austria, Praha for Czech Republic, Madrid and Ile de France regions.

Map 3.2.8 shows the spatial distributions of the four categories of regions and we can observe that Scientific regions are concentrated in the centre and in the north of Europe. We can observe 74 Scientific regions, 30 Research Intensive regions and 52 Human capital Intensive regions. But most of regions, 126, are concentrated on the third quadrant where we identify regions with no specialisation in knowledge activities. Among the 74 Scientific regions there are 59 regions belonging to EU 15 countries, 3 belonging to NMS and 12 belonging to Efta countries. Moreover, 58 are competitive regions, 3 are convergence regions and only one is a transition region.

[5] Re-scaled value = $[(xi) - \min(x_{1-n})]/(\max(x_{1-n}) - \min(x_{1-n})$. For more info see "European Innovation Scoreboard 2009"

[6] Since the choice of the weights is arbitrary, we run extensive simulations with different weights structures, but the classification of the scientific regions remains stable. Therefore, we prefer to adopt a distribution with equal weights.



Map 3.2.8. Scientific regions in Europe.

Regions with no specialization in knowledge activities are mainly located on the peripheral territories of Europe and Research Intensive regions are concentrated on territories characterized by a manufacturing productive specialization (i.e. Northern Italy, German regions). Finally, as expected Human capital Intensive regions are mainly on the north.

3.3. Knowledge networking regions

3.3.1. A definition

When defining Knowledge Networking Regions we follow the idea that knowledge is created within some crucial nodes (i.e. firms and universities) which tend to co-locate in specific places. Knowledge is then diffused and exchanged either through a diffusive pattern in which spatial proximity is essential or according to intentional relations based on a-spatial networks.

Translating these ideas to the regional level, **knowledge networking regions** can be understood as regions that rely on external sources of knowledge and on facilitating interactive learning and interaction in innovation. This knowledge diffusion can take place through diffusive patterns based on spatial proximity (henceforth "spatial linkages") and/or through intentional relations based on a-spatial networks or non-spatially mediated mechanisms ("a-spatial linkages").

A combination of different measures is used to assess the degree of regional a-spatial linkages, namely:

- Co-patents with other ESPON regions: number of patents co-authored with inventors from outside the region.

- Inflows: number of inflows of inventors coming from other regions (from where they bring knowledge, brain gain).[7]
- Cross-regional patent citations: number of citations made to patents of other regions. In spite of the advantages of citations as being a straightforward measure of knowledge flows, it could be argued that they represent the output of any form of knowledge transmission, instead of the exact mechanisms through which knowledge is transferred.

We next provide a detailed descriptive analysis of the various indicators suggested to characterise knowledge networking regions. More specifically in our approach, knowledge networking regions can be defined with reference to the high use of first, spatial and, second, a-spatial linkages with external-to-the-region sources of knowledge. In this respect, indicators of both types of linkages can give descriptive evidence of the geographical distribution of such knowledge networking processes across European regions.

3.3.2. Spatial linkages

The level of "spatial linkages" is measured by means of external R&D, external patent applications and external Framework Program budgets. In the three cases, in order to obtain the external, but at a short-distance, values of these three proxies, we weight the original data by a row-standardized first order contiguity matrix. In other words, what we obtain is the average of R&D in the neighbouring regions (understanding "neighbouring" as the regions which share a common border with the region under consideration). The same would apply for patent application and Framework Program budgets. Although the results commented in this section on the spatial linkages are mainly based on Maps 3.3.1 and Tables 3.3.1 and 3.3.2 to point out the results for these three variables relative to population, the reader will find in Section 3 of the Scientific Report the maps and tables for all the periods not only in relative but also in absolute levels.

According to the **R&D per capita developed in the neighbouring regions**, we observe that the "competitive" regions show the highest mean values (Table 3.3.1). On the contrary, regions showing the worst performances are "convergence" regions and those belonging to the NMS. In fact, the level of R&D expenditures per capita in the "competitive" regions is 5 times higher than the one observed in "convergence" regions. An important point here is that variability within each sample of regions is very high, according to the coefficient of variation (Table 3.3.2), so that important differences are observed when considering how well co-located (how well surrounded) is a region in terms of R&D investments. This high heterogeneity is specially observed in regions belonging to the NMS and "convergence" regions.

As for the geographical distribution observed in the maps (Map 3.3.1), the same that occurred with R&D expenditure in each region (in the scientific approach), in the case of R&D expenditure per capita in the neighbouring regions, three different patterns are observed: High expenditure levels in some regions of the core of Europe (Germany, Switzerland and the South of the UK) as well as in the Scandinavian countries; a second group with values in the average or below in Benelux, France, the North of Italy, the North East of Spain and the North of UK; and finally a last group consisting of the Eastern countries, Portugal, most of Spain and Greece with a low level of expenditure in R&D. Among the 10 best performances in R&D expenditure in per capita terms we find regions in Denmark, Germany, the Scandinavian countries (Sweden, Finland and Norway) as well as in Switzerland.[8]

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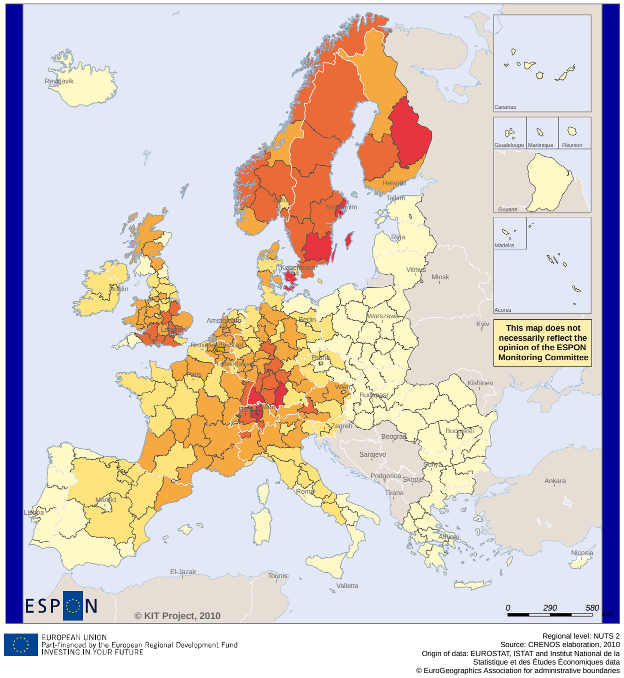
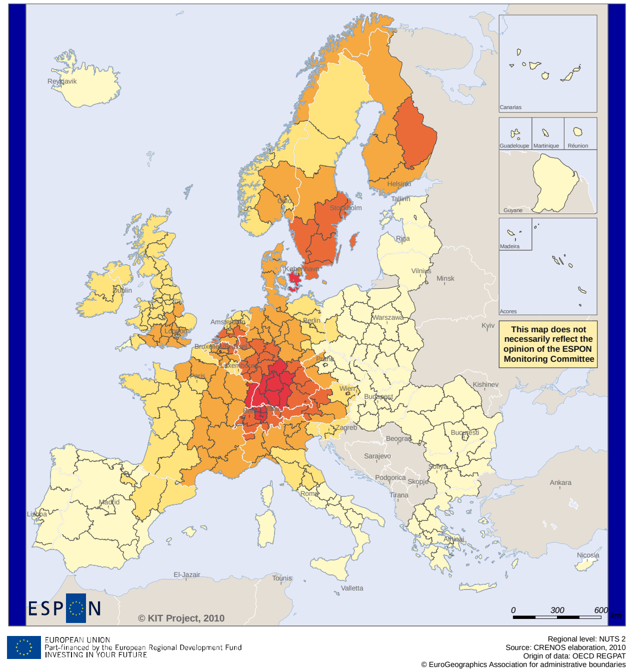
[7] Additionally, and complementary to the inflows measure (which proxies the regional brain gain), it is possible to think, as some authors have pointed out (Saxenian, 2005) that the dichotomy brain drain/brain gain might be overcome by the concept of brain circulation. Thus, it is perfectly possible that regions exporting talent may benefit as well from knowledge inputs from outside the region because of enduring social relationships between the left talented individual and his/her former colleagues. Thus, the flows of inventors (outflows) going to other regions might be computed as well. Although we obtained the values for this variable in the ESPON regions, as given in Section 4.3 of the Scientific Report, there is a high correlation between inflows and outflows of inventors. This is the reason why we will be using only the inflows as an indicator for a-spatial linkages.

[8] According to Table A2.3 in Section 4.2 of the Scientific Report, some regions in France and Italy appear among the 10 best performances in R&D in absolute terms, whereas they are not longer present in per capita terms.



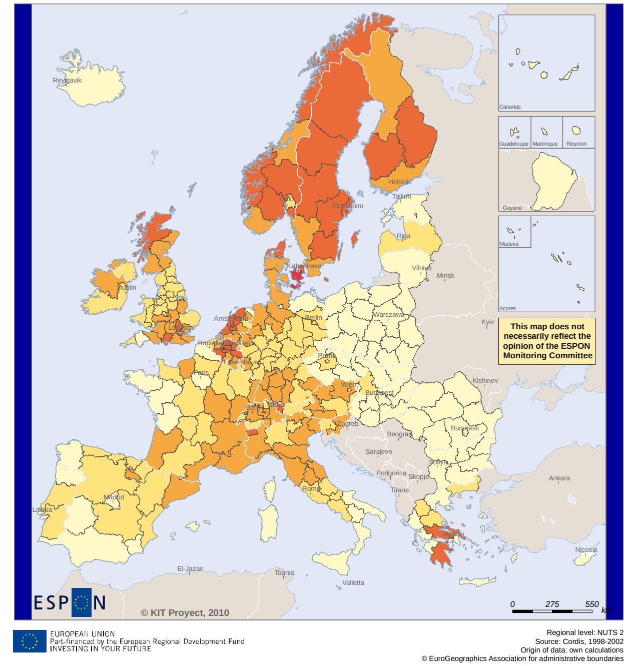
Intramural R&D expenditure per capita in the neighbouring regions (1000 population). Average 2006-2007

- 0,0000 - 0,2020
- 0,2021 - 0,4601
- 0,4602 - 0,7370
- 0,7371 - 1,1127
- 1,1128 - 2,6300



Patent activity per capita (1000 population) in the neighbouring regions. Average 2005-2006

- 0,0000 - 0,0431
- 0,0432 - 0,1062
- 0,1063 - 0,1860
- 0,1861 - 0,3184
- 0,3185 - 0,4945



Average funding pc in FP in the neighbouring regions

- less than 9625
- 9625 to below 21693
- 21693 to below 36325
- 36325 to below 62397
- 62397 and more

Map 3.3.1. Geographical distribution of the main indicators for spatially mediated linkages.

Note: Data refer to the most recent period available: 2006-2007 for R&D: 2005-2006 for Patent activity; 1998-2002 for FP funding.

Table 3.3.1. Average values of the main indicators for spatial and a-spatial linkages.

	ESPON whole sample	Countries			EU Regions		
		EU 15	EU 12, NMS	EFTA 4	Convergence	Transition	Competitive
INDICATORS OF SPATIAL LINKAGES							
R&D expenditure in the neighbouring regions (2006-07)	0.40	0.46	0.08	0.81	0.11	0.27	0.55
Patent activity in the neighbouring regions (1995-97)	0.06	0.07	0.01	0.14	0.01	0.02	0.09
Patent activity in the neighbouring regions (2005-06)	0.10	0.12	0.01	0.21	0.02	0.04	0.15
FP funding in the neighbouring regions (1998-2002)	18,961.46	21,914.58	4,914.82	28,442.15	6,603.50	14,576.96	25,315.81
INDICATORS OF A-SPATIAL LINKAGES							
Co-patents (1995-97)	140.58	160.57	9.53	330.57	17.09	56.89	201.93
Co-patents (2002-04)	249.11	283.04	36.56	537.22	49.92	106.49	351.49
Inflows (1995-97)	4.90	5.35	0.17	15.40	0.60	1.99	6.64
Inflows (2002-04)	7.39	8.56	1.18	13.38	1.63	3.23	10.58
Citations (1995-97)	50.01	58.27	1.46	108.87	3.40	12.80	75.28
Citations (2002-04)	69.35	81.11	3.81	140.75	7.23	22.57	103.31

Note: All the variables are given in per capita terms (1000 population in the case of spatial linkages; 1 million population in the case of a-spatial linkages).

The variable **Patents per capita in the neighbouring regions** follow a similar pattern than the one described for the case of Patents, due to the high spatial association of similar values in the European territory as observed when analyzing the scientific approach. Since regions with high/low values of patents tend to be surrounded by regions with high/low values of patents, the maps observed for patents and patents in the neighbouring regions resemble substantially. Therefore, the main conclusions are maintained. With respect to the evolution in time (Table 3.3.1), for all the chosen samples the average value of patents in the neighbouring regions grows between 1995 and 2006, being "competitive" regions and those belonging to the EFTA countries the ones showing the best performances. On the contrary, regions belonging to the NMS show the lowest values and do not experience any improvement in time. Additionally, the heterogeneity observed across European regions is very important (Table 3.3.2), with the highest values for the coefficient of variation in the regions belonging to the EU "NMS" and "convergence" regions. Again, the lowest heterogeneities are shown in the cases of the EFTA countries and the "competitive" regions, a constant result over time.

Table 3.3.2. Coefficient of variation of the main indicators for spatial and a-spatial linkages.

