Executive Summary

ESPON 2.1.2 - The Territorial Impact of EU Research and Development Policies

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ECOTEC

Priestley House
12-26 Albert Street
Birmingham
B4 7UD
United Kingdom

T **+44 (0)121 616 3600**
F **+44 (0)121 616 3699**
www.ecotec.com

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Executive Summary

1.1 Introduction and Study Objectives

This report is the final report for ESPON Project 2.1.2 : The Territorial Impact of European Union R&D Policy. ECOTEC Research and Consulting Ltd is the lead Partner for this ESPON Project. The project is aimed at supporting policy development by providing new knowledge, concepts and indicators on territorial trends and policy impacts related to an enlarged European Union in the field of Research and Development policy. In this respect, the project uses the EU 27 as the territorial unit of analysis and as far as possible includes Norway and Switzerland, where relevant. The ESPON studies are intended to inform:

- Those factors relevant for a more polycentric European territory.
- The development of territorial indicators and typologies, capable of identifying and measuring development trends as well as monitoring the political aim of a better balanced and polycentric EU territory;
- The development of tools supporting diagnosis of principal structural difficulties, as well as potentialities. This should include disparities within cities and regenerating deprived urban areas;
- The investigation of territorial impacts of sectoral and structural policies, such as the Structural Funds;
- The development of integrated tools in support of a balanced and polycentric territorial development.

The objectives for this study were wide-ranging and include the following general objectives:

- To develop methods for territorial impact assessment of sectoral policies
- To develop territorial indicators, typologies and concepts, establish a database and map-making facilities and sustain the project by empirical, statistical and/or data analysis.
- To analyse territorial trends, potentials and problems deriving from the policy, at different scales, and in different parts of the European territory.
- To show the influence of the policies on spatial development at relevant scales
- To show the inter-play between EU and sub-EU spatial policies and best examples for integration

- To recommend further policy developments in support of territorial cohesion and a polycentric and better balanced EU territory
- To find appropriate instruments to improve the spatial co-ordination of EU sector policies and the ESDP
- To consider the provisions made and to provide input for the achievement of the horizontal projects under priority 3.

In addition, the study is expected to:

- Identify and gather existing territorial indicators to measure and display the state, trends and impacts of R&D policy and propose new indicators where necessary.
- Operationalise the policy options of the ESDP relevant for a territorial impact analysis of R&D policy, and development of a methodology for impact analysis at a EU scale.
- Conceptualise and elaborate a territorial impact analysis for R&D policy with special consideration of the following points:
- How far R&D policy addresses emerging border and integration problems, taking into account the variety of regions and enlargement. Does EU R&D policy provide adequate accessibility in the regions of Europe?
- What spatial effects are expected in terms of current and future R&D policy?
- How far does EU R&D policy support the concentration of development corridors and polycentric development and what other spatial effects are emerging?
- How far does EU R&D policy affect the spatial diffusion of innovation and knowledge in Europe?
- Consider what kind of resources are available at EU level to conduct R&D policy and whether the necessary co-ordination take place with national policy;
- Consider what the territorial conditions that allow regions to take best advantage R&D policy are, in terms of innovation and economic development;
- Consider how R&D policy at EU and Member State level should be designed and co-ordinated to promote an equal access to knowledge infrastructures for all European territories;
- Consider how the Structural Funds and R&D policy could develop a more coherent and effective approach in promoting R&D capacities and territorial cohesion.

1.2 R&D and innovation

Research and Development (R&D) and innovation are related but distinct concepts. R&D is defined by the OECDI as “any purposeful activity that adds to the stock of scientific and technical (S&T) knowledge”. It refers to the full spectrum of S&T research activities (e.g. pure basic, strategic basic, applied, experimental and development) in universities, industry, public research institutes and the non-profit sector.

Agreed definitions of innovation are more illusive. The OECD Oslo Manual describes innovation as “technologically new or improved products and processes that have been introduced onto the market (product innovation) or used within a production process (process innovation)”. However, this formulation ignores the non-technological dimensions of innovation, such as organisational or managerial change, and focuses on the outputs (new products and processes) of a complex and often poorly understood process of innovation. Similarly, in the field of management, innovation is generally defined as “an internally generated or externally purchased device, system, policy, process, product or service that is new to the adopting organisation” (Damanpour, 1991). Among numerous typologies of innovation advanced in the literature, three have gained wide recognition: technical vs. administrative innovations; product vs. process innovations, and radical vs. incremental innovations.

1.3 R&D, innovation and growth

Evolutionary theories of economic growth stress the role of R&D and innovation in securing sustained and lasting growth trajectories of economies. The incorporation of ‘technological progress’ into economic growth models as an endogenous variable highlights the fact that the accumulation of knowledge generates increasing returns. Regions with strong R&D endowments are also likely to attract more of these factors establishing strong processes of cumulative causation. Conversely those regions that do not have existing endowments may continue to lag behind and may indeed see the gap with wealthier regions widen.

Innovation itself is an iterative process, building on the results of R&D activity and in turn informing – and being informed by – new research and innovations in products and processes. In this respect innovation is an intensely social process and is dependent upon

[I] Oslo Manual (1997)

the social and cultural context in which it takes place. As there are many routes to innovation aside from undertaking R&D the question thus becomes one of how firms make use of knowledge (regardless of source) and how they access that knowledge. The focus of attention of researchers has, then, gradually shifted from the inputs into the R&D process to the flows of knowledge emanating from R&D activities; to the means by which firms process knowledge and to how that knowledge is harnessed.

The generation of new knowledge through R&D remains at the heart of the innovation process. The territorial dimension to this has come under increasing scrutiny over the past two decades with the introduction of the concept of national innovation systems and, more latterly, regional innovation systems. These concepts recognise the importance of the institutional setting in influencing levels of innovation. In considering the components of national and regional innovation systems and how these affect overall levels of R&D and innovation researchers have tended to alight on factors such as the absorptive capacity of territory and the efficacy of knowledge transfer and exchange within a system and between systems.

What constitutes the absorptive capacity of a region has been much discussed within the academic literature. There is a general agreement that this includes factors such as the available 'knowledge' infrastructure, such as universities, research institutes and science parks; the skills of the resident population; the financial system; the networks of exchange within a region and the network of intermediary institutions. For many, a region needs a 'critical mass' of these various attributes in order for it to engage to any meaningful extent in high-level R&D activities.

There is a further debate as to the importance of spatial proximity in facilitating knowledge exchange. Whilst some writers argue that spatial proximity remains a crucial dimension in promoting research and innovation, owing to the importance of tacit learning, others feel that with modern communication systems we can talk of the notion of 'relational' proximity and so reduce the significance of spatial proximity. The evidence is currently mixed in this area, although the strongest evidence continues to suggest that knowledge spillovers decline with distance, reinforcing the case of those that stress the importance of spatial proximity. All authors though acknowledge the importance of non-local linkages as a means of introducing new knowledge into a system and overcoming tendencies towards lock-in and path dependency.

1.4 EU R&D policy

The European Union's role in the field of R&D is set out in Article 163 (ex 130f) of the Treaty establishing the European Community and in subsequent articles up to Article 173. The immediate objectives of EU R&D actions are broadly targeted towards the following types of activity:

- Promoting International R&D collaboration
- Establishing networks of SMEs
- Creating mechanisms to stimulate and support innovation
- Increasing EU wide human capital
- Building up knowledge infrastructure in less favoured regions and links to more advanced regions

At present the principal tools to achieve these objectives are the EU Structural Funds and the EU RTD Framework Programmes. In addition to the Framework Programmes and the R&D-related actions funded under the mainstream Structural Funds, the Commission has also operated a number of pilot actions or limited initiatives in support of R&D development. During the 1994-1999 funding period, these took the form of Regional Innovation Strategies (RIS) and Regional Technology Transfer (RTT) actions. Under the current programming period (2000-2006), the first of three strands of Innovative Actions funded through the ERDF aims to support regional competitiveness on the basis of innovation. DG Research also administers a pilot programme called Regions of Knowledge, established on the initiative of the European Parliament. In each case, regions apply to the Commission for selection though open competitions.

All these different aspects of Community policy in the field of R&D now operate in the context of a strategic goal, on the part of the EU, to create a European Research Area (ERA). The concept of the European Research Area (ERA) was established in the Commission communication Towards a European Research Area, published in January 2000, in advance of the Lisbon Summit of March that year. The basic idea underpinning the ERA is that the issues and challenges of the future cannot be met without much greater integration of Europe's research efforts and capacities.

The RTD Framework Programmes are multi-annual programmes that fix the objectives and priorities for activities to promote cooperation in the field of R&D, the dissemination of research results and the training and mobility of researchers in the EU. The First Framework Programme (FP1), launched in 1984, ran until 1987 and was succeeded by FP2 (1987-91), FP3 (1990-94), FP4 (1994-1998) and FP5 (1998-2002), until the recent launch of the Sixth Framework Programme (FP6) in November 2002. FP6 comes to an end in 2006 and it is proposed that it will be replaced by a 7th Framework Programme. FP7 is intended to run from 2007 to 2013.

Actions in the area of Research, Technological Development and Innovation financed by the Structural Funds have become comparable in size, although different in nature, to those financed by the Framework Programmes. R&D related actions have received a significant share of funding in Objective 1 and Objective 2 regions, under both the 1994-1999 and the 2000-2006 Programming Periods. In the current programming period (2000-2006) the distribution of Structural Funds between activities is recorded through the use of codes assigned to different Fields of Intervention. One of these codes (number 18) relates to actions in support of RTDI. The relevant intervention codes – relating to eligible actions - for the current programming period are:

18	Research, technological development and innovation (RTDI)
181	Research projects based in universities and research institutes
182	Innovation and technology transfers, establishment of networks and partnerships between businesses and/or research institutes
183	RTDI Infrastructure
184	Training for researchers

1.5 Methodology

In addressing the objectives for this study we have focused on four principle areas of activity:

- Firstly we have examined the capacity of regions in the EU in terms of R&D and innovation activity
- Secondly we have sought to examine the value of developing different typologies of regions based upon this analysis
- Thirdly we have examined the distribution of EU R&D policies and their spatial effects
- Finally we have drawn upon the findings of these three areas of work to reflect on the lessons to be learnt.

A full summary of the methodology adopted is contained in the Scientific Summary.
R&D and innovation in the EU

We illustrate our analysis of R&D and innovation in the EU through examining the following facets of regional R&D and innovation potential:

- Levels of R&D activity - through analysis of R&D intensity - and the engagement of the private sector in this activity
- Measured using R&D intensity and business expenditure on R&D
- The human capital available to R&D in the EU's regions
- Measured using R&D personnel and Human Resources in Science and Technology (Core)
- The distribution of high-level R&D infrastructures
- Measured on the basis of the leading publishing universities in the EU, the location of international science park and European Business Innovation Centres
- The overall quality of human resources in the EU's regions as a basis for innovation activities
- Measured on the basis of the proportion of the workforce employed in high and medium-high technology manufacturing, high technology services and the proportion with tertiary education

The broad EU picture is one of a strong 'heartland' closely approximating to the central 'pentagon' traditionally identified in core-periphery analysis. However, strengths outside of the pentagon are identifiable in the northern periphery, where regions in Sweden and Finland are amongst the most significant EU players in R&D and innovation, the south-western fringe of the pentagon, where regions of France and northern-Spain perform strongly on certain key indicators and, to a lesser extent, the western periphery. Many of the strongest growth rates in key indicators are to be found in more peripheral regions, demonstrating that a process of catch-up for some is visible. Looking at each facet in a little more detail and illustrated in the related maps:

R&D intensity

When viewed on a European scale, the regional figures for R&D intensity demonstrate the weaker positions of the periphery of the EU. Map ES1 shows R&D intensity across the EU-27 against the EU average, based on current data availability. The strong performance of Sweden, Finland and parts of the UK, Netherlands, Germany, France and Austria is clearly visible.

Business expenditure on R&D

The distribution of BES R&D in Europe in 1999 is shown in Map ES2. Whilst the overall pattern remains similar to that reported for GERD it is apparent that a number of high expenditure regions are dependent on the public funding of R&D. Business expenditure is rather more concentrated in a limited number of regions than Gross expenditure as a whole.

R&D personnel

In the EU-15, the levels of R&D employment as a percentage of the labour force largely mirror the pattern of R&D expenditure, with many of the highest regional concentrations of total R&D personnel located in the Northern part of the European territory (Map ES3). The average level of total R&D employment in the old EU-15 in 1999 was 1.36% of the labour force, although analysis highlights a number of core regions with rates considerably above this.

Human resources in science and technology (core)

The pattern of distribution of HRSTC as a proportion of total employment across the regions of the old EU-15 produces interesting results. Two countries come out as clear leaders: Sweden (6 out of the top 25 regions, including Stockholm with the highest overall figure) and Belgium (7 out of the top 25 regions). This is largely explained by the fact that both these countries have high levels of the working age population with tertiary education and important concentrations of high technology sectors (both countries perform particularly well in terms of total employment in High Technology Services. Other leading regions in the old EU-15 include core or capital regions in Finland (Uusimaa, Manner-Suomi), the UK (Inner London), Germany (Berlin), France (Ile de France) and the Netherlands (Utrecht). The lowest scoring regions against this indicator are found in Portugal, Greece, Italy and Austria. Italy and Austria also record comparatively low levels of tertiary level education, even in core economic areas. This most probably reflects differences in the exact classification of the educational qualifications used and demonstrates one of the problems associated with international comparisons involving educational attainment levels.

Distribution of research and innovation infrastructures

The location of leading knowledge infrastructure across the EU is highly concentrated. Map ES5 highlights the location of the EU's leading publishing universities, internationally recognized science parks and European Business Innovation Centres. Analysis of the location of this infrastructure across Europe demonstrates some strong patterns, highlighting the importance of a limited number of regions. 4% of EU regions account for 40% of the leading research universities and institutes; 46% of recognised Science Parks and 25% of Business Innovation Centres. In contrast, 76% of regions contain none of these.

Employment in high and medium-high technology manufacturing

The average level of employment in High and Medium High Technology manufacturing sectors in the EU-15 in 2001 was 7.57%, compared with a figure of 6.63% across the candidate countries. The highest proportions of employment in these sectors in the EU-15 are found in Germany, where the top seven regions are all located. The region with the highest proportion of the labour force engaged in high technology manufacturing sectors is Stuttgart with 21.08%. Other top performing regions include Franche Comté, Piemonte and Comunidad Foral de Navarra. The bottom 50 regions include a high proportion of regions from cohesion areas of Southern Europe, along with a number of regions from core economic areas of the continent such as Outer London (1.96%), Utrecht (2.14%) and Noord Holland (2.56%). The figures for these latter regions reflect the proportionately dominant role of the service sector in these areas.