	ESPON whole sample	Countries			EU Regions		
		EU 15	EU 12, NMS	EFTA 4	Convergence	Transition	Competitive
INDICATORS OF SPATIAL LINKAGES							
R&D expenditure in the neighbouring regions (2006-07)	0.9	0.72	1.23	0.39	1.23	1.13	0.57
Patent activity in the neighbouring regions (1995-97)	1.1	0.86	2.56	0.66	2.2	1.49	0.65
Patent activity in the neighbouring regions (2005-06)	1	0.86	2.09	0.67	1.88	1.32	0.67
FP funding in the neighbouring regions (1998-2002)	0.9	0.75	0.86	0.51	1.2	0.99	0.63
INDICATORS OF A-SPATIAL LINKAGES							
Co-patents (1995-97)	1.8	1.51	1.87	1.57	2.71	1.57	1.31
Co-patents (2002-04)	1.6	1.43	2.99	1.23	2.49	1.55	1.26
Inflows (1995-97)	1.8	1.16	2.65	1.83	2.96	1.8	0.98
Inflows (2002-04)	1.6	1.39	4.71	0.93	3.16	1.83	1.22
Citations (1995-97)	1.3	1.03	1.83	1.06	2.4	1.5	0.81
Citations (2002-04)	1.3	1.05	1.78	0.95	2.31	1.26	0.84

As for the spatial distribution (Map 3.3.1), the pattern observed in the maps does not change in the time span considered, with the core of Europe concentrating the highest values of patents in the neighbouring regions, followed by the Scandinavian countries, both at the beginning and at the end of the period. On the contrary, Southern Europe as well as the Eastern regions are persistently surrounded by a low patenting activity. Looking at the first ten positions of the ranking of being surrounded by high values of patents, it seems clear that there is a leading position assumed by Germany and Switzerland.

With respect to the **Fifth Framework Programme**, we use three different variables, one measuring the average number of participants in the neighbouring regions, and the other two the average project funding in the neighbouring regions in absolute and relative terms, respectively. As for the participation in the 5FP, we observe that the regions surrounded with higher number of participants are mainly regions of the EU15, with preponderant values in the Mediterranean area of France, Spain, Italy and Greece. The Netherlands, South of UK and Finland and Sweden are also well co-located in this sense. However, the map changes substantially when funding is taken into account and specially funding per capita (Map 3.3.1). In this case, the Mediterranean area stops being well surrounded of regions with high levels of FP funding (only Greece presents high values), being the Scandinavian regions (the ones in Finland, Sweden, Norway and Denmark) as well as those in the Benelux the ones that are surrounded by higher funding in per capita terms. Finally, according to Table 3.3.1, "competitive" regions show the highest values as well as the regions in the EFTA countries. Regions belonging to NMS and "convergence" regions present the worst performances.

If one ranks regions for average project funding in the neighbouring regions, the following rank emerges: 1 Danish (Sjaelland) region and 1 Greek (Peloponnisos) together with 2 Belgium regions (Vlaams Gewest and Vlaams Brabant), two Dutch (Utrecht and Zuid Holland), 2 Swedish (Stockholm and Smaland med oarna), and 2 Norwegian regions (Hedmark og Oppland and NordNorge). The regions in the bottom list belong to some of the EU NMS (Bulgaria, Romania and Poland) and to some countries in the south of Europe (Greece, Spain, Portugal and Italy).

3.3.3. A-spatial linkages

As proxy for "a-spatial linkages" we use Co-patents, Inflows of inventors and Citations made to patents from other regions (no matter if they are contiguous or not). In all the cases we have the absolute value as well as the relative one in per capita terms (over one million population). Although the results commented in this section on the a-spatial linkages are mainly based on Map 3.3.2 and Tables 3.3.1 and 3.3.2 to point out the results for the three variables relative to population, the reader will find in Section 3.3 of the Scientific Report the maps and tables for all the periods not only in relative but also in absolute levels, as well as the ranking of regions for each indicator.

According to **co-patents in per capita terms**, we observe that the "competitive" regions show the highest mean values (Table 3.3.1), whereas "convergence" regions and those belonging to the NMS show the worst performances, a consistent result along time. With respect to the variability within each sample of regions according to the coefficient of variation (Table 3.3.2), it seems to be importantly high in the NMS and in "convergence" regions. Therefore, differences across regions are more important in those regions that are among the ones with the lowest values in co-patenting activity.

As for the geographical distribution of the co-patents observed in Map 3.3.2 as well as in the top ranking, we can conclude that some of the German regions are the ones presenting the highest values in Europe together with Liechtenstein and one Swiss region (Nordwestschweiz). On the opposite site of the table, with the lowest values, we find regions in some of the NMS (Romania, Bulgaria and Poland) as well as in the Southern countries (Greece, Portugal and Spain). An additional and interesting result is that in the intermediate range of values for the co-patenting activity and surrounded by regions with lower values, we find some of the regions hosting the capital cities such as the ones where we find London, Stockholm, Copenhagen, Brussels, Berna, Vienna and Zagreb.

The variable **Inflows of inventors in per capita terms** presents a similar pattern to the one observed for co-patents (Table 3.3.1), in the sense that the "competitive" regions show the highest mean values whereas the regions showing the worst performances are those belonging to the NMS and "convergence" regions. This is a consistent result along time although it must be said that the differences have diminished, since in the first period under consideration (1995-97) the mean values in the "competitive" regions were 11 times higher than the ones observed in the "convergence" regions and are around 6 times higher in the final period under consideration (2002-04). With respect to the evolution in time, we observe that the average value of inflows of inventors increases between 1995 and 2004 at very high rates in all the groupings of regions except that of the EFTA. Finally, according to Table 3.3.2 in relation with the variability within each sample of regions, it seems that differences across regions are more important in those regions that are among the ones with the lowest values of inflows of inventors (the regions of the NMS and in "convergence" regions).

As for the geographical distribution, according to Map 3.3.2, it seems clear that there is a leading position assumed by Germany in attracting inventors from other regions in Europe, together with the Dutch region of Noord Brabant, the British of Surrey, East and West Sussex, Liechtenstein as well as the Swiss region of Nordwestschweiz. Interesting enough, the Slovenian region of Zahodna Slovenija is also in the top ten ranking. On the contrary, Southern Europe as well as the Eastern regions are persistently the ones showing lowest values of inflows of inventors. It is also worth pinpointing that the Scandinavian countries, despite the best results in some other indicators of knowledge networking, do not show to be in the best position when attracting inventors from abroad, but are situated in an intermediate level.

Finally, the variable **Citations made to patents from other regions** in per capita terms reflect to what extent the innovation patented in other regions is beneficial for one region's knowledge development. The observed general pattern is exactly the same as the one observed for the other two indicators of a-spatial linkages (Tables 3.3.1 and 3.3.2):

- "Competitive" regions show the highest mean values;
- regions in the EFTA countries are the ones depicting the highest mean values;
- regions showing the worst performances are those belonging to the NMS and "convergence" regions, a persistent pattern through time;
- with respect to the evolution in time, it can be observed that the average value of cross-regional citations grows between 1995 and 2004 at a high rate of almost 40% in the case of "competitive" regions and at a growth rate of around 110% for "convergence" regions. An even more spectacular increase is observed in the group of regions belonging to the NMS, where the growth rate in the period under consideration was higher than 160%. In other words, we observe the highest growth rates in the case of areas with low levels of citations, although huge differences among them still persist;
- the mean values in the "competitive" regions are around 22 and 14 times higher than the ones in the "convergence" regions in the first and last period, respectively. And the regions in the EU15 countries present a citation index which is 40 times higher than the one in the regions in the EU NMS in the first period available, and 21 times higher in the last period. Therefore, although differences are still very important, they are diminishing across time;
- according to the coefficient of variation, differences across regions are more important in those regions that are among the ones with the lowest values of citations ("convergence" regions and those regions of the NMS).

Looking at Map 3.3.2, we observe that many German regions appear in the top range together with 2 Swiss regions (Nordwestschweiz and Zürich) and the Dutch region of NoordBrabant followed by some of the Southern regions in Sweden and Finland. In an intermediate position we find some of the regions in Austria, France, UK, Denmark and North of Italy whereas the regions showing the lowest values of cross-regional citations belong to the EU NMS and the south of Europe.

3.3.4. Knowledge networking regions in Europe

In summary, throughout the former subsections we have presented a descriptive analysis of the channels by which a region may have access to external (external-to-the-region) sources of knowledge, depending upon whether the channel is spatially/geographically mediated or made through non-spatially mediated mechanisms. All in all, the mechanisms by which regions may access external (to the region) knowledge depending on the described classification can be summarized in Figure 3.3.1.

Using these different dimensions, the real challenge is to compute a single measure that allows us to assert whether a given region might be labeled as a *knowledge networking region* or not. In order to do it, we will construct a composite indicator for the dimension of "spatial linkages" and another one for "a-spatial linkages". This way, networking regions are those regions above the European average in terms of specialisation on both types of linkages. This will allow us at developing a synthetic indicator that provide, first, a unique classification of European regions according to the relational approach and, second, a ranking of European regions according to their knowledge networking performance.

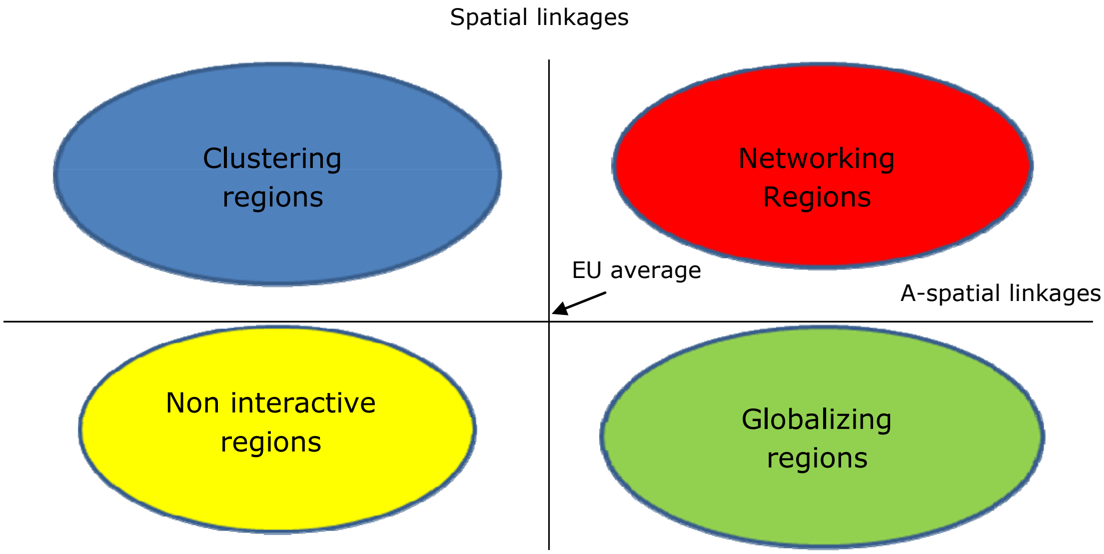


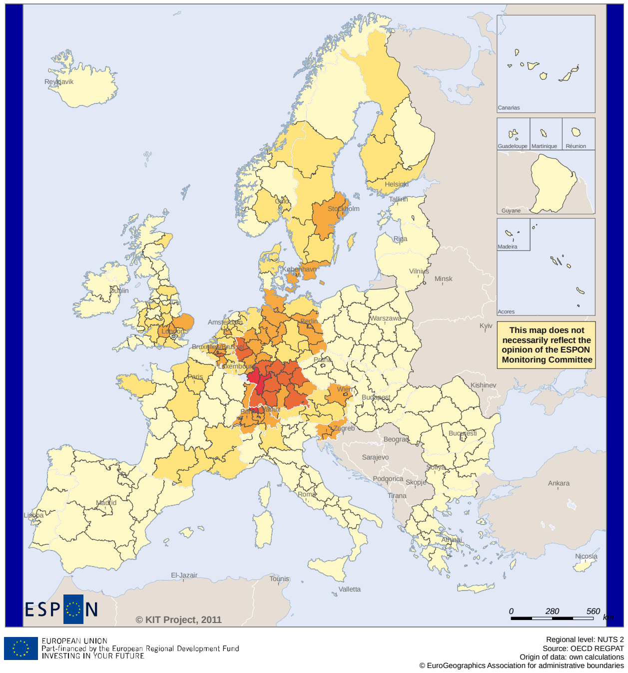
Figure 3.3.1 Definition of knowledge networking regions.

Therefore, to identify knowledge networking regions we construct two synthetic indicators, a first one for the dimensions of "spatial linkages" and a second one for that of "a-spatial linkages". Both these synthetic indicators are developed following the procedure used in the European Innovation Scoreboard 2009. Specifically, since the indicator variables we are using for the two different categories of linkages can be highly volatile and have skewed data distributions (where most regions show low performance levels and a few regions show exceptionally high performance levels), data will be transformed firstly using a square root transformation. Secondly, based on the square root values, re-scaled values are obtained by subtracting the Minimum value and then dividing by the difference between the Maximum and Minimum value. The maximum re-scaled score is thus equal to 1 and the minimum re-scaled score is equal to 0.[9] For each kind of linkage (spatial and a-spatial) a composite indicator is calculated as the unweighted average of the re-scaled scores for all indicators within the respective dimension (see Table A5.1 in Section 3.5 of the Scientific Report for detailed information on the indicators used to develop the synthetic indicators).

Knowledge networking regions are those European regions showing for both synthetic indicators, on spatial and a-spatial linkages, values greater than the European average. Regions showing values greater than the average for spatial linkages indicator but lower than the average for a-spatial linkages are labelled *Clustering regions*. On the contrary, regions characterized by values lower than the average for spatial linkages but higher for a-spatial linkages are indicated as *Globalizing regions*. Finally, regions showing values lower than the average for both indicators are *Non-interactive regions*.

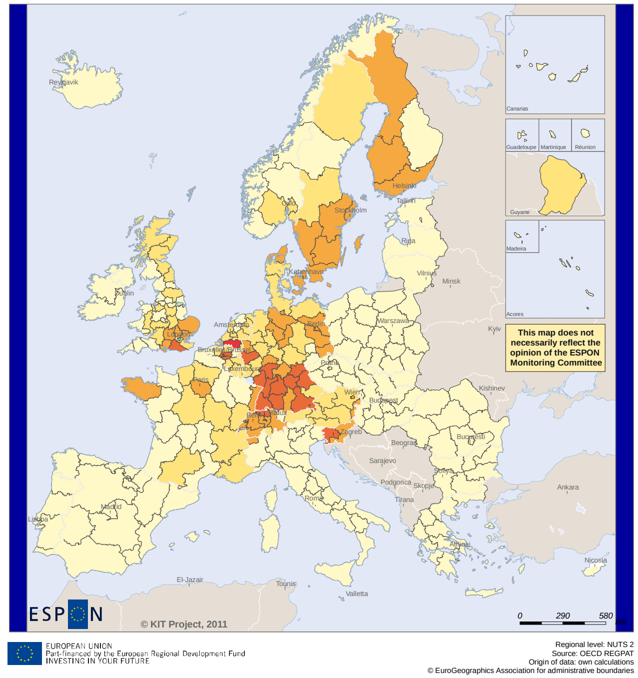
Map 3.3.3 shows the spatial distribution of the four categories of regions according to the relational approach. We observe that *Networking regions* are concentrated in the centre of Europe as well as in the Scandinavian countries, whereas the *Non-interactive regions* are mainly those belonging to the NMS and some specific regions in the South European countries (the whole of Portugal and Greece, most Spain except the North-East area, and the South of Italy). More curious is the kind of regions that we find in the other two quadrants. The regions that appear to be specialised in a-spatial linkages, called *Globalizing regions*, consist of 4 German regions (Berlin, Brandenburg-Nordost, Mecklenburg-Vorpommern and Dresden),

[9] For determining the maximum and minimum scores in the normalisation process we do not include outliers. Positive outliers are identified as those values which are higher than the average plus 2 times the standard deviation. Negative outliers are identified as those values which are smaller than the average minus 2 times the standard deviation.



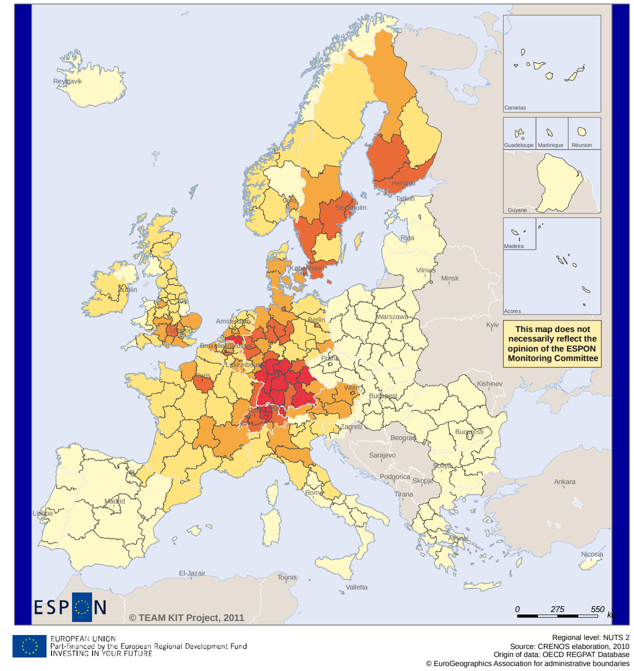
Co-patenting per capita, average 2002-2004

- 0 - 137
- 138 - 387
- 388 - 827
- 828 - 1875
- 1876 - 3313



Inventors' inflows over million population, average 2002-2004

- 0,0 - 4,2
- 4,3 - 12,0
- 12,1 - 25,0
- 25,1 - 64,2
- 64,3 - 116,4

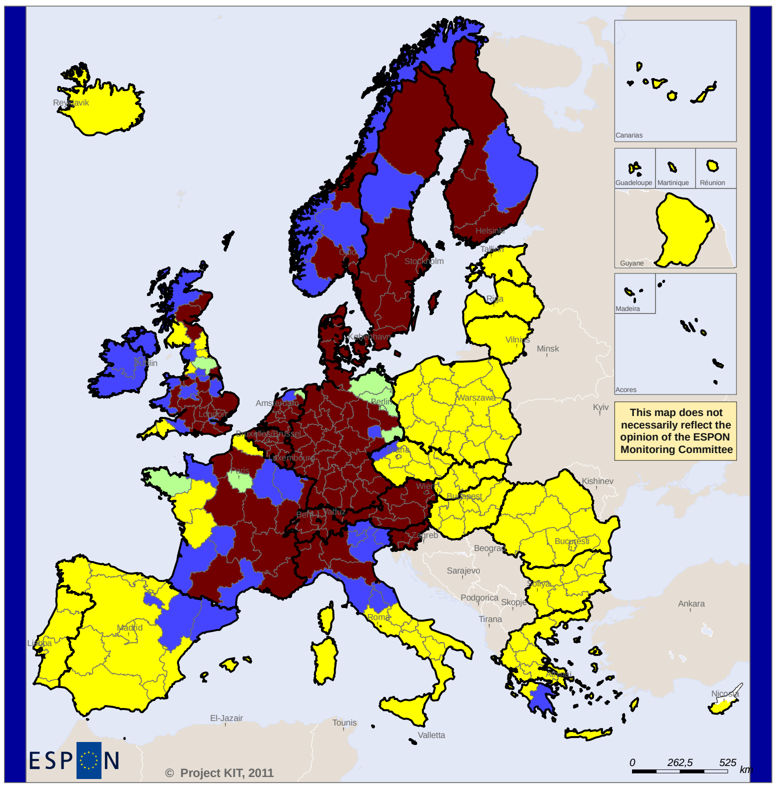


Cross-regional citations made per capita (1 milion population). Average 2002-2004

- 0 - 27
- 28 - 81
- 82 - 151
- 152 - 254
- 255 - 445

Map 3.3.2. Geographical distribution of the main indicators for a-spatially mediated linkages.
Note: Data refer to the most recent period available, 2002-2004.

2 French regions (Île de France and Bretagne), two British regions (Inner London and North Yorkshire) and the Dutch region of Groningen. It seems therefore that some of the regions hosting the capital cities in the Western Europe make a relatively higher intensive use of non-spatially mediated mechanisms with other European regions; in other words, they relate to other regions through citations, inflows and co-patents more intensively than the benefit they can obtain from the knowledge located more closely to them. On the other hand, among the 41 *Clustering regions* we find some regions in the Nort-East of Spain and North of Italy, some in the South of France as well as those French regions close to Paris and Germany, some regions in the West of UK and the whole of Ireland, as well as the regions in the three Scandinavian countries that are not labelled as Networking regions. Summarising, the Clustering regions seem to consist of regions that belong to the EU15 and that are close to the core regions that are both spatially and non-spatially specialised.



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Regional level: NUTS 2
Source: AQR elaboration, 2011
Origin of data: OECD REGPAT Database, Cordis, EUROSTAT, ISTAT and Institute National de la Statistique et des Études Économiques data
© EuroGeographics Association for administrative boundaries

Category	Meaning	Specialization in spatial linkages	Specialization in a-spatial linkages
1	Non-interactive regions	No	No
2	Clustering regions	Yes	No
3	Globalizing regions	No	Yes
4	Networking regions	Yes	Yes

Knowledge networking regions

- Non-interactive regions
- Clustering regions
- Globalizing regions
- Networking regions

Map 3.3.3. Knowledge networking regions in Europe.

Moreover, we observe that most of the Networking regions belong to the EU15 and EFTA, with only two belonging to the NMS, specifically two regions in Slovenia (Zahodna Slovenija and Vzhodna Slovenija). In fact, when looking at the whole list of Networking regions, apart from these two exceptions, the rest of regions belong to these countries: Germany, Switzerland, Sweden, Belgium, Finland, Netherlands, France, United Kingdom, Austria, Norway, Denmark and the North of Italy. Therefore, apart from the 2 Slovenian regions and the 4 Italian regions in the North, no other region in the South of Europe and among the NMS appear in the list.

This provides evidence of a clear core-periphery pattern in the geographical distribution of the regions that in one way or another rely in external sources of knowledge for the development of innovation.

Furthermore, according to Table 3.3.3, most of the regions belong to the group of “Competitive” regions. Non-interactive regions belong in their most to the South of Europe in the EU15 as well as to the NMS, with most of them being “Convergence” regions. All the Globalizing regions belong to the EU15 and are mostly “Competitive”, similar to the Clustering regions.

Table 3.3.3. Typologies of Regions.

	ESPON whole sample	Countries			EU Regions		
		EU 15	EU 12, NMS	EFTA 4	Convergence	Transition	Competitive
Networking Regions	124	111	2	11	5	6	103
Globalizing Regions	9	9	0	0	3	0	6
Clustering Regions	41	36	1	4	3	5	33
Non-Interactive Regions	113	59	53	1	73	18	21

Note: The total number of ESPON regions considered is 287.

3.4 Innovation in Europe

3.4.1. Data source

The fundamental relevance of innovation process in contemporary economies is not in general matched by quality data. The Community Innovation Survey (henceforth, CIS)[10] represents one of the best attempts to measure innovation rates. It is structured as a micro survey, with questions to individual firms throughout the EU27 countries plus Norway and Iceland. Six waves have so far been collected, the first one having been collected in 1992, the last made available being the 2008 wave.

CIS data are unequally stratified across space. Since in some EU countries data are not stratified at NUTS2 level, such spatial detail is not publicly made available. The KIT project offers a major improvement in this direction, by providing a robust methodology to estimate regional CIS data. This Section presents an overview of the spatial distribution on the estimated data, while a detailed description of the methodology is shown in Chapter 4 of the Scientific Report, where also maps of the national values made available from EUROSTAT are presented.

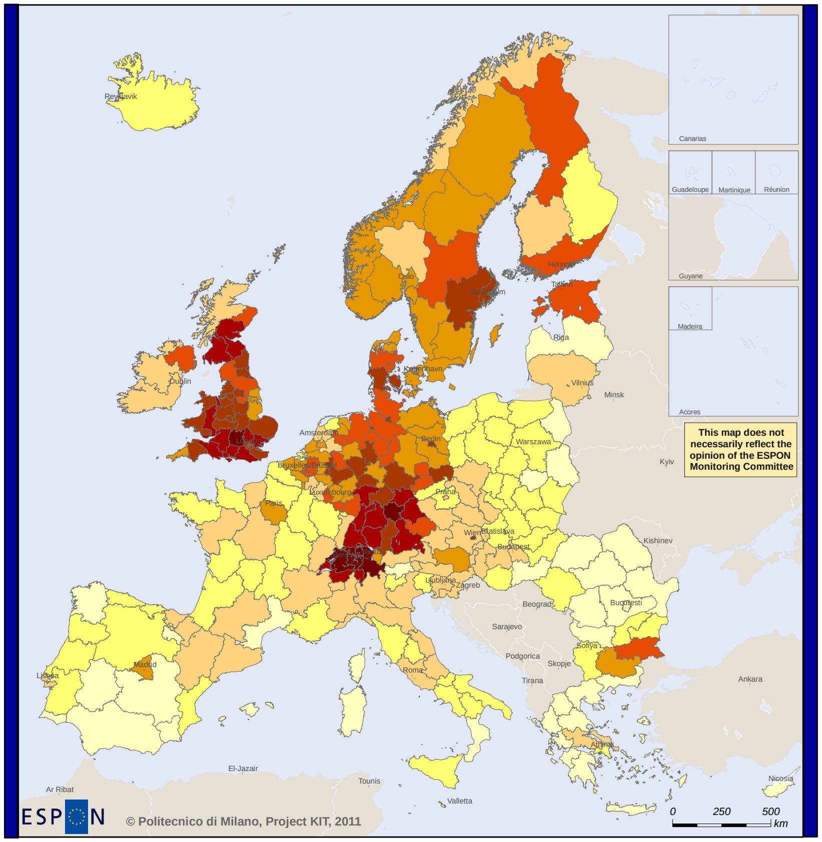
3.4.2. Product innovation

The shares of product innovation only is depicted in Map 3.4.1. The fundamental variable for measuring innovation rates is related to sheer product innovation.[11] Spatial concentration characterizes product innovation. This variable displays consistent concentration in strong countries, the core of product innovative activity in Europe being carried out in German, Scandinavian, Swiss and British regions, with a few notable exceptions outside these areas. EU15 regions tend on average to innovate more, and significantly so, than Eastern ones; the same applies to denser regions, while rural regions display a relatively lower product innovation rate. In general, in countries where product innovation is high, concentration seems pronounced. Spatial concentration of product innovation, on the contrary, strongly characterizes countries with low product innovation rates. This is the case of Portugal, where Lisbon is the only area with some product innovation activity; Spain, with Madrid, Barcelona and a few Pyrenean regions; Greece; and some NMS. Italy represents an exception to this pattern, since several regions in the Northern and central part of the Country display similar product innovation rates.