Employment in high technology services

In 2001, 3.61% of the EU-15 labour force was employed in High Technology Services. The highest levels of employment in these dynamic sectors of the economy are found in North Western Europe, in London and the South East in the UK, in Stockholm, Helsinki, Utrecht and the Paris region (Map ES7). Berkshire, Buckinghamshire and Oxfordshire, all in the UK, registered the highest figure at 4.65% of the labour force. In the New Member States and Accession countries, 2.34% of the labour force in 2001 was employed in high tech services. The highest proportion was found in Estonia (3.38%), with similarly high levels in the Czech Republic, Hungary, Malta and Slovakia (3.22%, 3.24%, 3.06% and 3.03% respectively). Romania, Cyprus and Latvia had the lowest rates of employment in these sectors (1.43%, 1.83% and 2.01%).

Proportion of the population with tertiary education

Map ES8, based on data currently available to the project, shows the NUTS 2 regional picture for tertiary level educational attainment for 2000. The aggregate proportion of the working age population with tertiary education in the EU-15 for this year was 21.2%. As can be seen, the regions with the highest levels of highly qualified people in current members of the Union are concentrated in the Nordic Countries and parts of Germany, the Netherlands and the UK. The lowest levels are found in Northern Portugal, parts of Italy and Greece. The disparity between the Länder of the former GDR (characterized by high levels of tertiary education) and the rest of Germany reflect the legacy of different education systems and illustrate why international comparisons on the basis of this indicator need careful interpretation.

1.6 Typologies

In constructing a typology of regions for this study we have sought to identify indicators that reflect regional strengths in R&D, together with indicators of levels of innovation activity. In doing so we have focused on the following aspects:

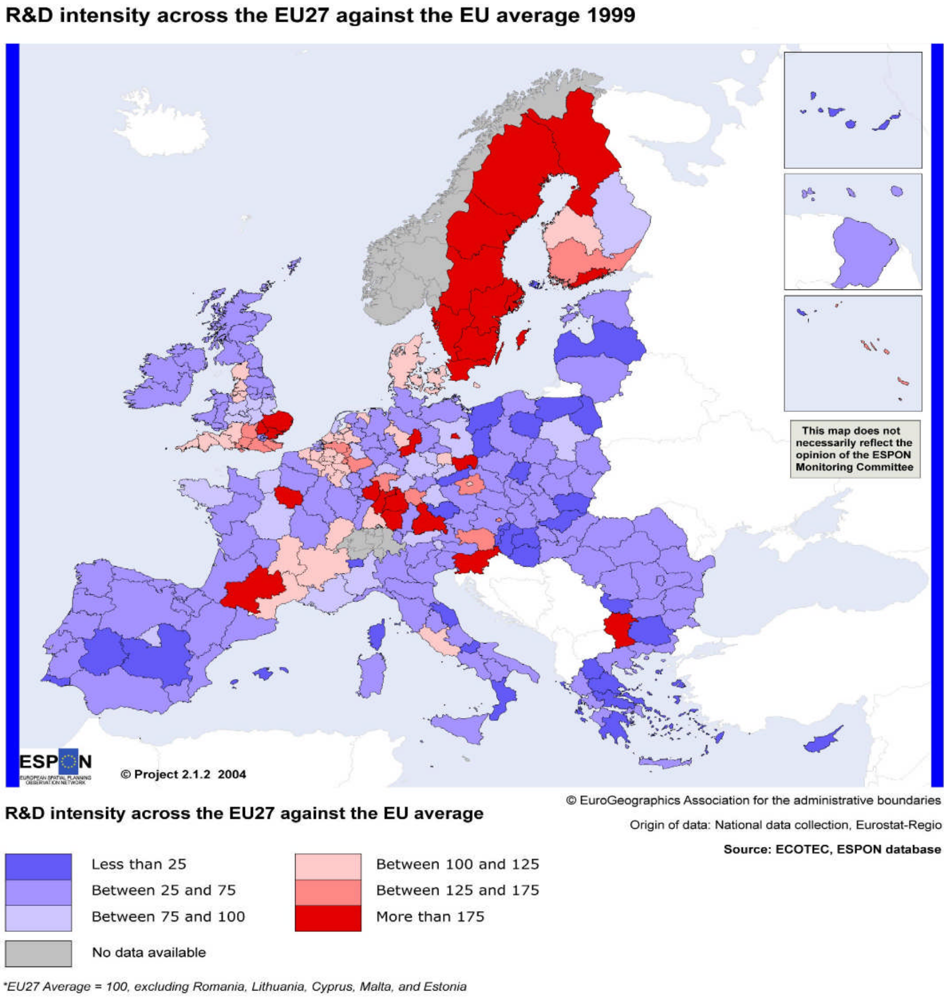
- Levels of R&D activity within a region
- Level of R&D capacity (as measured by available human resource)
- Firm profile
- Skills of the resident population

Two methods were used to construct the typologies for this study.

Firstly, we used an approach based on z-score analysis. This provides a measure of the distribution from the European average (based upon the standard deviation from the mean) for each region.

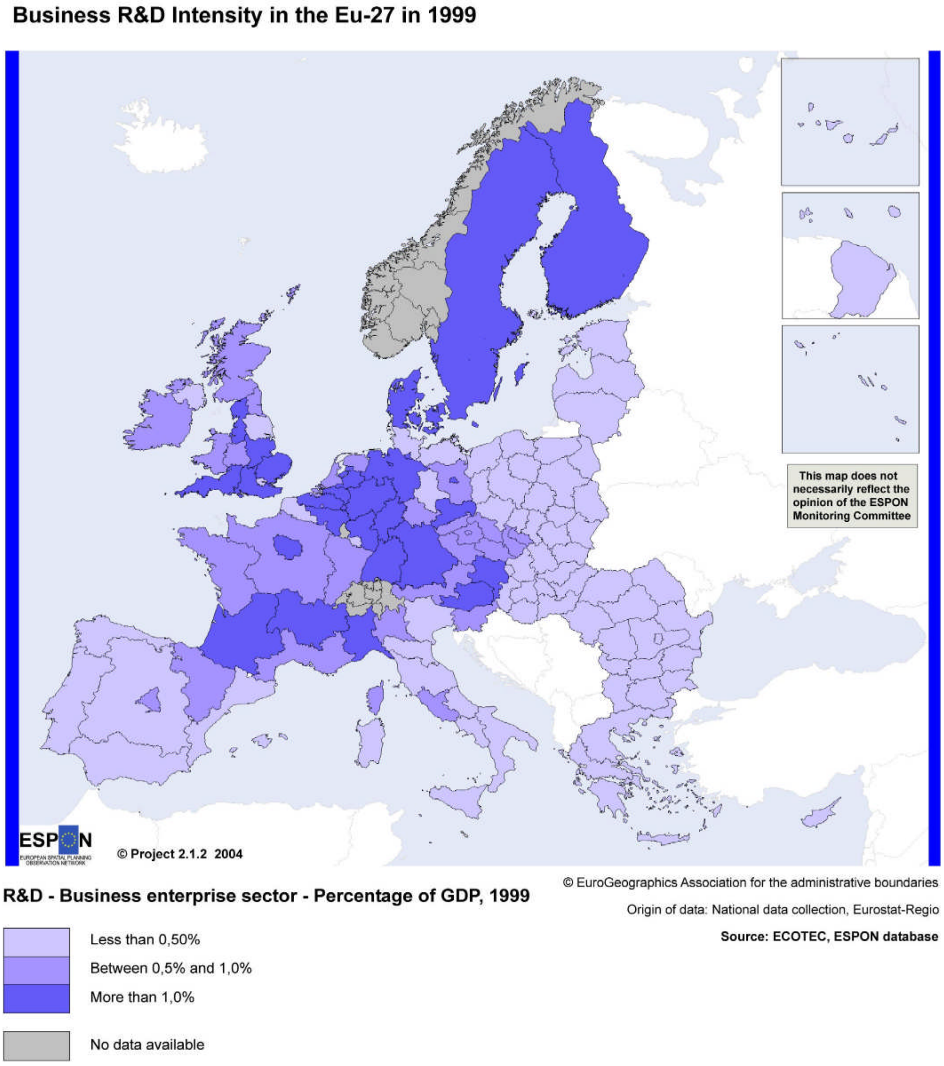
Secondly, a k-means cluster analysis was also undertaken. This is a form of nearest neighbour analysis which uses statistical techniques to identify clusters of regions with similar attributes based upon the data used.

Map ES1 R&D intensity across the EU-27 against the EU average



Data for CZ, HU, SK and LU corresponds to the year 2000
Data used for IE and SE are from NUTS1
Data used for BE, CY, EE, LT, LV and RO are from NUTS0
CH, MT and NO: no data

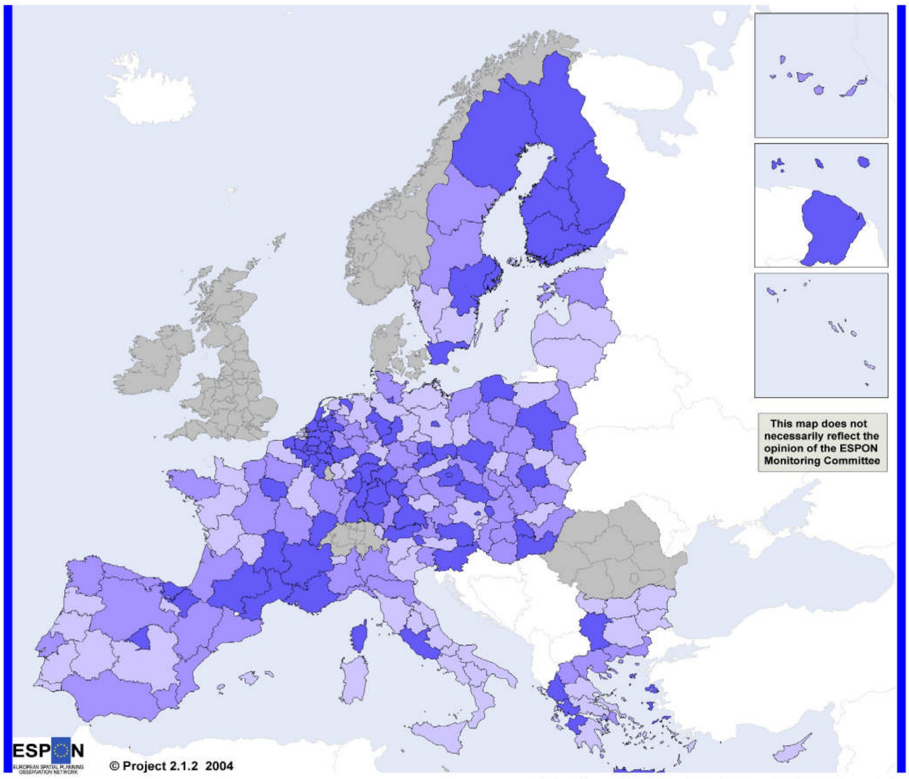
Map ES2 Business R&D Intensity in the EU-27 in 1999



Data: NUTS II except UK (NUTS I) Belgium, Ireland (NUTS 0) Year: 1999 (At 1998)

Map ES3 R&D Personnel as a Percentage of the Labour Force in the EU-27 (Most recent available year)

R&D - Personnel as a percentage of the labour force in the EU27
(Most recent available year)



R&D - Personnel as a percentage of the labour force in the EU27

- Less than 0,7%
- Between 0,7% and 1,2%
- More than 1,2%
- No data available

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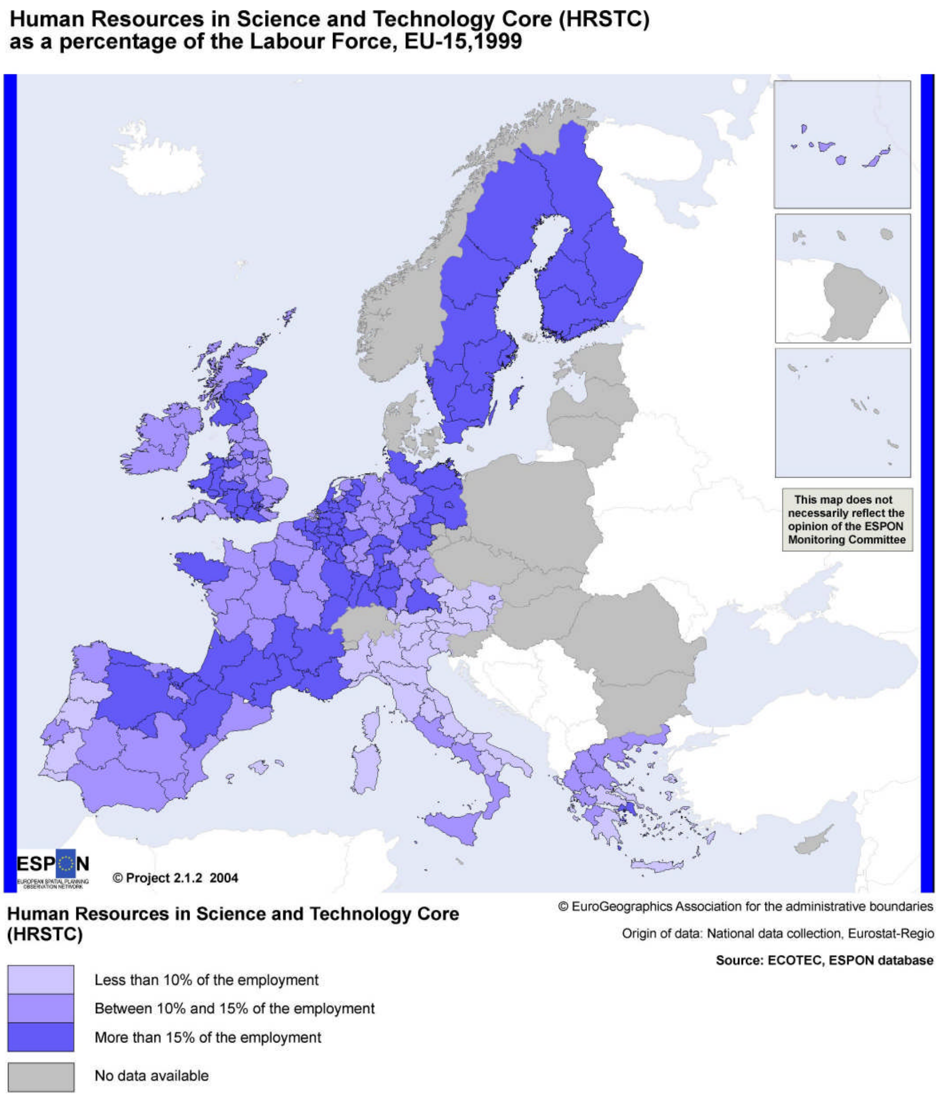
Origin of data: National data collection, Eurostat-Regio
Source: ECOTEC, ESPON database