Spatial patterns characterize the variable not only across country, but also within countries; in fact, capital regions tend to display higher product innovation rates, with some notable

[10] Information on CIS micro data can be retrieved at the EUROSTAT portal http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/cis; additional information can be found in Chapter 4 of the Scientific Report.

[11] The question originally administered to interviewees was “During the three years 2002 to 2004, did your enterprise introduce new or significantly improved goods or services?”.



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Regional level: NUTS2
Source: Politecnico di Milano, 2011
Origin of data: Community Innovation Survey 2004
© EuroGeographics Association for administrative boundaries

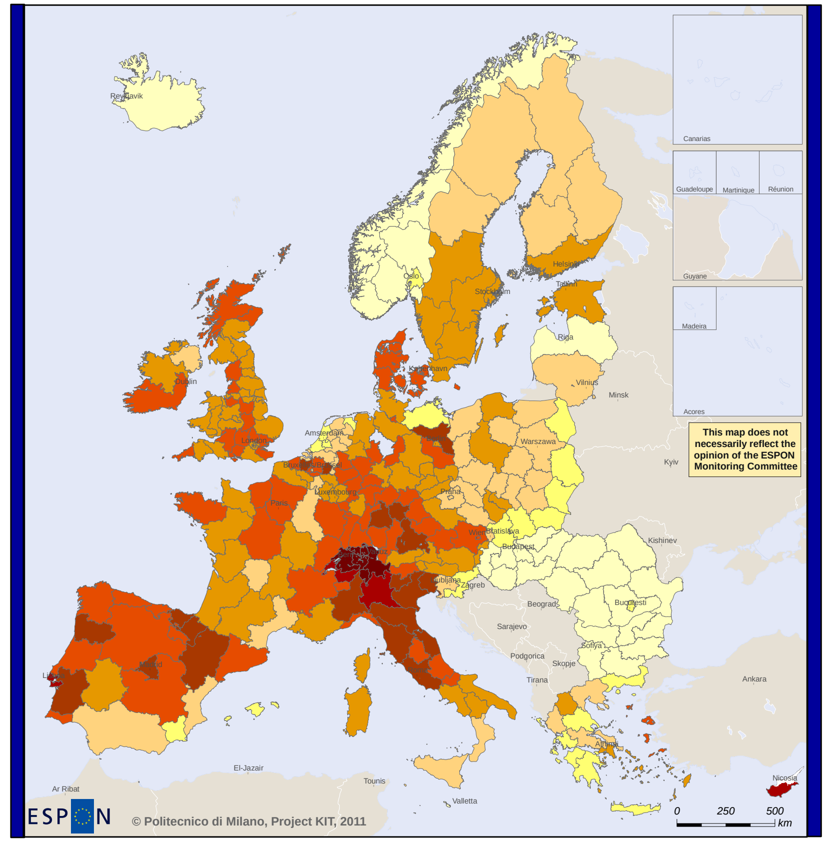
KIT estimates

Share of product innovation only

- NA
- 0 - 3.26
- 3.27 - 5.92
- 5.93 - 9.12
- 9.13 - 12.80
- 12.81 - 17.30
- 17.31 - 23.43
- 23.44 - 33.45
- 33.46 - 44.42

Switzerland: share of product innovation.
Iceland: CIS3 data.
Latvia and Slovenija: CIS 2006 data.

Map 3.4.1. Share of product innovation only.



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Regional level: NUTS2
Source: Politecnico di Milano, 2011
Origin of data: Community Innovation Survey 2004
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KIT estimates

Share of process innovation only

- NA
- 0 - 5.40
- 5.41 - 8.09
- 8.10 - 10.09
- 10.10 - 12.32
- 12.33 - 14.71
- 14.72 - 18.01
- 18.02 - 25.92
- 25.93 - 55.08

Switzerland: share of process innovation.
Iceland: CIS3 data.
Latvia and Slovenija: CIS 2006 data.

Map 3.4.2. Share of process innovation only.

exceptions of regions also registering consistent innovation performance despite not hosting the capital city (e.g. Rhone-Alps and Toulouse in France).

3.4.3. Process innovation

A second relevant question asked in the CIS 2002-2004 survey explores the process side of innovation (Map 3.4.2).[12] In general, process innovation shows a more dispersed pattern than product innovation. Countries such as Portugal, Spain, France, Germany, and the UK do not display a remarkable concentration of process innovation within their boundaries. The variance associated with this variable is much lower than the same measure associated with product innovation. This finding further strengthens the case for a more evenly distributed practice. In fact, this is also reflected in the case of NMS, that are unexpectedly characterized by homogeneous spatial trends.

Process innovation takes place more frequently in densely populated regions and in metropolitan areas. A relevant dichotomy shows up between Western and Eastern countries, the former averaging process innovation rates higher by about 5% than regions in NMS.

Given the softer nature of process innovation, however, on average innovation rates are in the case of this variable consistently higher than product innovation. Overall, process innovation displays an average value, over the whole EU27, higher by just one percentage point than product innovation. In particular, it is worth stressing that process innovation displays on average higher values in Southern European countries[13] than in the rest of the Europe, by about two percentage points.

Overall, however, product and process innovation display remarkable levels of co-variation (Figure 3.4.1). On average, regions displaying large levels of product innovation are also simultaneously proficient in process innovation. A notable exception, identified with the shaded area in Figure 3.4.1, is represented by Southern European countries, notably Spain, Greece, Italy, and Portugal, where relatively insufficient performance in terms of product innovation is matched by superior performance in process innovation.

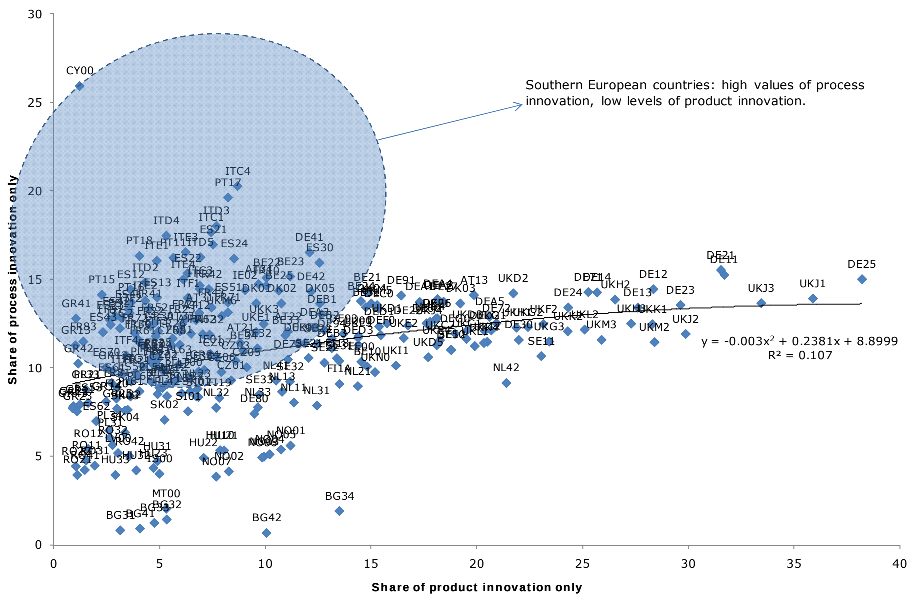


Figure 3.4.1 Shares of product innovation only and process innovation only.

3.4.4. Both product and process innovation

The simultaneous activity of innovating in product and process is shown in Map 3.4.3. This variable can be read as the subsample of interviewed firms displaying the best performance,

[12] The process innovation question reads as "During the three years 2002 to 2004, did your enterprise introduce New or significantly improved methods of manufacturing or producing goods or services?"
[13] Namely, Cyprus, Spain, France, Greece, Italy, Malta, and Portugal.

viz. innovating at the same time in product and process innovation. The pattern of this variable shows consistent country effects, with clusters of high innovativeness in Ireland, Finland, Sweden, Germany, Austria, Switzerland, and Greece. Some regions in countries outside the European core (namely, Greece and Portugal) display remarkable performance in this variable, while at the same time enjoying low levels or product or process innovation, as well as relatively lower performance of knowledge indicators presented before. This anomaly is already present in the underlying national value, from which KIT estimates depart.

The UK and Italy show a rather low innovation rate, and this statement holds on average true for most regions in these two countries. In the UK, notable exceptions are Berkshire, Bucks and Oxfordshire, Surrey, East and West Sussex, Hampshire and Isle of Wight, and Gloucestershire, Wiltshire and the Bristol and Bath area. Interestingly enough, NMS display a relatively diversified regional innovation rate; this is particularly true for Romania and Poland, the latter displaying a relatively better performance for the capital region and for most regions on the border with Germany.

3.4.5. Product and/or process innovation

A second indicator for the “product” and “process” innovation categories refers to the vector of “product and/or process” innovation (Map 3.4.4). This last case can be considered the most generic measure of product and process innovation. Therefore, the variable should yield, if somewhat blurry, a good overall picture of innovation activity in Europe.

Spatial patterns for this variable resemble those displayed by the variables “Product innovation” and “Both product and process innovation”, as it captures both phenomena at the same time. As a result, product and/or process innovation displays remarkable levels of concentration, with the bulk of innovative activities taking place in the strongest portion of Europe (Germany, Switzerland, the UK and Ireland, Scandinavian countries) with a few but relevant exceptions represented by some capital or metropolitan regions and single-region countries outside the core (Madrid, Lisbon, Ile-de-France, Lombardy, Athens, Estonia, and Cyprus).

Finally, it is interesting to notice the synergic nature of product and process innovation rates. In fact, a 3D graph (Figure 3.4.2) clearly shows that, on average, regions with higher tendencies to innovate in product also innovate in process. Along with a consistent concentration of values close to the origin of the axes, the graph also shows that the performance of top accomplishers in each category deviates and points at particular specializations either in product, or process innovation.

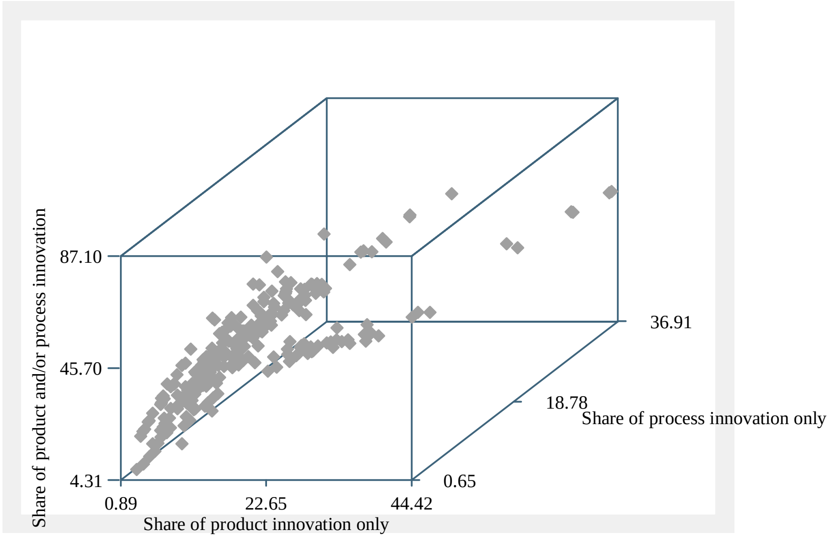
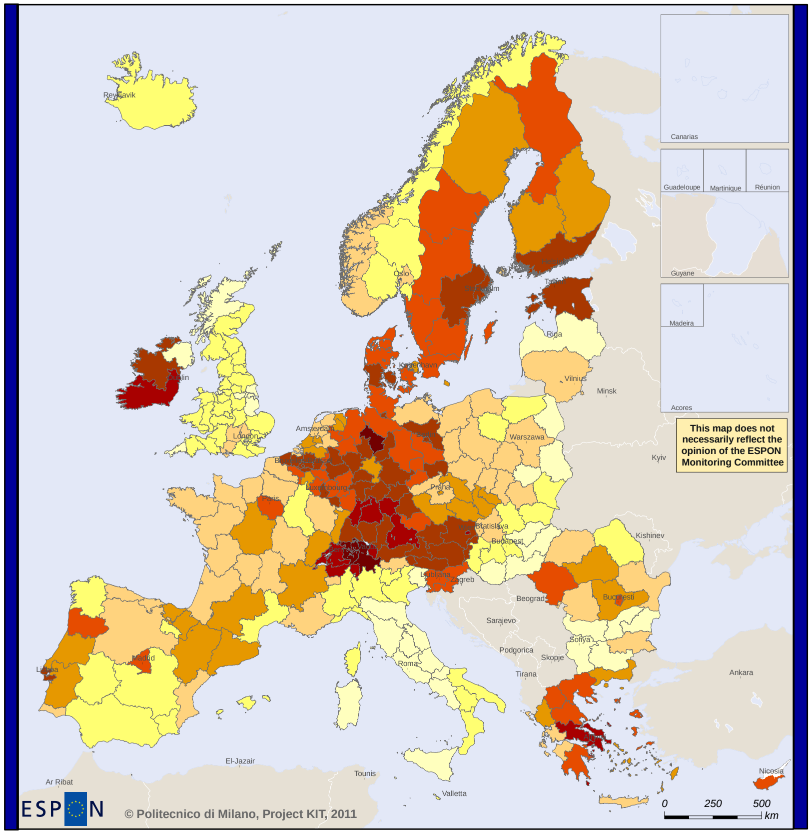


Figure 3.4.2. Product innovation, process innovation and product and / or process innovation.