1997: Germany, Greece, Netherlands
1998: Austria, France
1999: Spain, Finland, Sweden, Portugal, Slovenia
2000: For the rest of the countries

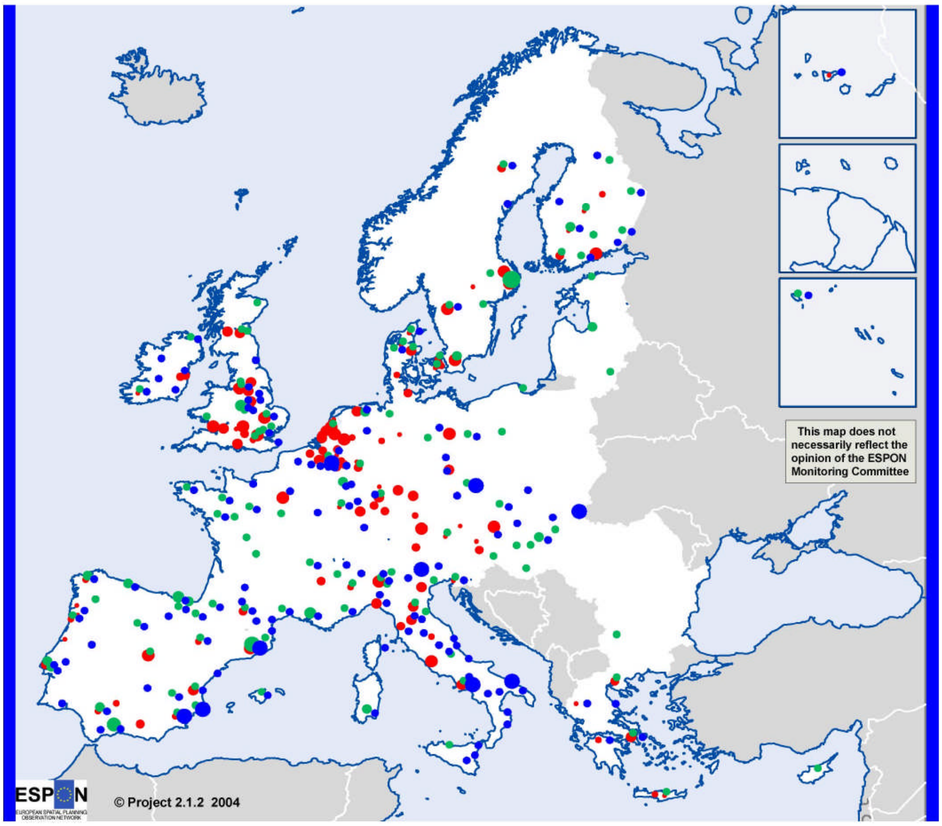
Map ES4 Human Resources in Science and Technology Core (HRSTC): EU-15 1999



Data: NUTS II except Ireland (NUTS I), Switzerland and Norway (NUTS 0)

Map ES5 High level R&D infrastructure across Europe

High level R&D infrastructure across Europe



Number of publications per university/ public reserch institution

- <2000
- 2000 to 4000
- 4000 to 8000
- >14000

Number of science parks (members of ISPA)

- 1 science park
- 2 science parks
- 3 science parks
- 4 science parks
- 5 science parks
- 6 science parks

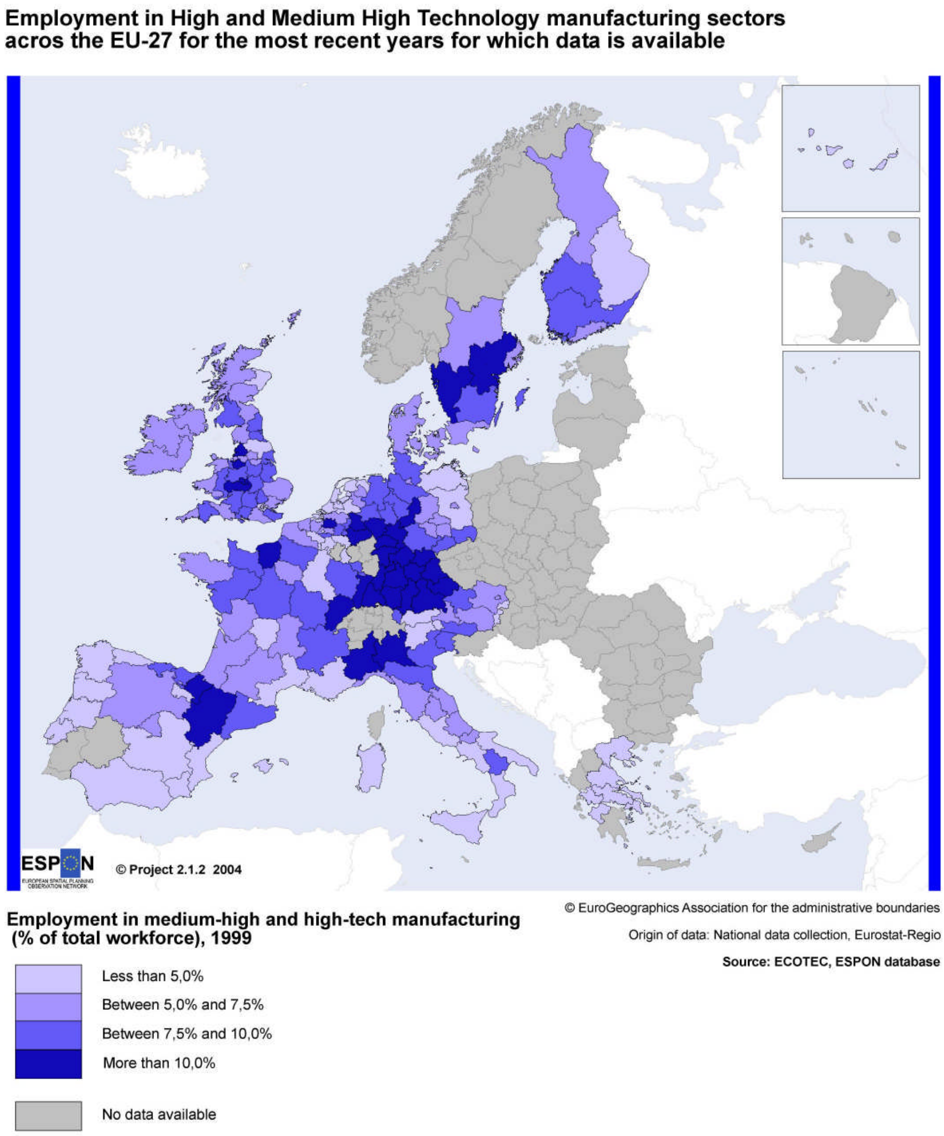
Number of business innovation centres

- 1 centre
- 2 centre

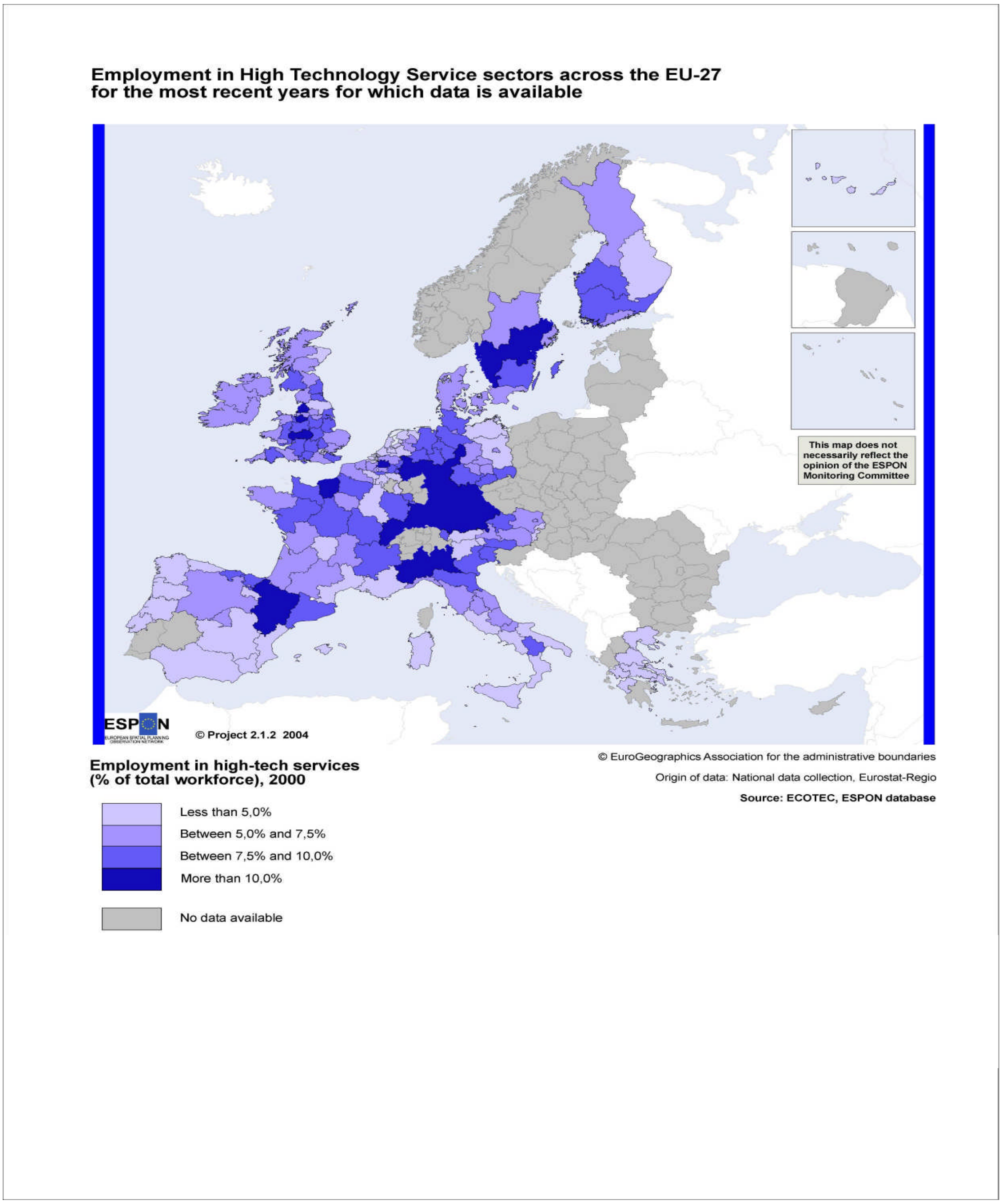
Origin of data: National data collection, Eurostat-Regio

Source: ECOTEC, ESPON database

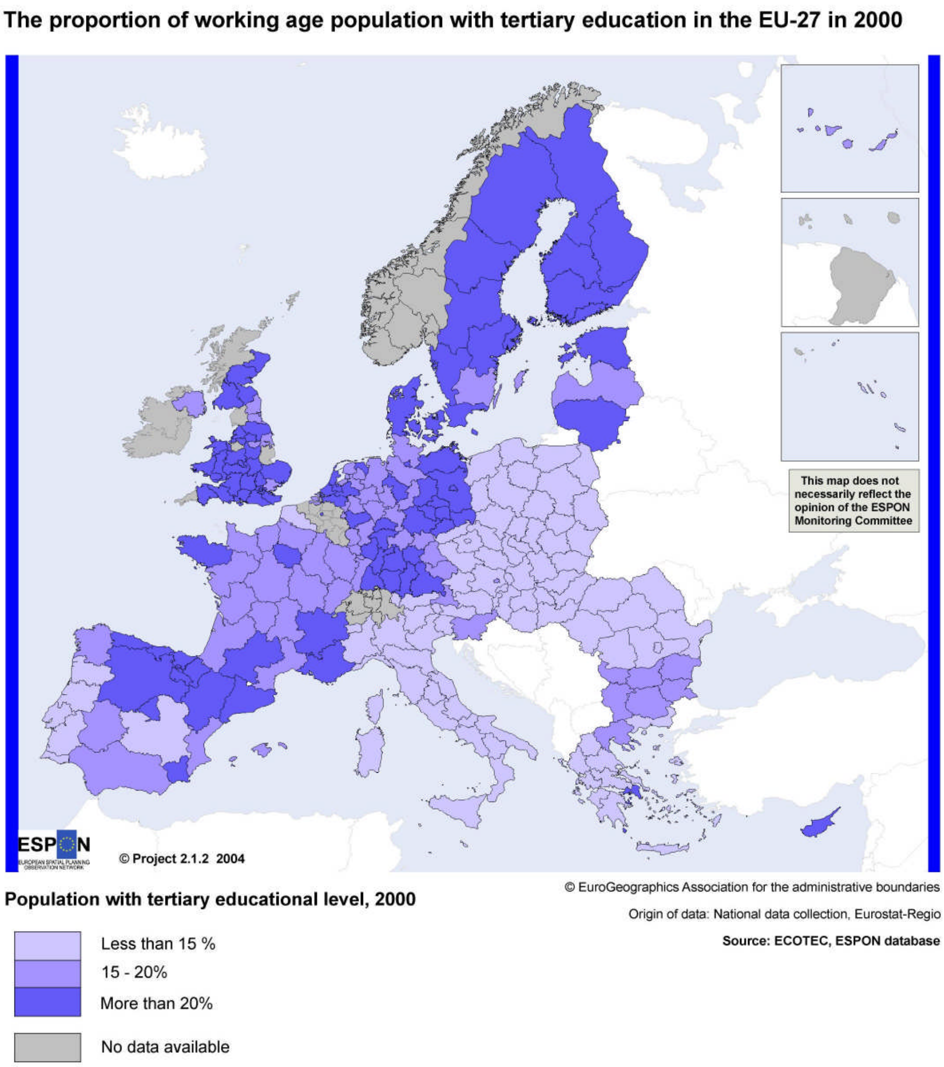
Map ES6 Employment in High and Medium High Technology manufacturing sectors across the EU-27 for the most recent years for which data is available



Map ES7 Employment in High Technology Service sectors across the EU-27 for the most recent years for which data is available.



Map ES8 The proportion of working age population with tertiary education in the EU-27 in 2000



Four typologies were developed using these two approaches and different combinations of indicators. We also compared the results of one the ESPON derived cluster typologies (Analysis 3) with a regional typology developed by the European Innovation Scoreboard, as agreed with the Monitoring Committee.

The indicators used to generate each of the typologies are set out in the scientific summary. The typologies themselves are broadly comparable, although there are some subtle differences between the categories of each typology, as illustrated below.

Z-score analysis

Type 1 - Low R&D capacity and low innovation capacity
Type 2 - Medium R&D capacity and medium innovation capacity
Type 3 - Low or medium R&D capacity but high innovation capacity
Type 4 - High R&D capacity but low or medium innovation capacity
Type 5 - High R&D capacity and high innovation capacity

Cluster Analysis 1

Cluster 1 - worst R&D performance, lowest share in high-tech employment;
Cluster 2 - mediocre R&D performance, strong HRSTC base;
Cluster 3 - mediocre R&D performance, average share of high-tech employment;
Cluster 4 - 2nd best R&D performance, average share of high-tech employment;
Cluster 5 - top R&D performers, strong HRSTC base, highest share of high-tech employment.

Cluster Analysis 2

Cluster 1 - low R&D capacity, low innovative capacity;
Cluster 2 - medium R&D capacity, low innovative capacity;
Cluster 3 - medium R&D capacity, medium innovative capacity;
Cluster 4 - high R&D capacity, medium innovative capacity;
Cluster 5 - high R&D capacity, high innovative capacity.

Cluster Analysis 3

Cluster 1 – Very high capacity for R&D and innovation
Cluster 5 – High capacity for R&D and innovation
Cluster 3 – Above average capacity for R&D and innovation
Cluster 2 – Average capacity for R&D and innovation
Cluster 4 - Below average capacity for R&D and innovation

Each of the four cluster approaches are illustrated in Maps ES9 to ES12. Looking across the different approaches taken to developing regional typologies demonstrates that each approach gives a broadly similar picture. On the whole the same parts of the EU emerge as centres of R&D and innovation strengths. However, there are differences and it is worth identifying these as an illustration of the variable results that emerge from typologies depending upon the factors that are taken into consideration and the technique used to compile a typology.

Comparison of the results for the Z-score typology with those for Cluster 1 immediately demonstrates the stronger position that regions in the core of the EU – and the northern periphery - occupy in the latter. This is primarily due to the emphasis on the distribution of business related R&D activity in Cluster 1 – where business expenditure on R&D and EPO patent applications are 2 of the 4 variables adopted. This typology is thus a good reflection of the location of private sector R&D strengths. Looking at Cluster 2 illustrates that the picture has become further concentrated. This is most probably the result of the combination of the 4 indicators into 2 composite variables which tends to 'even out' overall performance. In contrast the z-score analysis highlights a small number of regions located in southern Europe which have strong levels of R&D personnel which tends to pull their overall score 'upwards'.

Comparing the findings of the ESPON Cluster Analysis 3 and that of the EIS RSII (Map ES13) demonstrates that around 90% of all regions are categorised in a similar manner by each typology. This is a very strong level of comparability. Of the exceptions, almost two-thirds are to be found in one cell: categorised as cluster 5 by the EIS and as cluster 3 by ESPON 2.1.2, these are all located in Austria, Germany and France. In seeking an explanation for this we examine where differences might lie. Both the EIS and ESPON identify that these regions are largely characterised by below EU average R&D intensity (with the exception of Berlin, Vienna and Rhone-Alpes). Tertiary education levels are about EU average (although the EIS highlights the below average performance in lifelong learning – a variable that the ESPON typology does not use). The ESPON typology notes the better than average performance in terms of employment in high and medium technology manufacturing and in employment in high technology services, however as these variables are also included in the EIS approach this is likely to have been taken into consideration. The ESPON study considers the human resources working in R&D activities in the regions – a variable that the EIS does not consider. In each of these regions the figure for employment in HRST(C) is strongly above the EU average. It is likely that this is the reason for the better performance of these regions in the ESPON cluster analysis in comparison to that of the EIS.

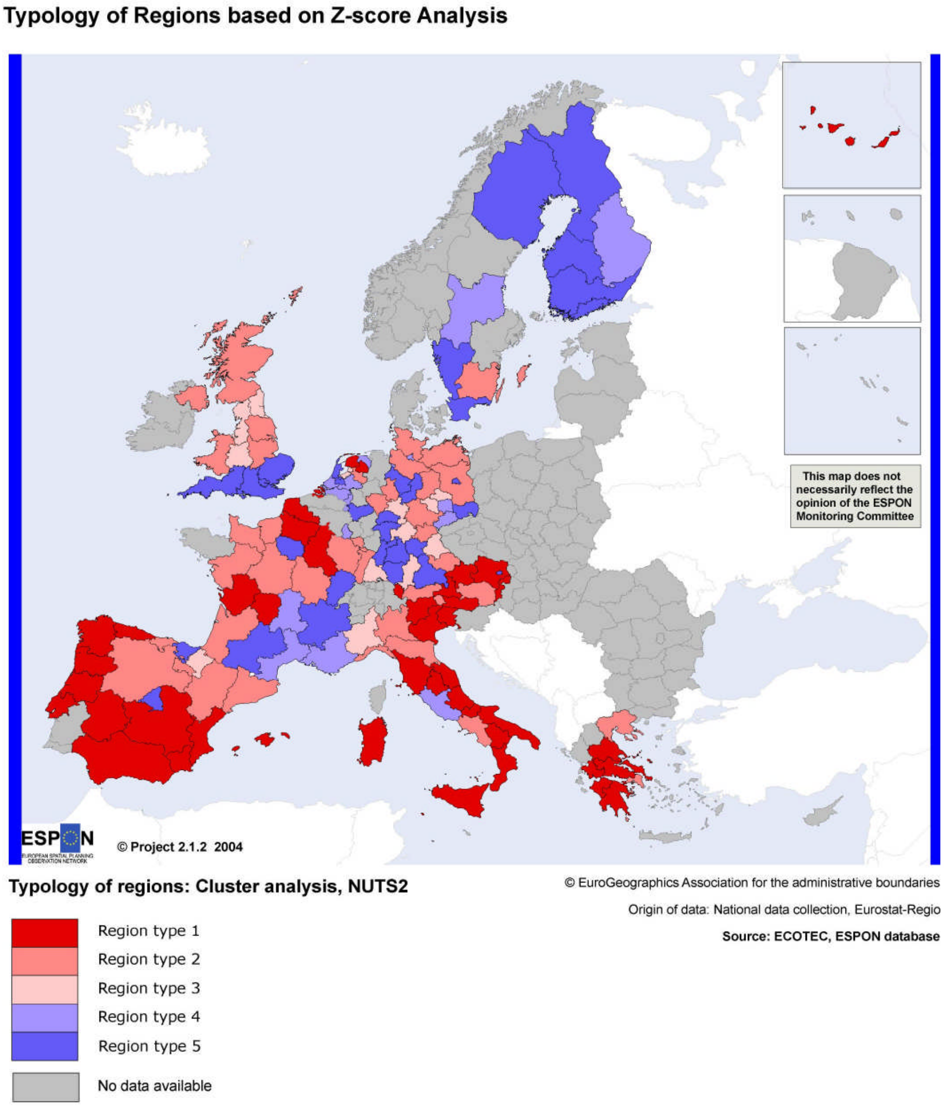
1.7 EU R&D Policy

1.7.1 Overall pattern of activity

The study has analysed the distribution of the two principal instruments of EU R&D policy: the Structural Funds and the RTD Framework Programmes.

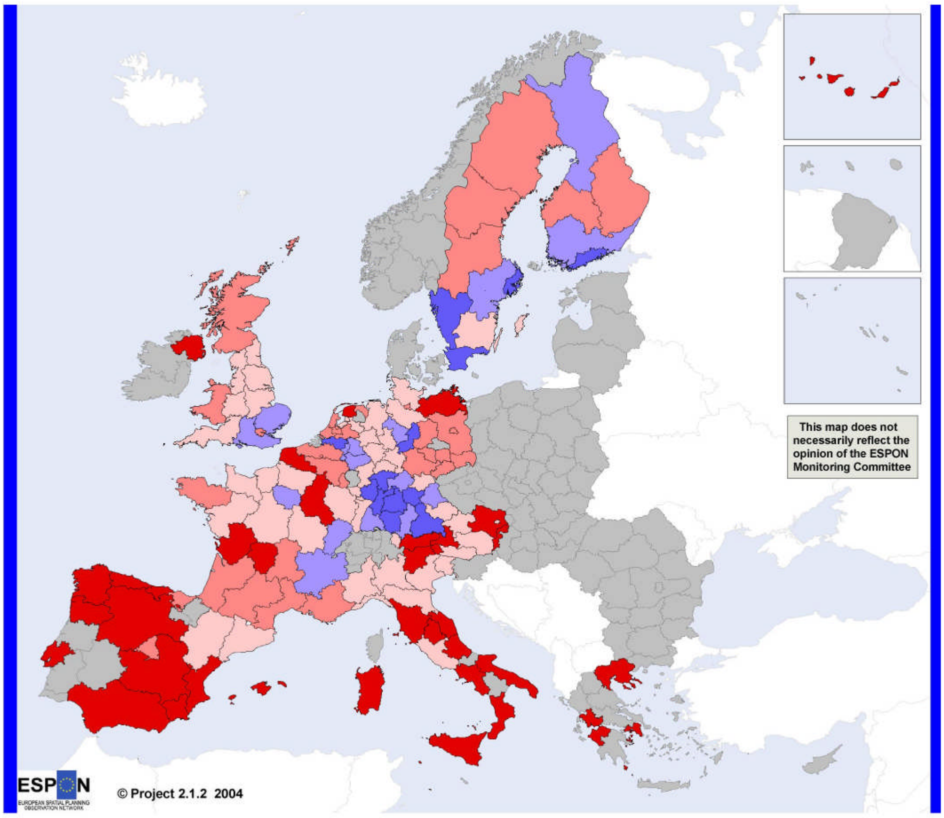
In terms of the Structural Funds, of the 243 programmes across the EU for which we have details, some €10 billion is planned to be spent on activities designed to stimulate R&D activity in the current programming period (Table ES1). The bulk of this expenditure (95%) is planned in the EU 15. This constitutes around 7% of all planned Structural Fund expenditure in these programmes, with programmes in the EU 15 allocating slightly higher proportions of their funds to R&D activities.

Map ES9: Typology of regions by Z-score analysis



Map ES10 Typology of regions: cluster analysis 1

Typology of Regions:Cluster Analysis 1



Typology of regions: Cluster analysis, NUTS2

- Region type 1
- Region type 2
- Region type 3
- Region type 4
- Region type 5
- No data available

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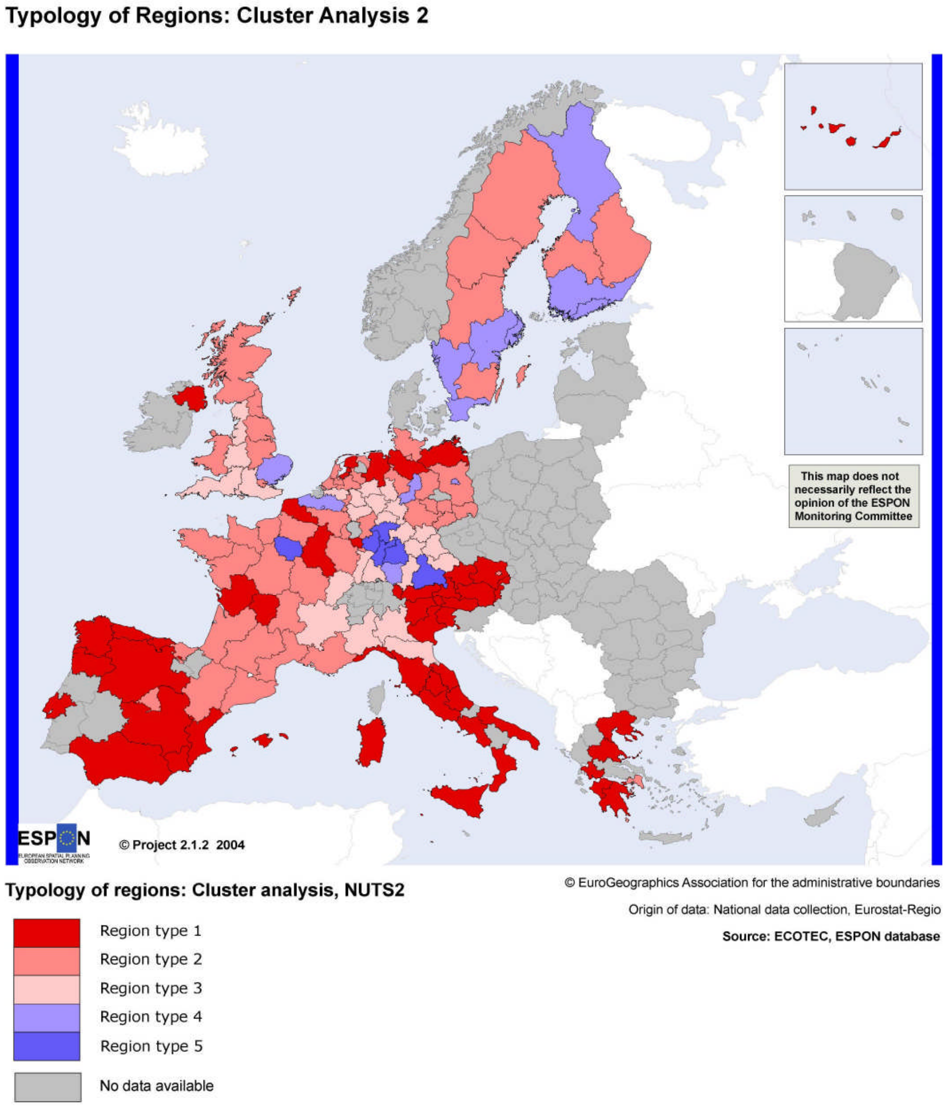
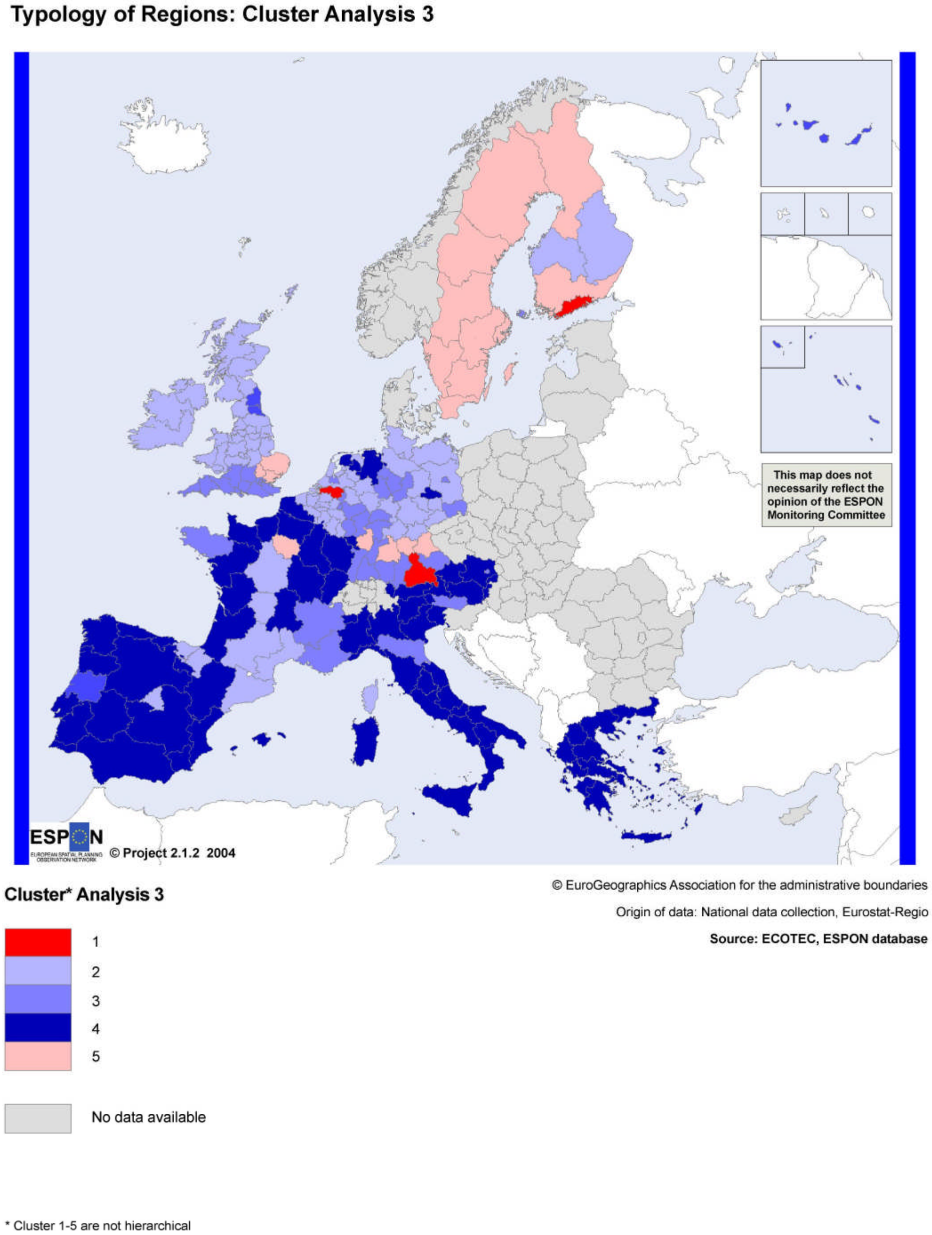
Origin of data: National data collection, Eurostat-Regio