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Regional level: NUTS2
Source: Politecnico di Milano, 2011
Origin of data: Community Innovation Survey 2004
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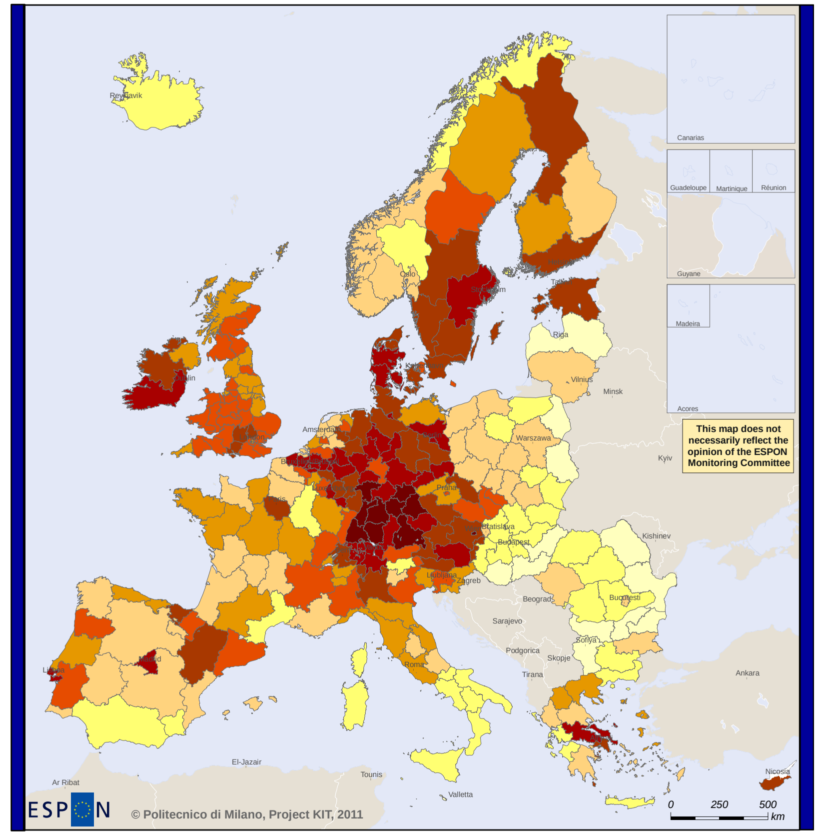
KIT estimates

Share of both product and process innovation

- NA
- 0 - 7.79
- 7.80 - 10.24
- 10.25 - 13.15
- 13.16 - 16.69
- 16.70 - 21.37
- 21.38 - 28.34
- 28.35 - 42.63
- 42.64 - 98.82

Switzerland: share of product and process innovation.
Iceland: CIS3 data.
Latvia and Slovenija: CIS 2006 data.

Map 3.4.3. Share of both product and process innovation.



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Regional level: NUTS2
Source: Politecnico di Milano, 2011
Origin of data: Community Innovation Survey 2004
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KIT estimates

Share of product and/or process innovation

- NA
- 0 - 16.31
- 16.32 - 23.53
- 23.54 - 28.72
- 28.73 - 33.97
- 33.98 - 40.04
- 40.05 - 47.53
- 47.54 - 59.06
- 59.07 - 87.10

Switzerland: share of product and process innovation.
Iceland: CIS3 data.
Latvia and Slovenija: CIS 2006 data.

Map 3.4.4. Share of product and / or process innovation.

3.4.6. Marketing and organizational innovation

A quite different perspective on innovation is provided by the marketing and organizational innovation map (Map 3.4.5). In this case, non-technological innovation progress are surveyed – for instance, quality improvements, reductions of environmental damages stemming from firms' production, reductions of energy consumption, creation of new markets, reduced labour costs, reductions of amount of materials required for production, and conformance to regulations.

The map highlights a significant concentration of marketing and organizational innovation in regions in the EU15 countries, with particularly high values in German and Austrian regions. However, the spatial distribution of this soft form of innovation seems much more even across the European space. The relatively even distribution is in particular remarkable when observed within countries, witnessing a similar innovative capability among regions.

This even distribution notwithstanding, spatial patterns characterize marketing and organizational innovation, with a consistently higher tendency to introduce such improvements in capital regions, and higher innovation rates also as density in regions increases, as well as in regions with large cities, bearing the diversified and creative environment leading to innovative behavior. NMS innovate in marketing and organization less than EU15 regions, on average by about nine percentage points. Similar patterns affect Nordic and Mediterranean countries, regions in the latter sample innovating less in marketing and organization by about five percentage points.

Marketing and organizational innovation is not an activity apart from product and process innovation. In fact, pure correlation between marketing and organizational innovation, on the one hand, and product and/or process innovation, on the other, is remarkably high (equal to 0.71 and significant at all conventional levels).

By matching these two variables (Map 3.4.6) it is possible to classify European regions according to their relative performance. The graph is to be read clock-wise, the first quadrant being in the top right corner. The label "Hard and soft innovators" identifies all regions (mostly in continental European and Nordic countries) which show a higher than average performance in both types of innovation. Symmetric is the situation ("Sub-performers") where both indicators lie below the European average. Finally, regions that show relative specialization either in "hard" (i.e., product and/or process) or soft (marketing and organizational) innovation can be identified.

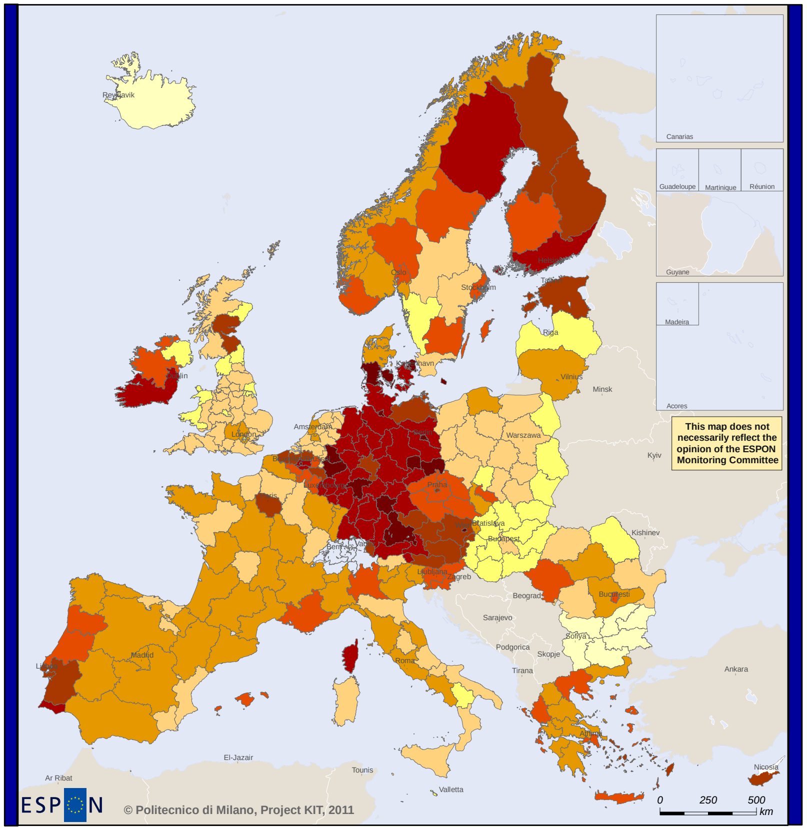
Map 3.4.6 shows a clear and strong Country effect in the spatial distribution of simultaneous specialization in both types of innovation. Besides, in most countries capital regions enjoy at least one specialization with respect to the rest of Europe, while Finland, Germany, Ireland, Sweden, and Austria display the densest presence of regions specialized in at least one of the two types of innovation. These statements point at the existence of different patterns of knowledge creation and innovation in European regions; therefore, they will be later explained in the KIT project.

3.4.7. Social innovation

Map 3.4.7 shows the spatial distribution of the broadband penetration rate, which best captures the diffusion of a modern ICT in everyday life, thus offering an interesting perspective on the social diffusion of a new technology. Data are collected in yearly surveys administered by EUROSTAT[14] and the vector here depicted represents a four-year average of the 2006 to 2009 surveys. In Some countries – viz., France, Poland, and Germany – data are collected at NUTS1 level.

The spatial distribution of this variable displays evident signs of country effects, naturally introduced in the data by the country-wide infrastructure ICT projects that both public as well

[14] See also the final report of ESPON project 1.2.3 "*Identification of Spatially Relevant Aspects of the Information Society"*, to which the choice of this indicator is inspired.



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Source: Politecnico di Milano, 2011
Origin of data: Community Innovation Survey 2004
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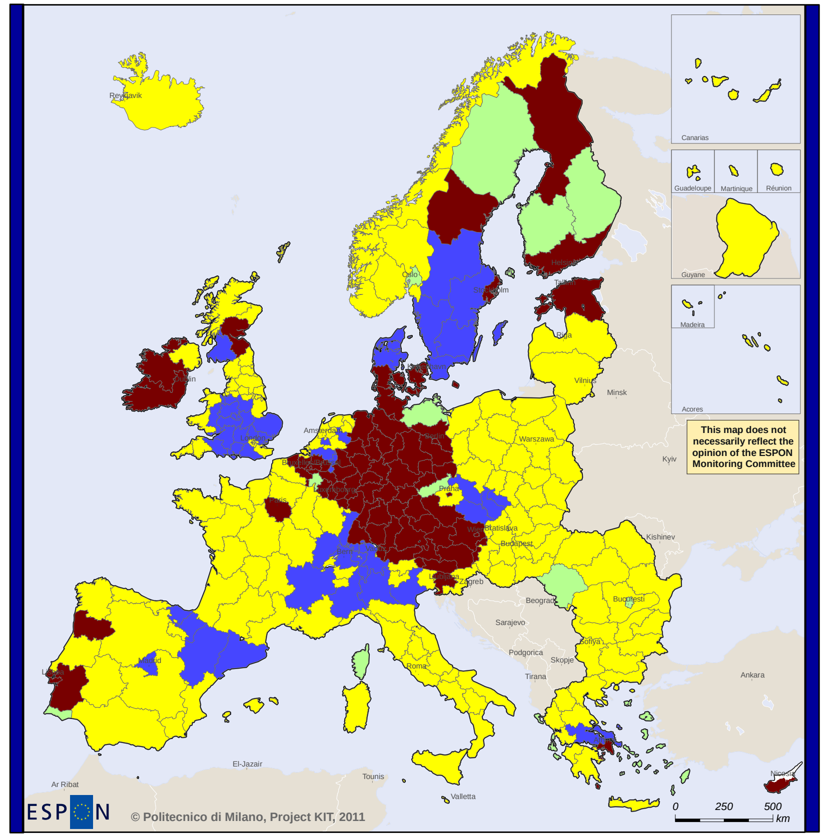
KIT estimates

Share of marketing and organizational innovation

- NA
- 0 - 9.05
- 9.06 - 15.24
- 15.25 - 19.81
- 19.82 - 23.53
- 23.54 - 29.56
- 29.57 - 37.50
- 37.51 - 48.05
- 48.06 - 78.36

Switzerland: share of product and process innovation.
Iceland: CIS3 data.
Latvia and Slovenija: CIS 2006 data.
Sweden: CIS 2008 data.

Map 3.4.5. Marketing and organizational innovation.



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Regional level: NUTS2
Source: Politecnico di Milano, 2011
Origin of data: IGEAT Matrix 2004
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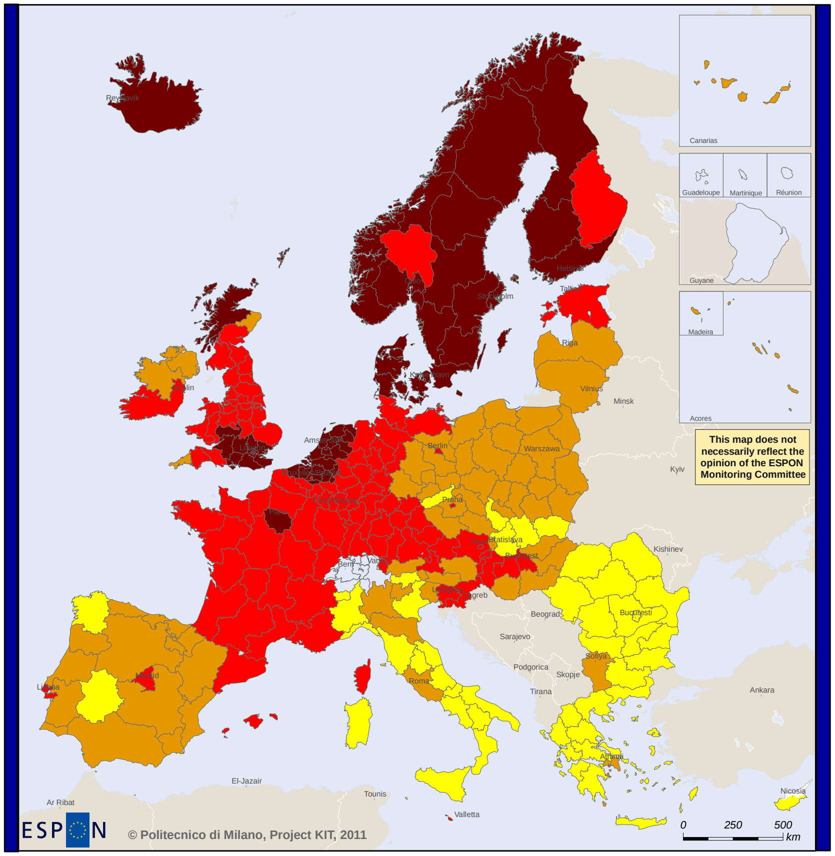
Product and/or process and marketing and organizational innovation

- Hard and soft innovators
- Hard innovators
- Sub performers
- Soft innovators

Number	Typology	Meaning
1	Hard and soft innovators	Performance higher than the European average in both product and/or process and marketing and organizational innovation
2	Hard innovators	Performance higher than the European average in product and/or process innovation; and lower than the European average in marketing and organizational innovation
3	Sub perfomers	Performance lower than the European average in both product and/or process and marketing and organizational innovation
4	Soft innovators	Performance higher than the European average in marketing and organizational innovation; and lower than the European average in product and/or process innovation

Map 3.4.6. Product and/or process and marketing and organizational innovation matching.