Source: ECOTEC, ESPON database

Map ES11 Typology of regions: cluster analysis 2



Map ES12 Typology of regions: cluster analysis 3



Map ES13 European Innovation Scoreboard: RSII typology

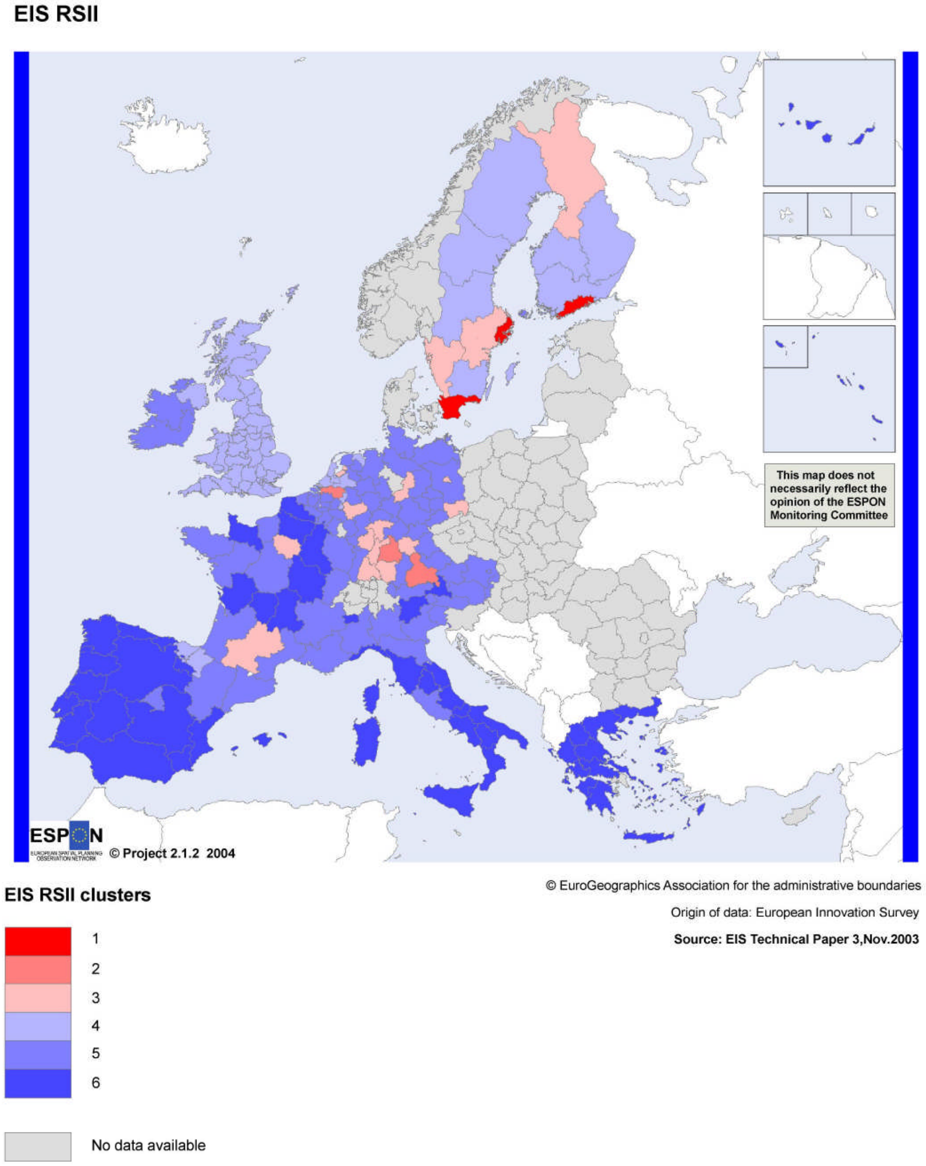


Table ES1 Structural Fund spending on R&D

	Planned spend on FOI 18	% of total planned SF spend	Actual spend on FOI 18 as % of total planned	Actual spend on all activities as % of total Structural Funds
EU 15	€9.5bn	7.7	44	47
NMS	€0.4bn*	6.5	0**	1**
Inter-regional programmes	€0.1bn	5.5	24	29

* NMS allocation spread over 3 years (2004-06) rather than 7 years as for EU15
**NMS records for actual expenditure very sparse. This is probably a significant underestimate of actual position.

By June 2005 programmes in the EU 15 had spent some 44% of all their planned expenditure on R&D activities for the period 2000-2006. This is only slightly behind the overall profile of expenditure in these programmes, which is currently standing at 47% (Table ES1). Spending on R&D activities in the inter-regional programmes, whilst significantly lower than in the EU15, is also broadly keeping pace with the pattern of overall spend. The situation in the NMS is more difficult to assess. The records provided by DG Regional Policy suggest that actual expenditure on R&D was just 0.05% of planned expenditure by June 2005. However, there are very significant gaps in the data record suggesting that this may be a product of limited returns.

In terms of the broad spatial distribution of planned expenditure across the EU there are no significant patterns apparent (Map ES14). The weakest levels of expenditure are planned in Greece, the Netherlands, northern France and central Italy. It seems that outside of the south-eastern Mediterranean area peripheral regions attach a stronger importance to R&D expenditure, with strong levels of expenditure planned in the Iberian peninsular. There are also strong plans present across Germany.

When looked at as a proportion of overall programme values (Map ES15) the picture weakens slightly, although the overall picture remains much the same. Regions in Spain and Germany both dedicate a higher proportion of programme funds to R&D activities, whilst regions in Greece are in general providing lower proportions of programme funds for these actions. The picture in southern Italy is mixed.

Maps ES16 and ES17 show the total number of project participants in the Fourth and Fifth Framework Programmes respectively (both Primary and Subsidiary contractors) across the EU-27, Norway and Switzerland, weighted by population (total project participations per million population). Participation levels in the New Member States and Accession Countries are lower and a number of other clear patterns are visible:

Strong 'islands' of activity are visible in the Iberian peninsular; north west France and central Europe.
There is a relatively strong 'cross' of regions focused on the north of Italy extending north south from the Benelux countries to Rome and east west from Slovenia through to north east Spain.
Ireland, the UK, Sweden and Finland demonstrate general strengths but in the case of the UK and Sweden pockets of weak participation can be identified

1.8 Fit with cohesion objectives

The bulk of R&D activity is planned to take place in regions which are eligible for support under Objective 1 of the Structural Funds. A total of €7.12bn[I] is intended to be invested in R&D activities by the Structural Funds through Objective 1 programmes, this constitutes around 7.04% of allocated programme funds. The proportion of Structural Funds allocated to R&D activities in Objective 2 programmes is higher, at 10.72%, although the overall amounts are naturally less, at €2.38bn[II]. The importance attached to R&D actions in Objective 1 regions is also rising. Overall, Objective 1 programmes have increased the amounts allocated to R&D activities by almost 10% since the programmes were agreed, nearly double the 5.5% increase in total programme allocations in the same period. Objective 2 programmes on the other hand have only increased their allocations by around 2.5%, somewhat lower than the total programme increase of 3.7%.

In examining the spatial pattern of activity (Map ES18) the strongest levels of actual expenditure are visible across Spain and northern Portugal; south west France, the UK, Ireland and Germany. In contrast, the weaker position of Italy and Greece is clearly apparent from the figures available. When looked at in terms of actual expenditure as a proportion of planned expenditure (Map ES19) a similar picture emerges, although parts of the UK and Germany appear to be committing a smaller proportion of funds than the absolute analysis suggested.

Quantitative data on different types activity in the Structural Funds is recorded through the use of Field of Intervention codes. In the case of R&D the broad FOI code is number 18, with four sub-categories (181, 182, 183 and 184). These relate to:

[I] Based on 69 programmes
[II] Based on 81 programmes

181 Research projects based in universities and research institutes
182 Innovation and technology transfers, establishment of networks and partnerships between businesses and/or research institutes
183 RTDI Infrastructure
184 Training for researchers

Planned expenditure levels are set out in Table ES2 below. Across the EU-15 support for the development of networks (FOI 182) has the most planned expenditure dedicated to it. This is a feature of the number of programmes planning activity in this area. Looking at the average spend per programme shows that, relatively, support for the promotion of research funds receives more attention. The pattern is reinforced when we turn to actual expenditure levels, on average expenditure has been strongest under FOI 181 reflecting the planned expenditure balance. Note that as more than one FOI can be undertaken in each programme, the averages will not sum.

Table ES2 Levels of planned expenditure by R&D Field of Intervention

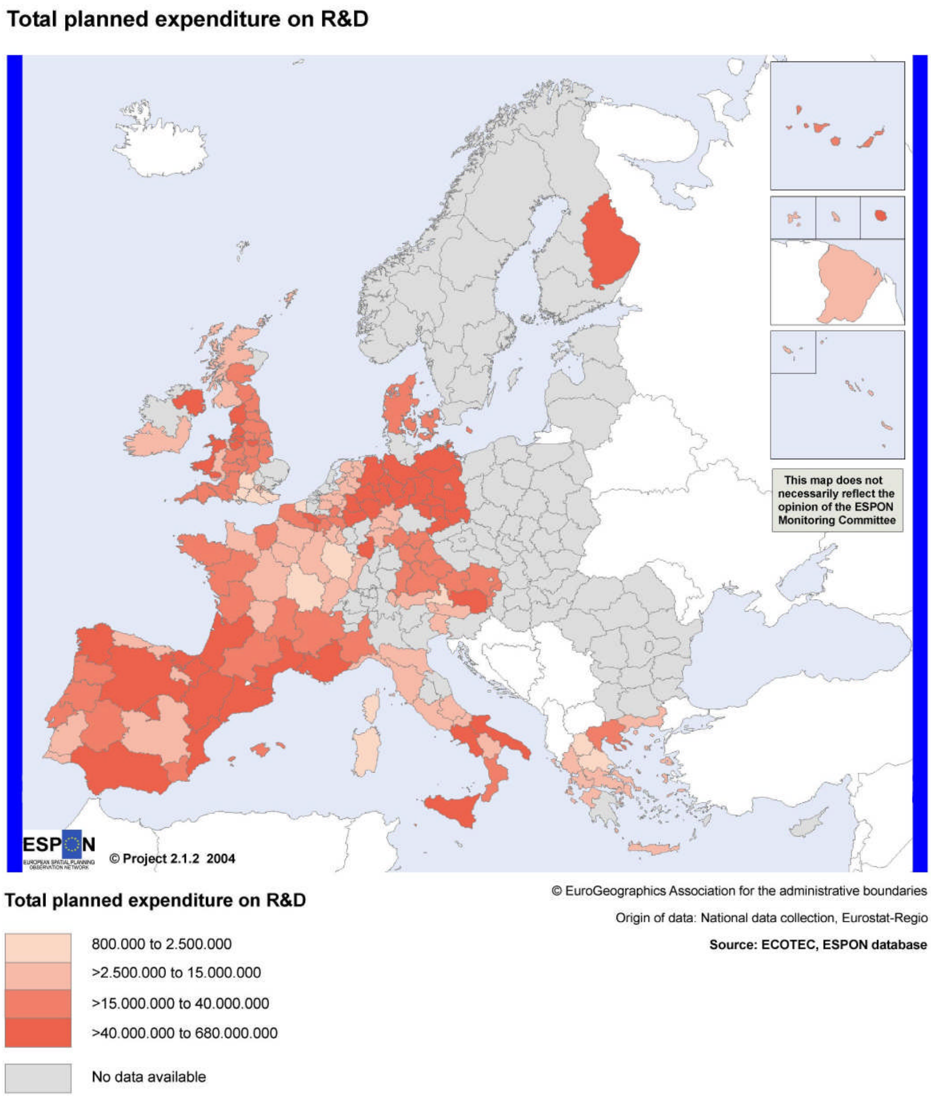
FOI	Planned expenditure 2005 (€)	No. of programmes	Average planned spend per programme (€)	Average actual spend per programme (€)
18	783,753,082	29	27,025,968	12,846,655
181	2,519,308,471	75	33,590,780	16,261,627
182	3,421,138,271	130	26,316,448	10,329,827
183	2,447,717,374	93	26,319,542	11,226,129
184	330,580,467	9	36,731,163	20,620,229
Total	9,502,497,665	150	63,349,984	27,764,431

In assessing the contribution of the Framework Programmes to the EU's cohesion objectives we have taken into account participation levels in the Framework Programmes allowing for GDP and R&D expenditure. Given that the less-favoured regions of the EU tend to have lower values for both the aim of the analysis is to see to what extent the Framework Programmes provide opportunities for organizations based in these areas.

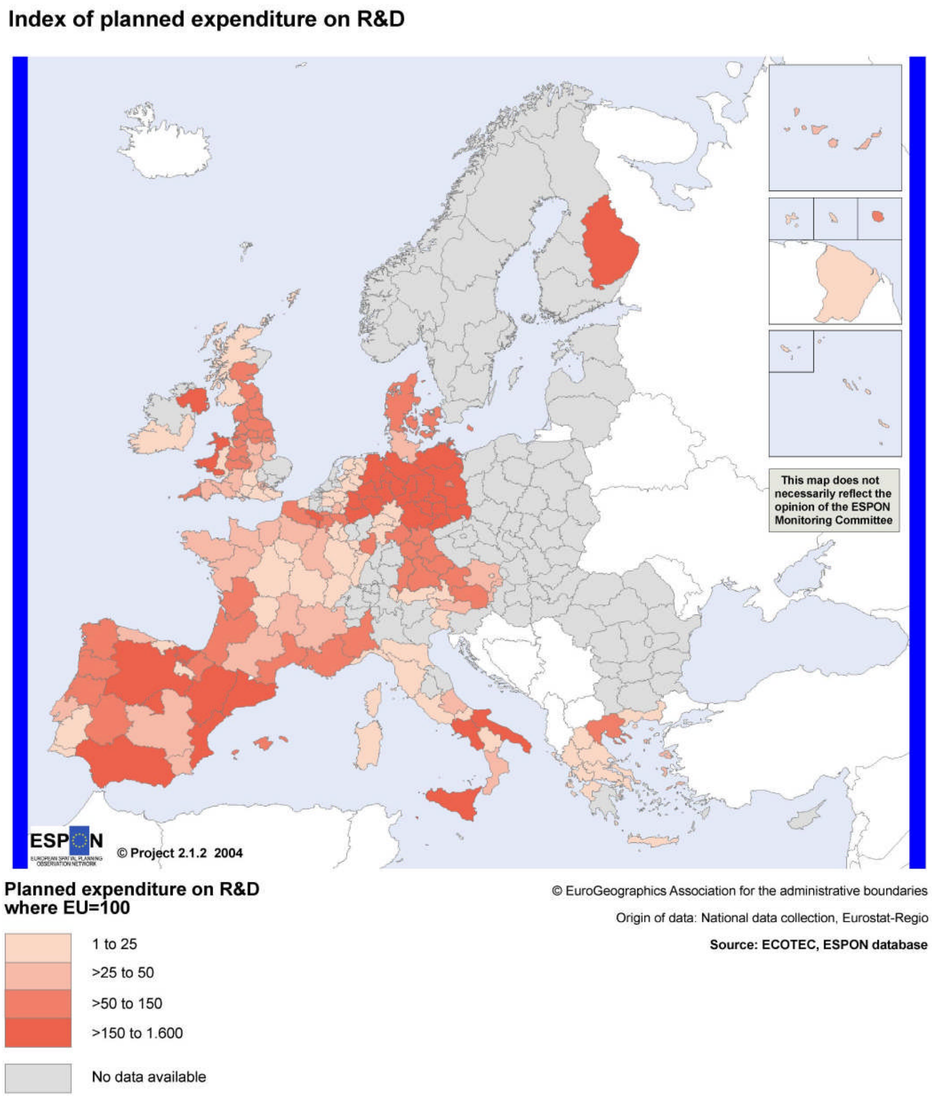
Examining the spatial distribution of Framework Programme participation, once GDP is taken into consideration (Map ES20 and ES21 for the 4th and 5th Framework programmes respectively) illustrates that many regions that were previously not seen to be strong beneficiaries under the Framework Programmes (based on the number of participations relative to population) now appear more strongly. In particular, as well as strong points in the UK and the Benelux, it is worth noting the strong 'islands' apparent in Spain and

Greece as well as some of the New Member States. Although substantial swathes of the European territory do not have high levels of participation in the Framework Programmes, even in these areas strong patterns are evident. In particular, the areas of stronger performance in Portugal and the crescent stretching around southern France and into central Italy are worth mentioning. The stronger relative performance of the EU's peripheral regions is further apparent when we allow for R&D expenditure. Although there are data limitations for this analysis it demonstrates that the regions with the greatest number of projects per million euros of total expenditure on R&D (GERD) are predominantly located in the Member States on the periphery of the EU. In contrast, (Maps ES22 and ES23) regions which have the lowest levels, relatively, of participation are now predominantly located in Germany and France.

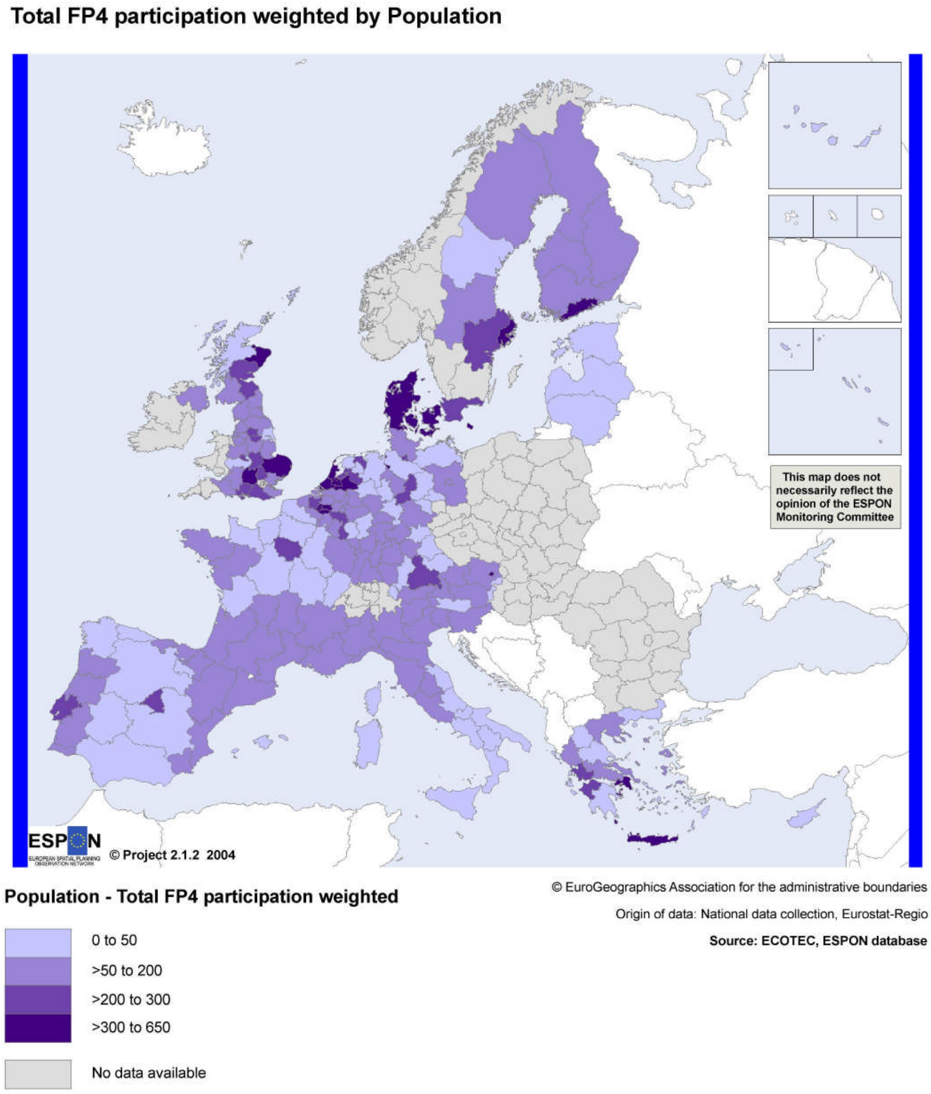
Map ES14 Planned spending on R&D by Objective 1 and 2 programmes



Map ES15 Planned spending on R&D as a proportion of Structural Fund programme values

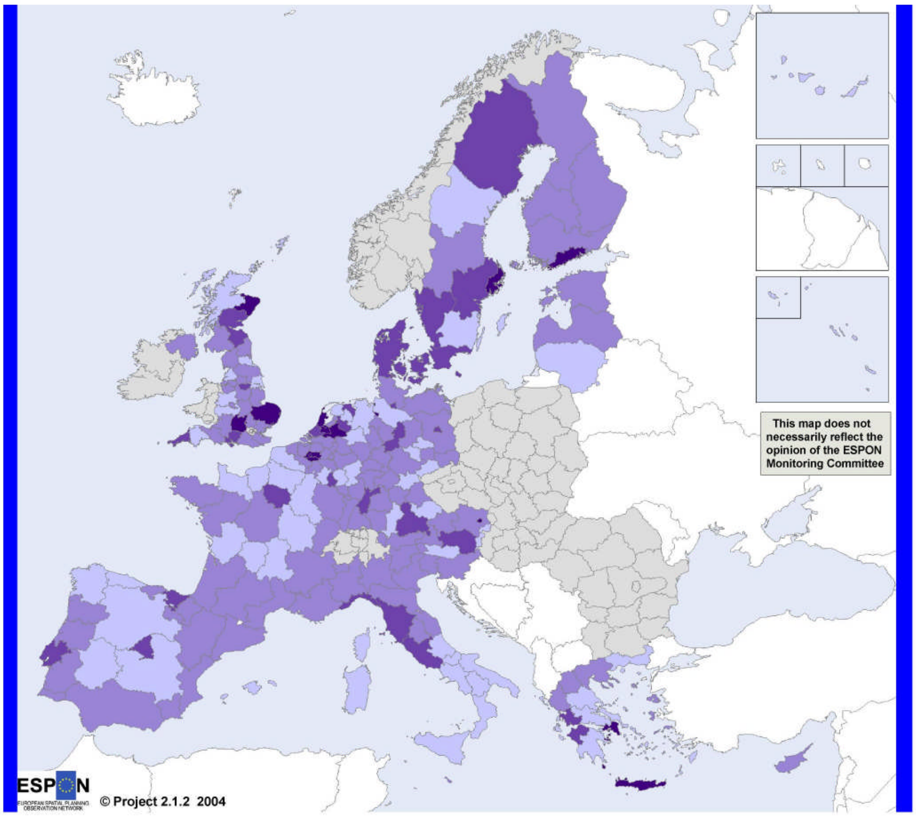


Map ES16 Number of FP 4 projects per million population



Map ES17 Number of FP 5 projects per million population

Total FP5 participation weighted by Population



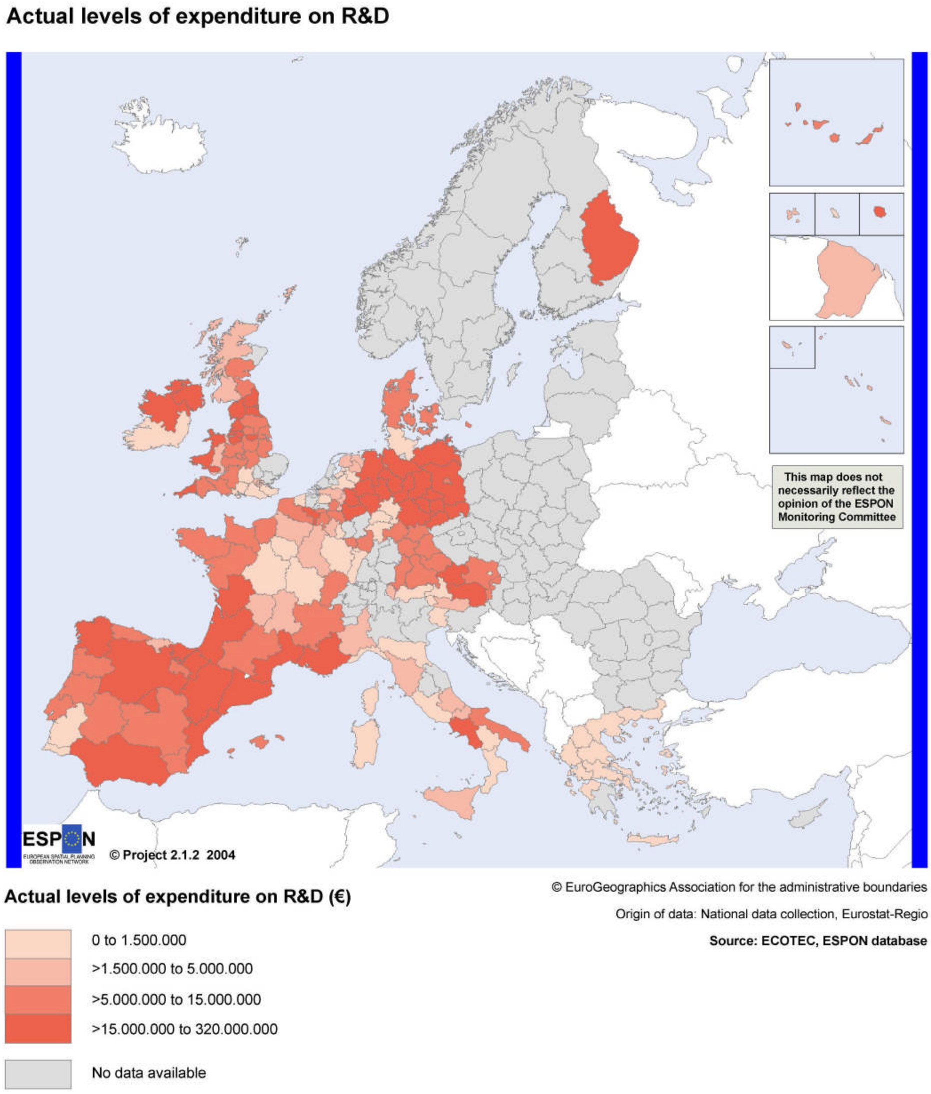
Population - Total FP5 participation weighted