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Regional level: NUTS2
Source: Politecnico di Milano, 2011
Origin of data: EUROSTAT ICT surveys, 2006-2009
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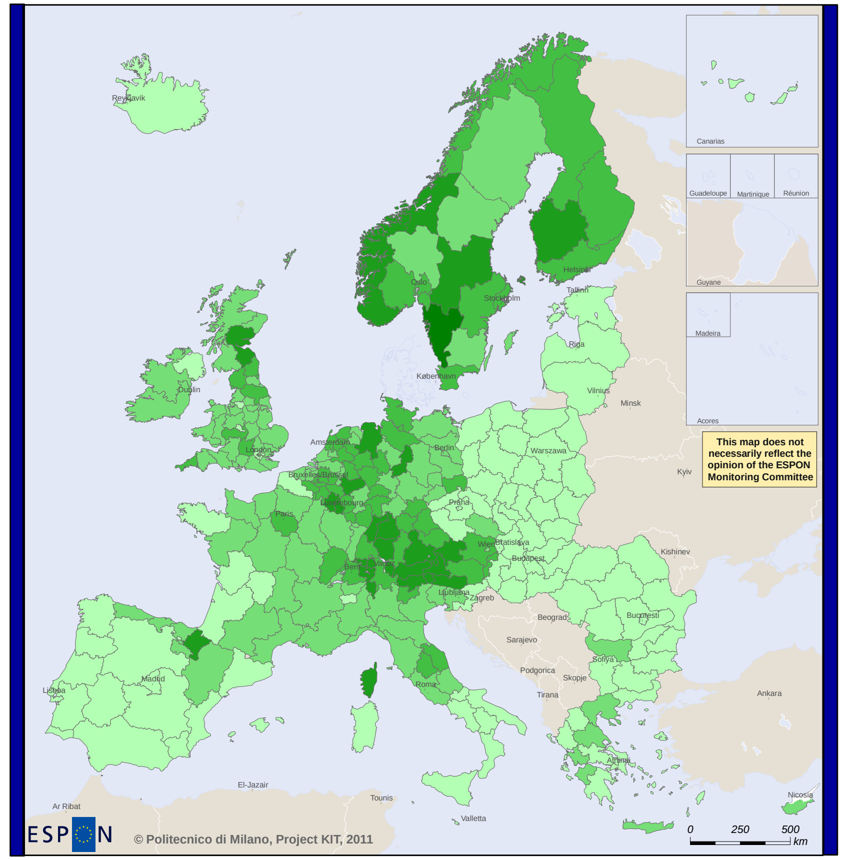
Social dimension of innovation

Average broadband penetration rate

- NA
- 0- 29.5
- 29.51 - 45.25
- 45.26 - 61
- 61.01 - 84

Map 3.4.7. Social dimension of innovation.



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Regional level: NUTS2
Source: Politecnico di Milano, 2011
Origin of data: EPO and CRENOS, 2000-2006
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Environmental innovation

Green patents per 1,000 pop.

- < 0.003
- 0.003 - 0.005
- 0.006 - 0.010
- 0.011 - 0.022
- 0.023 - 0.051

Map 3.4.8. Environmental innovation.

as private companies launch and manage. Also, broadband connections penetrated more – and most unlike other innovation indicators – in regions belonging to Nordic countries and in Netherlands, more than on continental Europe. Besides, everywhere capital regions show over-performance in this measure of innovation diffusion with respect to other regions belonging to the same Country. Peripheral regions (Italian, Romanian, Bulgarian and Spanish) present some consistent lag when confronted with frontier ones. However, a striking evidence can be also presented by comparing Polish and Baltic regions, with relatively lower standards of living, with richer regions such as the Irish and Northern Italian ones. This comparisons presents similar rates of broadband penetration, thus illustrating the case of a non linear relationship of the technology curve adoption as a function of the region's development stage.

3.4.8. Environmental innovation

An increasingly relevant dimension of innovative technologies has a green side. KIT project encompasses this component with a measure of the number of patent applications to the European Patent Office (henceforth, EPO) bearing a standard IPC (International Patent Classification) class which covers the following technologies: air pollution control/abatement; water pollution control (water and wastewater management); solid waste management; renewable energy (Wind, solar, geothermal, ocean, hydro power, biomass). The number of patent applications is then standardized by 1,000 inhabitants, in order to rule out the size effect. Data cover the years 2000-2006, and an average measure is calculated over the whole time span, in order to control for cyclical behaviour of the patenting activity. This indicator is shown in Map 3.4.8.

A core of innovative activity in green technologies as defined by the OECD stands out in continental Europe, Scandinavian countries and the UK; of lesser, through relevant, importance regions in France, Greece and Italy also present some positive contribution to the activity of patenting in one of the IPC classes above mentioned.

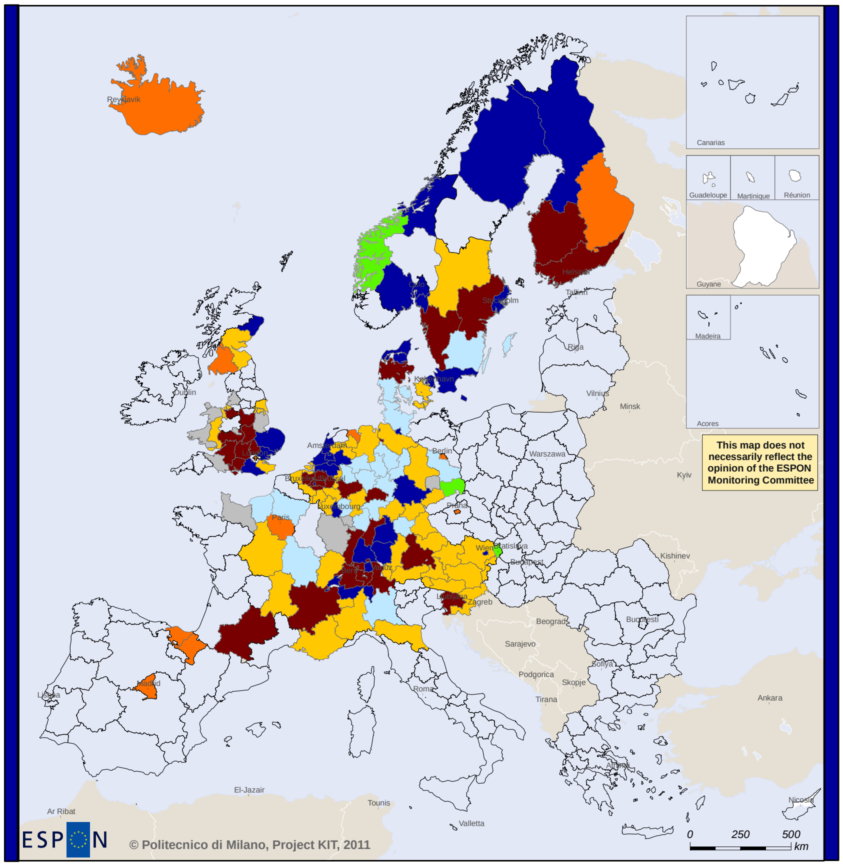
Following categories similar to those employed in the analysis of CIS data, the Map stresses a higher rate of innovation in green technologies in correspondence with denser and agglomerated regions, in regions belonging to countries of the EU15, and finally in regions belonging to countries belonging to the ESPON space, but outside the European Union.

3.5. The Knowledge Economy in Europe

Map 3.5.1 presents an integrated picture of the different typologies of knowledge economy regions. The picture looks very fragmented, with quite a reasonable number of regions being only networking, and mainly in the central part of Europe. Only three technologically-advanced regions host scientific functions (Dresden, Vestlandet and Bratislava), while most of the technologically-advanced islands that host knowledge are also networking regions. In general, scientific regions are also networking regions, witnessing that knowledge accumulation inside a region also requires networking activity, which allows for the acquisition of knowledge from outside. What is really impressive is that a very high number of European regions, mainly in Eastern countries and in the Southern peripheral countries is below the EU average in any process of high-tech specialisation, of knowledge creation, and knowledge acquisition.

The capacity to innovate of the different types of regions in the Knowledge economy is represented in Table 3.5.1. The most striking difference lies between knowledge economy regions and others. The former definitely show a higher innovation performance, whatever definition is adopted. Among knowledge economy regions, very limited and statistically non significant differences are registered. Scientific regions, although registering a high innovation rate, are not significantly more innovative than TAR or networking. This is true using both product innovation only, process innovation only, and product and/or process innovation. These results remind us that the territorial factors that enhance the implementation of new knowledge can be quite different from the factors which stimulate invention and innovation, and therefore that invention, innovation and diffusion are not necessarily intertwined, even at the local level. Although marginally different, vectors in the table point to a higher product innovation rate for scientific regions, a higher process innovation rate for TAR, and a higher joint product and/or process innovation for networking regions. In the case of marketing and organizational innovation, finally, the ranking once again changes, with TAR and networking regions significantly over-performing with respect to scientific regions.

Firms and individuals which are leading in inventive activity are not necessarily also leaders in innovation or in the widespread diffusion of new technologies. The real world is full of examples of this kind; the fax machine, first developed in Germany, was turned into a worldwide successful product by Japanese companies. Similarly, the anti-lock brake systems (ABS) was invented by US car makers but became prominent primarily due to German automotive suppliers.



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Regional level: NUTS2
Source: Politecnico di Milano, 2011
Origin of data: EUROSTATand RegPat
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Technologically-advanced regions

Knowledge economy regions

- NA
- None
- TAR only
- Scientific regions only
- Networking regions only
- TAR and scientific regions
- TAR and networking regions
- Scientific and networking regions
- Integrated knowledge economy regions

Typology	Numerosity
TAR only	9
Scientific only	11
Networking only	43
TAR and scientific	3
TAR and networking	19
Scientific and networking	29
TAR, scientific and networking	31
None	135

Map 3.5.1. The Knowledge Economy in Europe.

Table 3.5.1. Share of innovation by type of knowledge-economy regions.

Typologies	Share of product innovation	Share of process innovation	Share of product and/or process innovation	Share of marketing and organizational innovation
TAR	17.42	13.76	43.66	32.75
Scientific	18.16	13.48	43.71	29.51
Networking	16.19	13.20	44.24	31.95
Other	6.34	9.88	27.40	20.58

All these results tell us that at present *different innovation patterns characterise* Europe. Some regions are able to produce their internal knowledge, translate knowledge into innovation, and obtain the maximum efficiency and effectiveness from innovation adoption in terms of growth (the so called "linear model"). Other regions exist that are able to innovate getting the knowledge required from other regions; finally, regions exist that are able to innovate through a creative imitation of already existing innovation. These different patterns of innovation are supported by different local conditions. There is therefore a need to link context conditions to the single phases of the innovation process. Once this is done, *territorial patterns of innovation will be identified*, and this is one of the main aims of the next research steps.

3.6. The geography of scientific activity in China, India and the United States of America

The analysis presented here concentrates on understanding key territorial-level scientific activity trends by country, region and technology field. We show important differences between the spatial patterning of 'emerging' (China and India) and 'mature' (US) innovation systems. Both India (around Delhi and the South) and China (coastal regions) have highly concentrated territorial patterns of scientific efforts. During the 1990s spatial concentration of patenting in China also overtook that of India. By contrast, territorial patterns of innovation in the USA, while clustered, are much less agglomerated. The top three innovating regions in China and India contain 73% and 64% of patent counts by applicant, while in the USA the figure is 32%.

Spectacular urbanisation in India, and in particular, China has been the most visible symbol of change. India's cities alone could generate 70 per cent of net new jobs to 2030 and by then generate more than 70 per cent of GDP, reflecting urban population growth from 290 million in 2001 to 340 million in 2008, and 590 million in 2030 (MGI 2010). Similarly, China's urban population is expected to increase from 636 million in 2010 to 905 million by 2030 (UN Population Division 2010).