- 0 to 50
- >50 to 200
- >200 to 300
- >300 to 770
- No data available

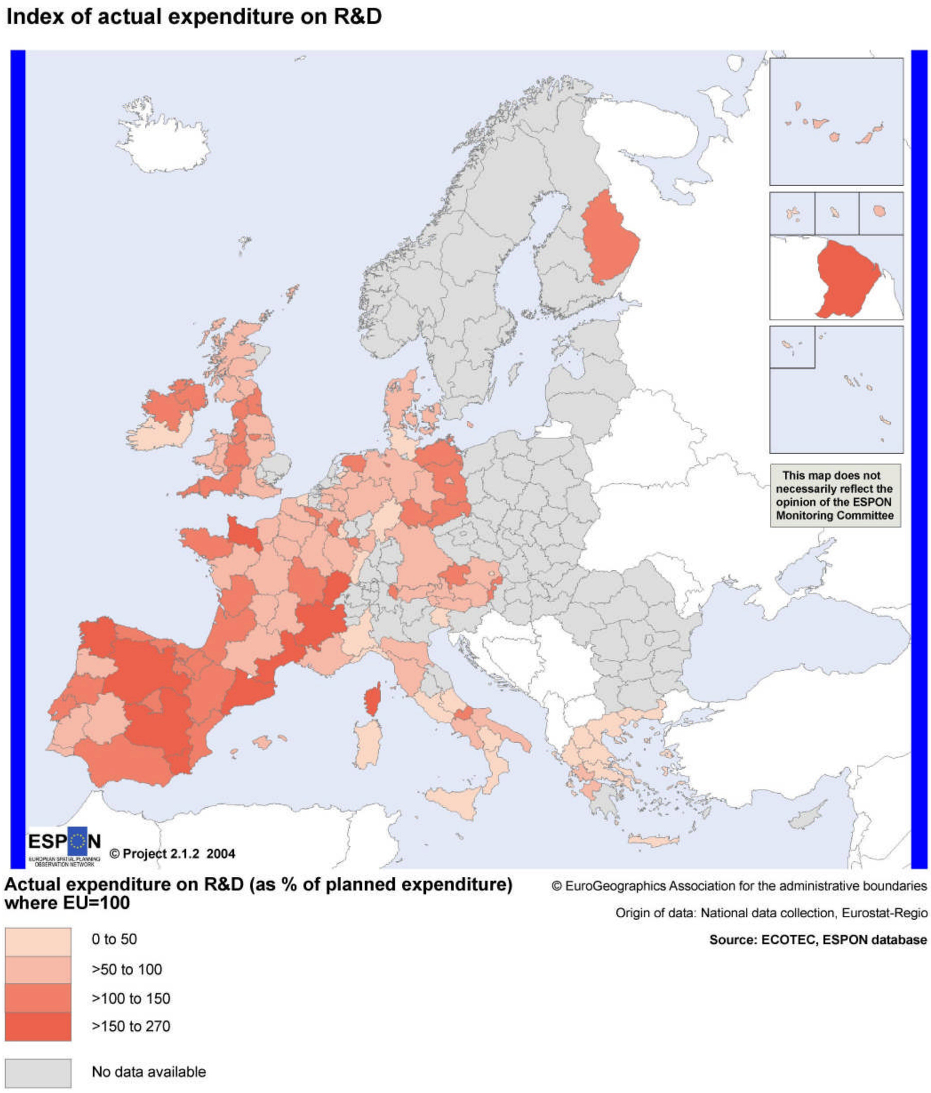
Origin of data: National data collection, Eurostat-Regio

Source: ECOTEC, ESPON database

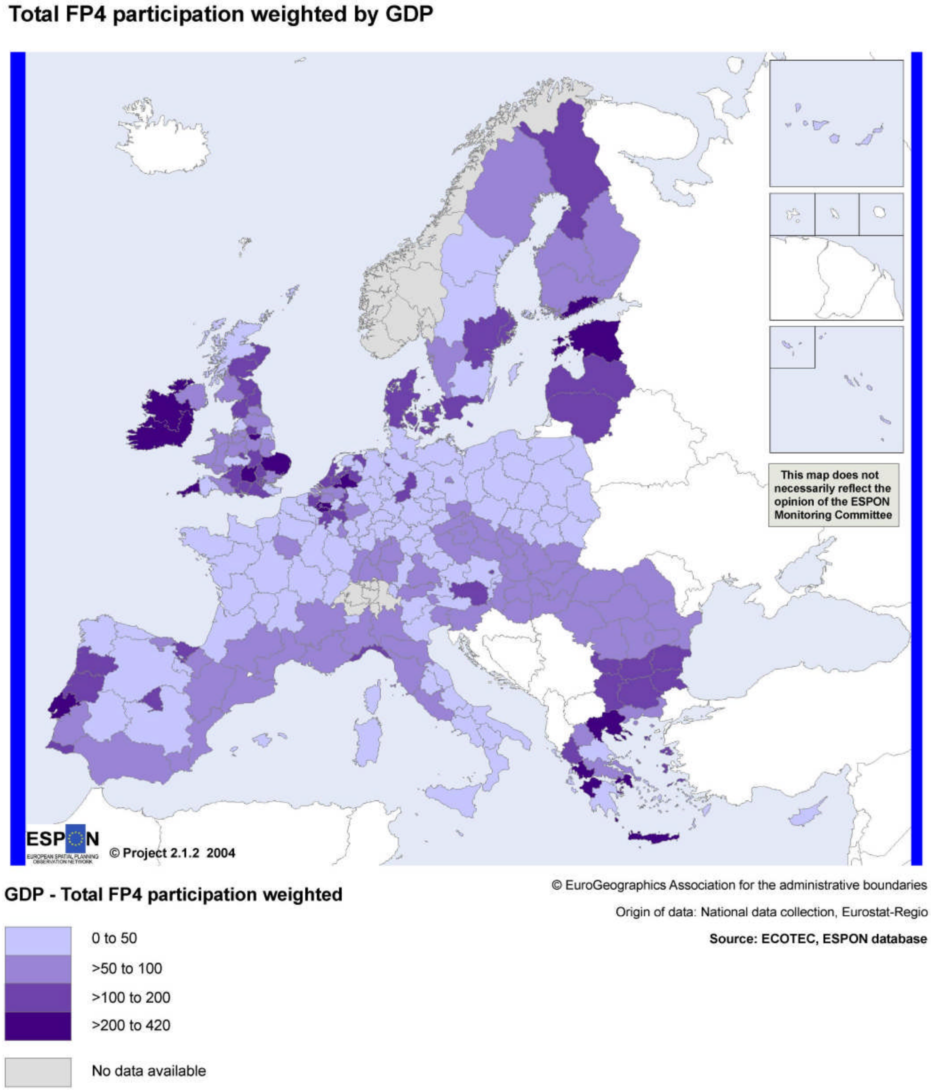
Map ES18 Actual levels of spend on R&D in Structural Fund programmes



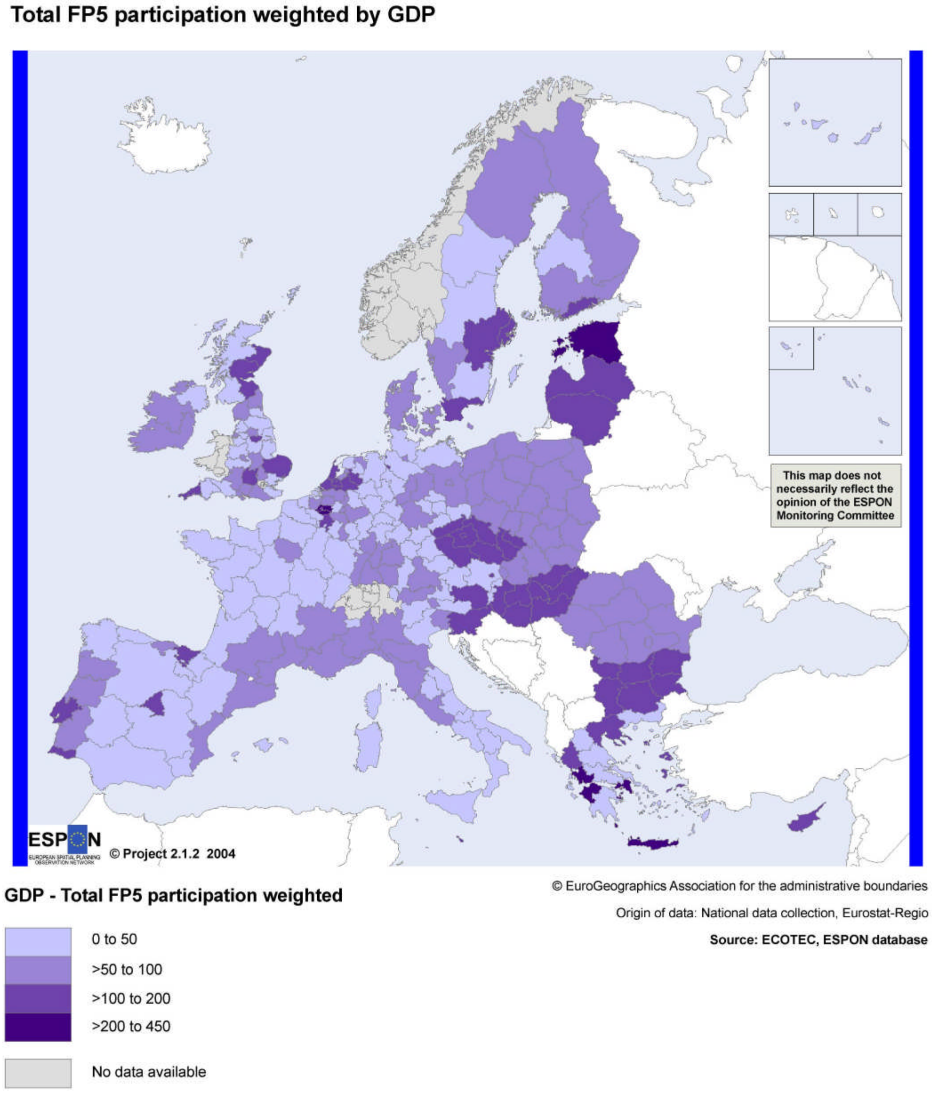
Map ES19 Actual levels of spend on R&D as a proportion of programme values



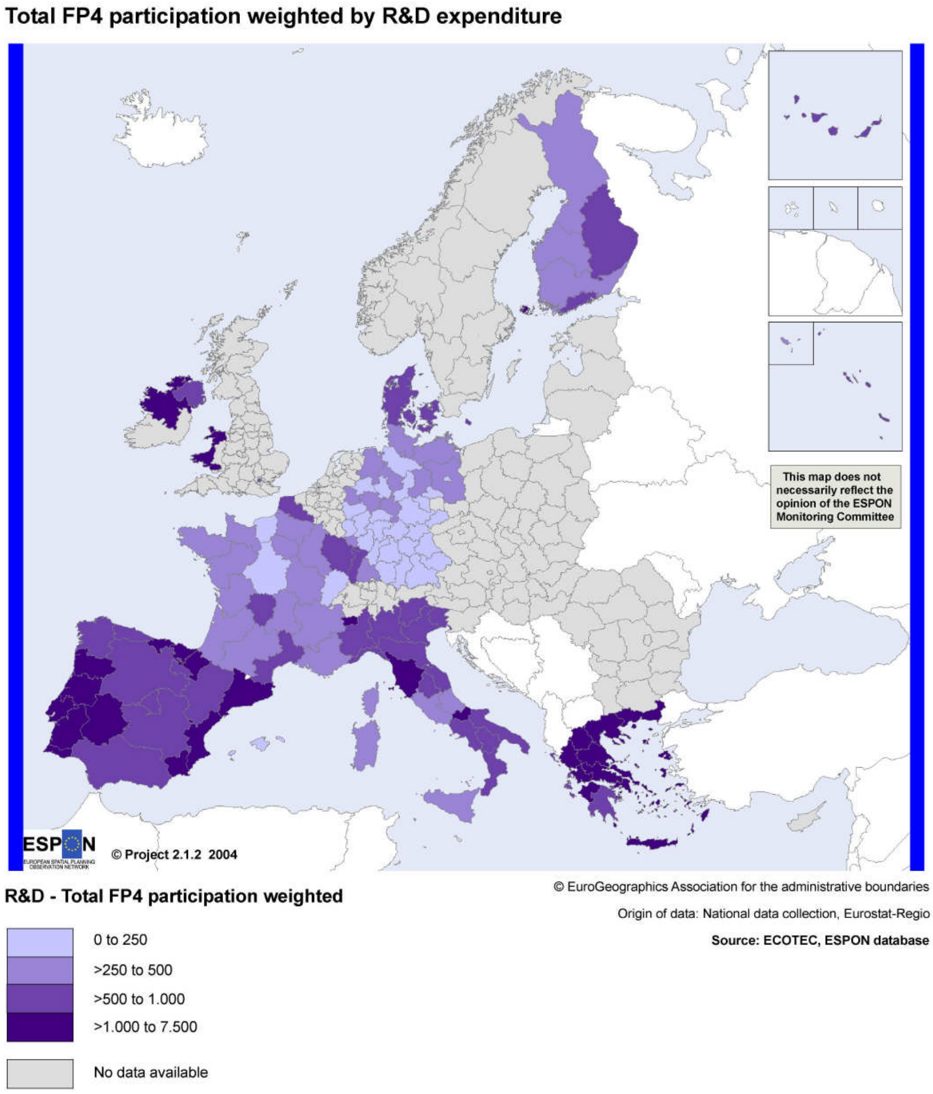
Map ES20 FP 4 participation allowing for GDP



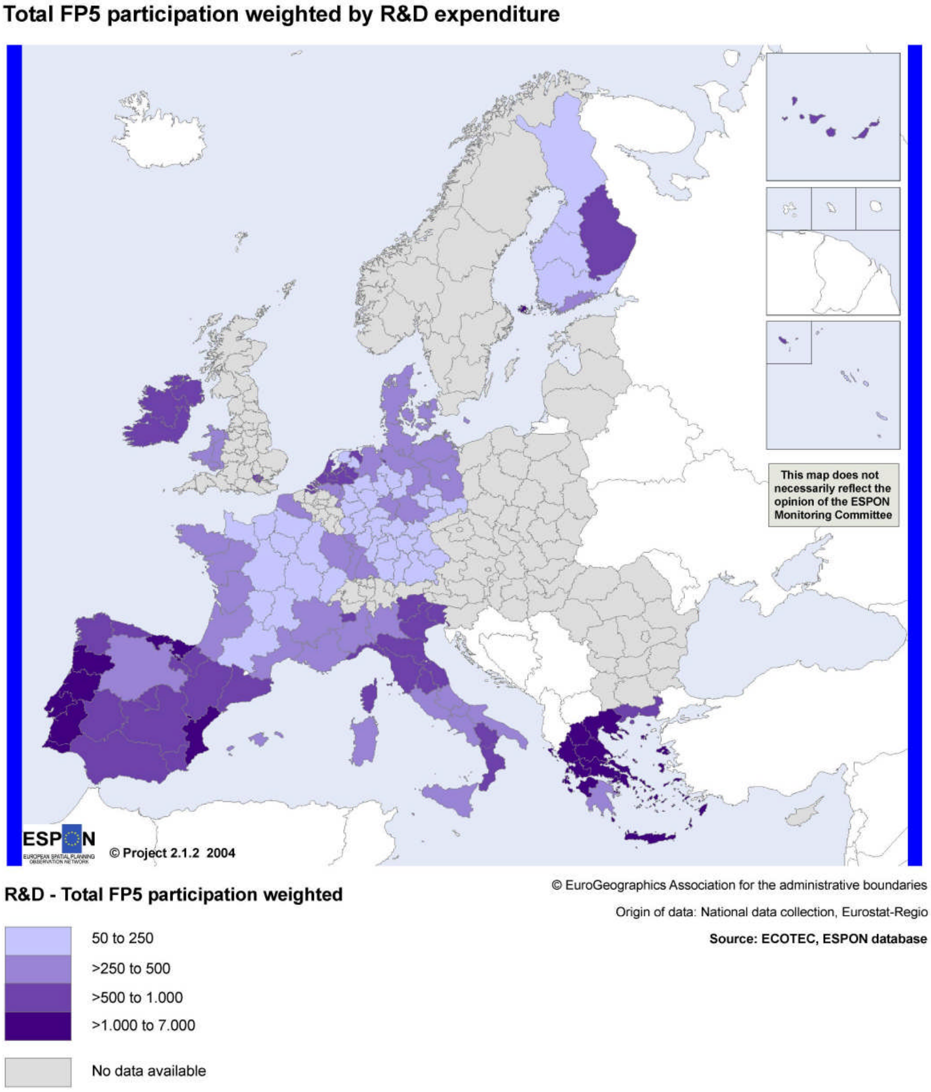
Map 21 FP 5 participation allowing for GDP



Map ES22 FP 4 participation allowing for R&D expenditure



Map ES23 FP5 participation allowing for R&D expenditure



On this basis the Framework Programmes do seem to be supporting project partners located outside of the 'core' of the EU and in regions with lower levels of R&D capacity (as traditionally measured). This lends weight to the suggestion that the Framework Programmes are, at least in principle, acting to support knowledge transfer and capacity building in Member States with lower levels of existing R&D inputs.