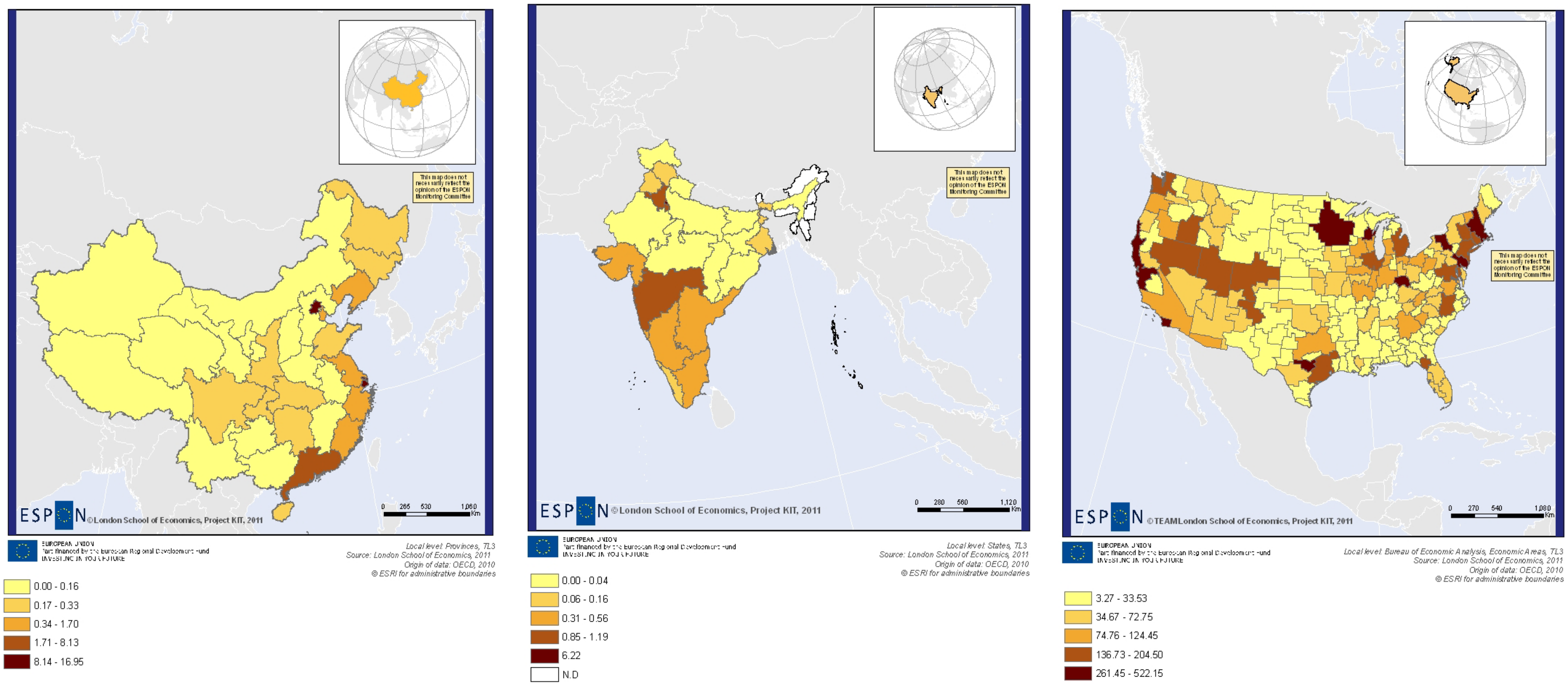
The past two decades have seen the globalisation of production and the globalisation of R&D (Fu and Soete 2010, Kuchiki and Tsuji 2010, Bruche 2009, Lundvall et al 2009, Yeung 2009). China and India have been at the forefront of these shifts (Parayil and D'Costa 2009, Leadbeater and Wilsdon 2008, Popkin 2007). Map 3.6.1 shows the key patterns, using population-weighted patent counts as the key measure of (visible) scientific activity. In each case the most appropriate, comparable spatial unit has been selected under the constraint of regionalised patent data availability from the OECD – Chinese provinces, Indian states, American BEA Economic Areas.

Our analysis shows that both India and China have spatially concentrated scientific activities. We confirm other analysis showing that in China for example, patenting activity is concentrated along coastal regions, especially in the South (Wang and Lin 2008, Sun 2003). Our Chinese data finds Guangdong is the leading province counting for 46% of total average PCT applicants. The next two are Beijing (14%) and Shanghai (13%). The overall system is highly agglomerated, with the top 3 regions accounting for 73%.

Patenting by technology fields highlights further differences. Biotechnology and ICT patenting broadly follows the country-level patterns, although with significantly higher than average levels of concentration in China and India. In nanotechnology, India's sectoral system is more agglomerated than China's. In all three fields, innovation India and China is much more spatially clustered than in the USA.

In India, patent counts are highest in high-tech clusters such as Bangalore, Chennai, Delhi, Hyderabad, Mumbai and Pune (Mitra 2007). At the regional level, a concentration of patents granted to Indian inventors are located in two states, Maharashtra and Delhi. Our data finds Maharashtra (Mumbai is its capital) and Delhi respectively count for 26% and 24% of total average PCT (Patent Cooperation Treaty) applicants. The third is Andhra Pradesh (13%, South-East of Maharashtra) and top 3 accounts for 64%.

It is useful to compare the recent experiences of India and China to that of the USA. Since the 1990s the US has increased its national patenting rate more or less continuously. During this period India and China began to increase their own patenting activity, with significant increases from the mid-1990s. During the 2000s India substantially improved its overall patenting rate and patent intensity. China achieved a spectacular jump in innovative activity, with per capita patenting rates rising over four-fold. These improvements in innovation 'outputs' reflect substantial investment in.



Map 3.6.1. China, India, USA: population-weighted patent counts by region, 1994-2007.

Source: OECD Regional Database. Notes: (1) population-weighted patent counts by applicant from OECD REGPAT Database, Patents filed under the Patent Co-operation Treaty (PCT), (2) Spatial units are provinces (China), states (India) and BEA Economic Areas (USA) ‘inputs’ like High Education enrolment rates and R&D expenditure.

The USA has a smoother spatial distribution of patents by applicant than either China or India. The three leading regions are San Jose-San Francisco-Oakland (Northern California), San Diego-Carlsbad-San Marcos (Southern California) and Appleton-Oshkosh-Neenah (Wisconsin). These three account for only 32% of all patenting by applicant, compared to 73% and 64% shares for, respectively, the leading Chinese and Indian regions. Generally, the more innovative regions in the US are located on the Western and Eastern seaboards, or the Great Lakes region (Michigan, Wisconsin). Less innovative areas are located in the Midwest or South, with a couple of exceptions – Houston-Baytown-Huntsville (Texas) and Denver-Aurora-Boulder (Colorado).

In China, as we have seen, the leading regions for innovation tend to be in coastal areas. Outside these regions, the next group of provinces, accounting for 1-3% of total patenting on average are also mainly coastal – only Sichuan (SW) and Hunan (Middle) are not coastal provinces. The middle and West of China are less innovative, such as Tibet, Qinghai and Ningxia, which are far SW or NW provinces.

In India, leading regions tend to be in/around Delhi and the South. The provinces in the next group, which % is above 1%, are generally around Delhi and Mumbai, such as Karnataka (8.7%, close to Mumbai), Haryana (7%, Delhi located) and Tamil Nadu (7%, South). States in north-east India or border states, are less innovative. Some of them do not have any patents applicants until 2007 (for example Assam on the North East border with Bhutan and Bangladesh).

The spatial distribution of patenting activity is evident when patent data is organised by ‘technology field’; OECD data follows standard IPC classifications, from which we explore counts for biotechnology, information and communications technology (ICT) and nanotechnology.

Biotechnology patenting is somewhat more spatially agglomerated in China and India than overall patenting; in China, the top three ‘biotech regions’ account for over 80% of overall patenting in the field. As with overall counts, however, both countries have more concentrated biotech patenting activity than the USA – where the top three regions account for just over 30% of all biotech patents. The distribution of ICT patents, where similar patterns persist.

Sectoral activity is even more agglomerated in China than in India, with both countries having long tails of trailing regions. Again, both countries’ ICT patenting is much more spatially clustered than in the USA. Nanotechnology patenting spatial trend is somewhat different over our study period. India has the more agglomerated sectoral patenting system than China, with the top three Indian regions accounting for over 80% of nanotech patenting, against an approximate 60% share for the leading Chinese regions. As with the other two industries, nanotech patenting in both of these countries is significantly more agglomerated than in the USA.

The evidence so far suggests India and China’s innovation systems are the product of interaction of global flows and local forces, which then influence spatial patterns of innovative activity. The next stage of the analysis will seek to understand these issues in more detail.

4. Description of further proceeding towards the Draft Final Report

4.1 The territorial elements behind the innovative patterns: conceptual novelties and future empirical work

The empirical results on the identification of the territorial elements that explain the different kinds of innovation pattern are not due for the interim report. However, in this WP the lead-partner has worked quite hard on the identification of the conceptual approach behind the empirical analysis (that will be run after the interim report) and went much more in depth with respect to the inception report, clarifying the empirical part that will be developed in the draft final report.

As mentioned in section 1, the philosophy that drives the project is that innovation policies need to go away from the simple equation that research means knowledge, and knowledge means growth. According to that view, R&D activities are essential for a region to be competitive, and be able to grow in a knowledge economy; in that view, innovation policies result in the distribution of R&D incentives.

However, the way in which regions produce knowledge and innovation substantially differs from one region to another, each region following a "territorial pattern of innovation".

A **territorial pattern of innovation** is defined as a combination of ***context conditions*** and of ***specific modes of performing the different phases*** of the innovation process. The latter is characterized, in a synthetic sketch, by three main phases:

- from information to knowledge;
- from knowledge to innovation;
- from innovation to regional performance.

Each of these phases requires context conditions that allow a region to go from one phase to another, by generating internally - or to attract from outside - knowledge and innovation.

Regions exist that are able to produce their internal knowledge, translate knowledge to innovation, and obtain the maximum efficiency and effectiveness from innovation adoption in terms of growth. Other regions exist that are instead able to innovate getting the knowledge required for that innovation from other regions (by networking); moreover, regions exist that are able to innovate through a creative imitation of already existing innovation. These are different patterns of innovation, explained by the local conditions that support one pattern of innovation or the other. There is no pattern that is by definition superior to the other in terms of efficiency and effectiveness of innovation on growth; on the contrary, each territorial pattern and efficient use of research and innovation activities to the regions specialized in that particular territorial pattern of innovation. The identification of the specific territorial patterns of innovation each region belongs to, becomes the crucial role to develop efficient ad-hoc innovative policies.

Three main territorial patterns of innovation can be conceptually highlighted:

- **an endogenous innovative pattern in a scientific network**, characterized by a high internal capacity of the region to produce science, general purpose knowledge and innovation, reinforced by a strong scientific networking with other strong research areas. This pattern is based on "**territorial receptivity**", defined as the capability of the region to interpret and use external knowledge for complementary research and science advances. This is expected to be present in large metropolitan regions (Figure 4.1.1);
- **a creative co-inventing application pattern**, characterized by the presence of applied, sector specific knowledge that allows the region to innovate once networked with the strong scientific regions where basic knowledge is created. This pattern is expected to be present in second rank urban city regions, and in highly specialized areas, like local districts. This pattern lies on the presence of "**territorial creativity**", defined as the ability of local actors to interpret and use external knowledge for their own needs, turning external basic science into applied innovation, co-inventing (Figure 4.1.2);
- **an imitative innovating pattern**, in which a region, with no knowledge creation and scientific absorption capacity, receives innovation from outside, and imitates it, in a more or less creative way. This innovation pattern depends on "**territorial attractiveness**", i.e. on the capacity of a region to attract external innovation, and use it in an appropriate way. This is a typical innovation pattern of catching-up regions (Figure 4.1.3).

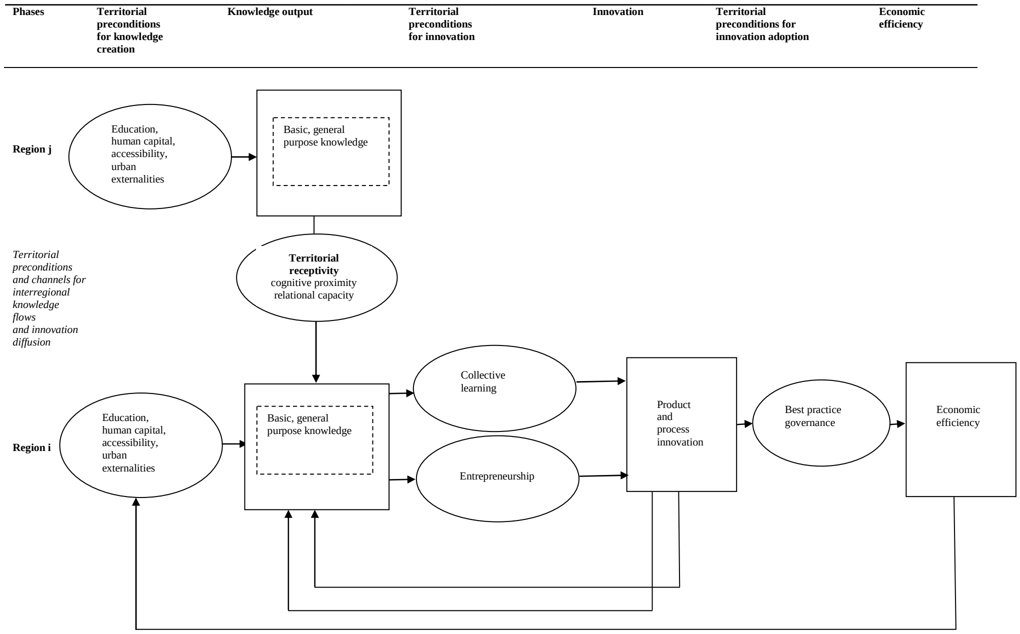


Figure 4.1.1. An endogenous innovative pattern in a scientific network.

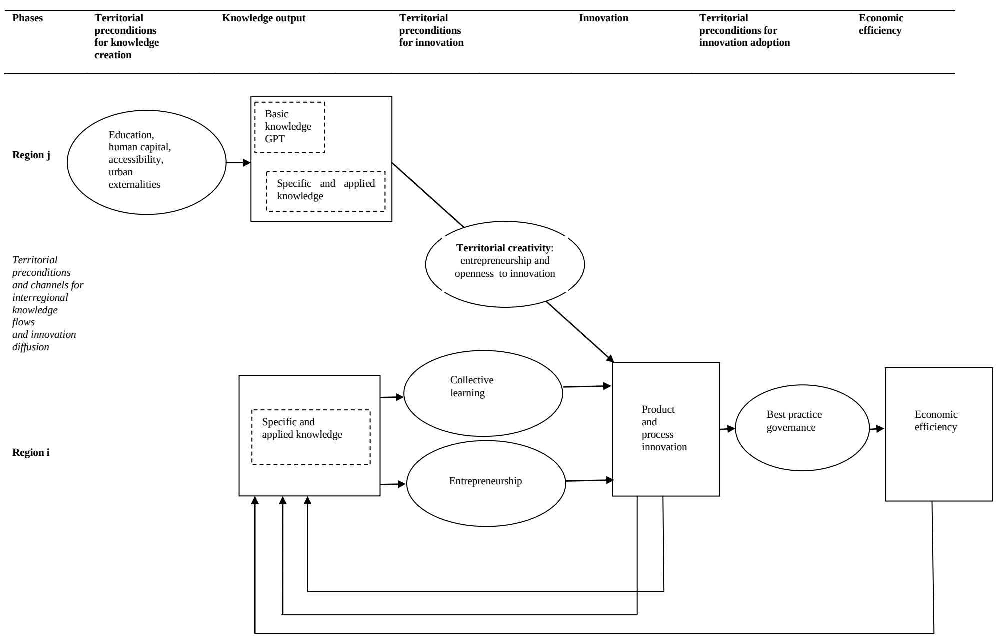


Figure 4.1.2. A creative co-inventing application pattern.

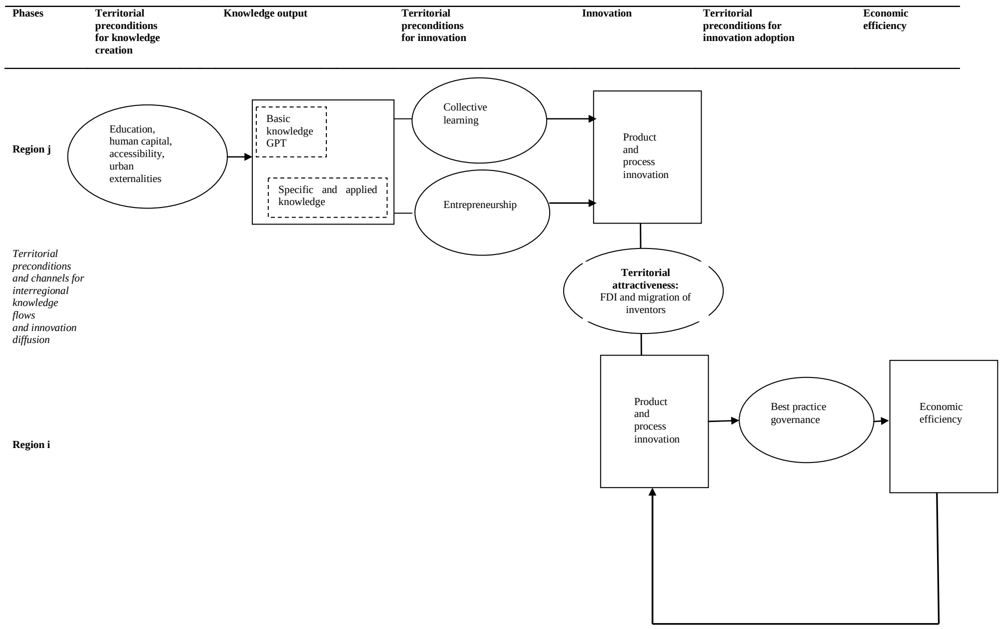


Figure 4.1.3. An imitative innovation pattern.

The identification of the territorial pattern of innovation for each region in Europe will be empirically developed in the draft final report. Indicators for the context conditions, for the stock of internal knowledge and innovation and for the flows of knowledge, as well as for territorial receptivity, creativity and attractiveness, will be built.

4.2 Knowledge and innovation impact analysis: future work on WP2.3.2

A third important aim of the project is the impact analysis, i.e. the capacity of regions to take advantage from innovation activity - in terms of productivity increases, employment and GDP growth. Four groups of "impact analysis" will be carried out with the aim to measure quantitatively:

- **the effects of innovation and knowledge on regional labour productivity, employment and GDP**. This analysis will be carried out for different territorial models of innovation, with the aim to demonstrate that the different territorial patterns are neutral vis-à-vis the effects that they generate on growth. Moreover, the analysis on the effects of innovation on productivity and employment growth will be carried out for different types of innovation, in order to measure whether it is true that product innovation creates new market opportunities, and therefore employment growth, and that process innovation is instead of detriment to employment growth;
- **the effects of innovation and knowledge on regional total factor productivity**, the latter estimated through econometric regional production functions, as a synthetic measure of the performance of regional economies;
- **the elasticities of regional growth to R&D**. In this case, especially when elasticities to R&D is measured for the different types of territorial patterns, we will be able to find out the degree of efficiency of the general thematically/regionally neutral and generic "orientation of R&D funding investments" policies;
- **the effects of innovation and knowledge spillover on regional growth**. An important question for policy makers is whether innovative regions show increasing returns in innovation; this would justify public investments given the high social returns from these investments. The intention is here to measure whether the mobility of inventors acts particularly on the innovative capacity of the recipient area.

For all points, maps with the results will be provided.

4.3 International comparison: future work on WP2.5

Up to now, the comparison developed between US, China and India has been made on the scientific capacity that each country has, and on the spatial distribution of the scientific activity. The evidence so far suggests India and China's innovation systems are the product of interaction of global flows and local forces, which then influence spatial patterns of innovative activity. The next stage of the analysis will seek to understand these issues in more detail. Especially, the territorial elements that explain the spatial trends in patenting activities in China, India and the USA will be highlighted.

4.4 Case studies: WP2.4

The case study areas have been chosen following specific criteria presented in Annex 1 of this report. The scope of the case study is to explore those aspects of the project that are outside the scope of quantitative study, where each study is devoted to understanding the territorial aspects (material and intangible) that support either endogenous knowledge creation or knowledge acquisition. The focus is on channels of *knowledge creation* within the firm, and between the firm and external entities; and on channels of *knowledge acquisition* from outside the region. The territorial elements to be highlighted derive from the theoretical framework. For knowledge sourced internally to the region territorial assets such as the local labour market, the presence of universities and R&D centres, supporting agencies and collective learning processes in association with other knowledge producers will be the main areas of interest. For knowledge sourced externally to the region the studies will concentrate on the main channels through which knowledge is attracted, including the presence of local creativity (smart entrepreneurship), the cognitive proximity of regions from where the knowledge comes, the presence of FDI, and the attraction of inventors from outside. The case studies will also examine the success and the limits of current policies to support innovation, and the personal view of individuals working in firms and public bodies on innovation policy strategies.

The case studies will be run according to a common protocol (presented in Chapter 6 in the Scientific Report) and based on semi-structured qualitative interviews following a common schedule for all case study areas. Interviews at firms will contain sections on the basic information for the firms interviewed; the innovation capacity of the firms in quantitative and qualitative terms; the local channels through which firms get new knowledge to innovate; the importance of knowledge sourced externally to the region on the firm's innovative capacity; and a section on innovation policy. Interviews at local agencies for innovation support will contain sections on the aims and scope of the agency interviewed; the major innovation support activities developed; the major successes achieved and constraints encountered in diffusing knowledge at the local level; and judgements on the innovation policy and on the major local assets that support innovation.

To assist comparison the case study reports will have common templates. For each type of study (knowledge creation and knowledge acquisition) the reports will contain a short description of the economy and innovation activity of the region. The knowledge creation studies will then contain a description of local elements that support innovation; limitations within the local system of innovation support; the channels through which knowledge is acquired by firms, distinguishing in particular contacts between local suppliers, competitors, and university or research centres; and a section on the successes and limitations of innovation policies especially concerning supports for knowledge creation and knowledge diffusion within the area. For knowledge acquisition case studies the same template will apply, but to describe knowledge acquisition from outside the region instead of knowledge creation and innovation within the firm and the region.

4.5 Policy implications: future work on WP2.6

The way the empirical part of the project is organised highlights the major scope of the project, i.e. that of demonstrating if **the traditional (almost) thematically/regionally neutral and generic orientation of R&D funding investments" policy** is still valid. Our impression is that this is not the case any longer, and that **a shift to a thematically/regionally focused innovation policy** is required.

If we are right, a number of policy implications have to be highlighted, namely:

- how can a national and regional innovation policy help a region to become aware of its "territorial pattern of innovation" (raise awareness of the regional capabilities)?
- how can a differentiated innovation policy support the development of the different "territorial pattern of innovation" (policy actions: right tools and instruments)?
- Coming out of a "structuralist" logic in favour of a dynamic one: which evolutionary paths of the single "territorial patterns" are worth a policy support and in which direction?
- which smart specialisation can a region have even within a certain territorial model of innovation (specific thematic area on which to invest)?
- who are the actors to whom the new innovation policy has to be addressed to (right beneficiaries)?
- which is the best "division of labour" among European/national and local policies (right policy actors)?
- which is the best governance that would apply for a particular innovation policy (governance)?

Replies to all these questions change according to the territorial pattern of innovation we address. Table 4.5.1 will be filled out once the project comes to the policy implications, and empirical results are obtained.

Table 4.5.1. A summary of policy suggestions.

Territorial models of innovation **Policy aspects**	**An endogenous innovative pattern in a scientific network**	**A creative co-inventing application pattern**	**An imitative innovating pattern**
Raise awareness of local actors of the territorial model in which they live			
Specific thematic areas on which to invest to support innovation			
Policy actions: right tools and instruments			
Beneficiaries			
Policy actors			
Governance			

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Annex 1. Selected case study areas

As asked by the MC and the ESPON CU, the case studies has been raised to a number of 12. The selection of the case studies has been based on a thorough thinking of the needs of the project.
Different criteria have been used for the identification of the case studies. The criteria must allow a comparison to be made between:

- different types of areas, within the same type of sector and institutional setting;
- different types of sectors, within the same type of area and institutional setting;
- different institutional settings, within the same type of areas and sectors.

In order to be able to run these comparisons, the criteria used for the identification of the case studies are the following:

1) Different characteristics of the areas

The case studies have been chosen in two distinct types of regions: diversified vs. specialized areas. The reason for this choice is that knowledge creation and diffusion mechanisms are expected to be different in areas specialized in a specific sector or in differentiated sectors. The role of localization vs. urbanization economies can be grasped and evaluated. Is knowledge creation process more easily developed in large diversified areas or in specialized areas? This question can be answered only if different types of areas are taken into consideration.

2) Different characteristics of the sectors

Another important point of view when running the case studies is the comparison between knowledge creation and diffusion in traditional and advanced sectors. The type of knowledge and the process of knowledge creation might be rather different in advanced rather than traditional sectors. Is knowledge creation process more easily developed in advanced sectors or in traditional sectors? Do traditional sectors take advantage of a specialized or a diversified context? Traditional and advanced sectors have been chosen in both diversified and specialized areas in all three Countries.

3) Different types of Countries

The case studies will be run in three countries that differ in terms of institutional aspects and in innovation and knowledge governance: a Southern European country, Italy, a Northern European country, UK, and an Eastern Country, Slovakia. This allows to have a comparison of the role of institutional aspects keeping the same sectoral and geographical context dimension.

4) Limited number of Countries

The relatively small number of countries is a strategic choice in order to have a comparable number of case studies within the same institutional setting (4 per country) and within the same type of sector (traditional vs. advanced) or of region (specialized vs. diversified). Spreading case studies all over Europe would not allow a comparison avoiding the "national effects".

At the end of the selection process, the following case study areas and sectors have been identified on best practice of knowledge spillovers and knowledge creation:

Banska Bystrica region	Wood processing industry
Bratislava	Automotive
Wales	Food
Tuscany	Wine
Piemonte	Automotive
Oxford	Biotechnology
Košice	ICT
Bratislava	ICT
Cardiff (Wales)	Digital Media/TV
Milan (Lombardy)	Media
Cambridge	ICT
High tech (Tuscany)	Arno Valley

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The ESPON 2013 Programme is part-financed by the European Regional Development Fund, the EU Member States and the Partner States Iceland, Liechtenstein, Norway and Switzerland. It shall support policy development in relation to the aim of territorial cohesion and a harmonious development of the European territory.

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