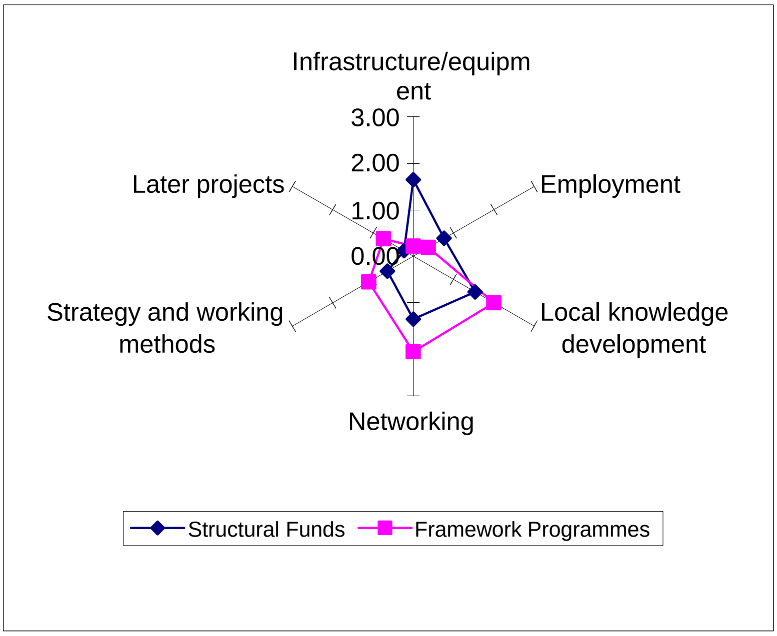
1.9 The territorial impacts of EU R&D policy

Taking the results of our case study analysis, we can identify 6 principal areas where EU R&D policies (both the Structural Funds and the Framework Programmes) are influencing the development of the EU's regions:

- Investment in Knowledge Infrastructure and Equipment
- Direct support for the knowledge base through investing in research and researchers
- Business support services encouraging the exchange of knowledge and promoting innovation
- Specific actions directly stimulating Technology Transfer and Networking
- The development of human capital
- Support for the development of the institutional dimension to R&D governance

The impacts of these activities are summarized in Figure ES1 below. The principal area where EU R&D policies are having a direct territorial impact is in the areas of networking and local knowledge development. This is a crucial contribution to the long term development of the EU's regions, given the value of acquiring and applying knowledge in economic development – as highlighted by academic literature.

Figure ES1 Territorial effects of EU R&D policies



One means by which EU R&D policy can have a wider territorial effect is though the existence of spillovers. The message emerging in this area from our case study work is mixed. At the one level there was a very clear belief that the benefits of the Framework Programme projects did not extend beyond the participating organisations, but other correspondents were more positive. In particular they highlighted the strong spillover effects that were present at the macro-scale identifying the flow of knowledge between regions in Europe facilitated by the Framework Programmes. As they argued, the Framework programmes result in high frequency knowledge networks with strong ties. The various projects foster ties between research institutions and firms, stimulating active innovation networks. These are, it is argued, leading to new working practices, greater communication and enhanced levels of trust – all fundamental attributes for enhancing levels of innovation. The potential of the Structural Funds to establish and facilitate intra-regional linkages, connecting the region to the high-level knowledge networks of the Framework Programmes has been clearly identified in the case study work, with some strong examples of activity here. This is one area where there is a strong added value to complementary actions between the Structural Funds and the Framework Programmes and the potential for a more widespread approach here is apparent.

Another area where there is a clear potential for direct linkages to be established between the Structural Funds and the Framework programmes is in the financing of research projects. The evidence regarding use of the existing facility to part co-finance Framework Programme projects in regions eligible for Objective 1 through the Structural Funds is particularly sparse. Intuitively the facility appears to be a valuable instrument and the lack of such a facility would appear to enable certain perverse effects. The facility not only recognises that partners in Objective 1 regions may find it difficult to raise the 50% co-finance required for shared cost projects under the Framework Programmes but it also 'levels the playing field'. In the absence of this facility researchers may be tempted to simply seek research funds directly from the Structural Fund owing to the higher rate of grant available. Not only might this lead to the duplication of research efforts across the Union but it will also reduce the connections of these researchers to European knowledge networks, as provided by Framework Programme projects. This will serve to reduce the overall benefits potentially available to the regional economy.

1.10 Spatial effects

The ESDP sets out a number of policy objectives for EU R&D policies. We briefly consider the contribution of EU R&D policies to these before turning to an assessment of the contribution of EU R&D policies to the three-level spatial classification adopted by ESPON (macro, meso and micro-scales).

Overall, EU R&D policies are supportive of EU-wide spatial objectives, as set out in the ESDP. There is good evidence emerging from our case study work that programmes such as the RIS and RITTS innovative actions have stimulated the development of R&D orientations in spatial development policies and of EU R&D policies being integrated into spatial plans that have not been instigated by EU R&D policies. Another significant success of EU R&D policies has been to stimulate networking amongst companies and other regional institutions engaged in promoting innovation. The Structural Funds have been used on many occasions to establish research and innovation centres as well as to promote co-operation between higher education and applied research bodies and the private sector, whilst the Framework Programmes have also been instrumental in promoting such co-operative arrangements. Such actions are taking place in both economically strong and weak areas, although there is evidence that the relative impact is greater in economically weak areas. We are unable to come to a firm conclusion as to the effect of EU R&D policy on the expansion of the strategic role of major metropolitan regions and 'gateway' cities, especially in the peripheral regions of the EU. There is certainly anecdotal evidence that this is occurring in some parts of the EU. However, there is also evidence that EU R&D policies are being used to seek to counteract the expanding role of some major metropolitan areas. This provides something of a conundrum for policy makers and is an area where additional research would be valuable.

EU R&D policies have had substantial success in facilitating many Objective 1 regions to take part effectively in collaborative research projects and to develop their S&T resources. There is evidence for these positive longer-term effects from both actions undertaken through the Structural Funds and for those undertaken through the Framework Programmes. The same finding applies to the final EU-wide spatial objective of the ESDP. EU R&D policies are helping to broaden the technological absorption and creative capacity of many Objective 1 regions. It is through the successes of these policies that Objective 1 regions are more able to effectively participate in collaborative research projects.

Turning to the three-level analysis we can see very strong territorial impacts at the macro-level and at the micro-level. Effects at the meso-level are less strong.

At the macro-scale there is evidence that EU R&D policy is supporting the development of regions outside of the traditional core of the EU (the so-called 'Pentagon'). The largest levels of Structural Fund expenditure on R&D activity are to be found in regions surrounding the core, particularly in the south west of Europe and the Eastern Lander of Germany: a picture that is reinforced by patterns of actual expenditure. Relatively strong levels of planned, and actual, expenditure are also visible in the western periphery of the EU. In contrast, levels of planned and actual expenditure on R&D through the Structural Funds in the south eastern periphery of the EU appear relatively low.

The distribution of Framework Programme activity across the EU highlights the principal role of a scattering of regions. Some of these leading regions are located in the core of the EU and others are to be found in the northern periphery. Below this small number of leading regions is a large number of regions which record significant levels of participation in the Framework Programmes. These are broadly distributed across the EU with localised strengths apparent in most Member States, particularly (but not exclusively) around capital cities – where concentrations of research infrastructure are to be found. The strength of the support by the Framework Programmes to capital city regions and Ireland is more apparent when levels of GDP and – in a limited analysis – R&D expenditures are taken into consideration. In taking these variables into account the relative strength of Framework Programme support to regions in the northern periphery and the south eastern periphery of the EU is also apparent.

The effects of EU R&D policies are most strongly visible at the micro-scale. Within individual regions the Structural Funds are having important effects on supporting the development of research and innovation capacity. The Framework Programmes are also making a valuable contribution to the development of the knowledge and capacity of individual organisations within regions and, in some cases, this is also leading to wider spillover effects. Taken together these policy instruments are making an important contribution to the pursuit of territorial cohesion in the area of R&D and are supporting the practical development of a widely-spread European Research Area in practice.

In the best cases the EU's R&D policies are:

- Strengthening regional knowledge infrastructures – most particularly through investments by the Structural Funds in the development of research facilities, science parks and other facilities.
- Strengthening human resources for research and innovation in regions. This is a particular strength of the Framework Programmes and is more than just about the provision of training, it is also about 'learning-by-doing'.
- Strengthening the access to knowledge of companies and research bodies within regions. They are doing so through supporting the development of collaborative working arrangements as well as through dissemination and knowledge exchange networks. The value of an outward-looking culture – as emphasised in the case of Ireland – is an important factor here.
- Promoting new ways of working – the Framework Programmes were particularly identified as assisting in the introduction of new organisational strategies as a consequence of connections made with companies and other organisations located elsewhere in Europe.
- Influencing the importance attached to R&D strategies and the role of governance in facilitating the development of regional R&D capacity. Not only do EU R&D policies provide a means to stimulate research and innovation activity within a region where regional actors are active participants but they can also help to introduce new ideas and approaches from elsewhere.

There is though some evidence that within regions EU R&D policies can reinforce existing concentrations of activity and so potentially adversely affect spatial balance. The Framework Programmes are particularly prone to reinforcing existing clusters of activity. There are good examples in some regions of the Structural Funds working to 'spread' the benefits of these knowledge 'nodes' through promoting knowledge spillovers.

The meso-scale appears to be a much over-looked dimension to EU R&D policy. It has been described by the EPSON programme as representing disparities within Member States, however, it can equally be viewed as applying to trans-national regions in the EU. In our opinion this is closer to the ethos of the ESDP. The closest administrative representation of such areas are those of the INTERREG IIIB Community Initiative programme areas.

From the experience gained in the case study analysis it appears that national and regional policy perspectives have a strong bearing on the effectiveness of EU R&D policies at the meso-scale. In a number of regions EU R&D policies can be sent o be contributing to balancing the pattern of national R&D capacity, either because of a positive national policy effort in this direction or because of an increasing decentralisation of national policy making. Taking the alternative view of the meso-scale - whereby transnational working (such as through INTERREG IIIB programmes) is the measure - there is less evidence of significant policy actions supporting agreed spatial strategies for these areas. Whilst some 5% of INTERREG programme funds are available for R&D investments we have not found strong evidence of regions working closely together in this context within a common spatial strategy.

Looking at the direct effects of EU R&D policies as a whole (Table ES3 below) it would appear that their strongest functions are occurring at the regional (micro) and EU (macro) scale.

Table ES3 Spatial Effects of Different Elements of EU R&D Policy

	Macro-level	Meso-level	Micro-level
Infrastructure and equipment	*	*	***
Technological capacity	**	*	***
Networking	***	*	***
Human capital development	**		**
Employment			*
Governance and strategy			*

Source: Summary of case study analysis material

Note: The greater the number of “*”, the greater the effects felt at this level

Together these impacts are helping to achieve the EU's broader spatial objectives, particularly in stimulating the conditions for greater territorial cohesion. However, territorial cohesion is not the primary objective of EU R&D policies and EU R&D policies are currently achieving this in parallel with other objectives, principally the desire to make the EU the most competitive knowledge-based economy in the world by 2010 and the associated development of a European Research Area. Bringing these aims together is a crucial step for EU R&D policies.

1.11 Conclusions

The emerging picture of the EU's R&D geography is more complex than a simple core-periphery analysis would suggest. The evidence also suggests that the complexity will increase in the future rather than lessen as most of the strongest rates of growth in key indicators have been registered in peripheral regions. It is likely that enlargement of the Union will lead to a new emergent geography. Strong disparities do remain however and wider economic data suggests that the process of 'catch-up' of less-favoured regions is only weakly visible.

The complexity of the R&D picture across the EU suggests that some other means of grouping regions should be found. We have sought to combine the different indicators available to develop a typology of regions. Different statistical methods and different indicators naturally give different pictures of the EU territory. However, we have demonstrated that a cluster analysis using a broad set of readily available indicators can provide a valuable typology that might be used as a starting point for developing individual regional innovation strategies.

The spatial pattern of EU R&D policy expenditures are not evenly distributed. Whilst the Structural Funds broadly reflect the goals of territorial cohesion this is not universally the case, with the levels of expenditure planned, and occurring, in Greece for example being below the EU average. A stronger focus on strengthening R&D activity through the Structural Funds is visible in south-western Europe (particularly Spain, much of Portugal and the south west of France), the UK, Ireland and Germany.

On first sight the distribution of projects funded by the Framework Programmes appears to counteract territorial cohesion objectives, as economically stronger regions tend to have a larger number of firms and research organisations engaged in Framework Programme activities. However, closer analysis demonstrates that when economic strength is controlled for, and more particularly levels of R&D expenditure, many less favoured regions benefit disproportionately from the Framework Programmes.

EU R&D policies are demonstrably impacting on the spatial geography of R&D across the EU in a number of ways. Chief amongst these are the effects of making connections between firms and research bodies across the EU and the strengthening of the capacity of individual regions to participate in research and innovation activities.

The successes of EU R&D policies in stimulating the regional potential for research and innovation have included:

- The development of appropriate knowledge infrastructures
- Supporting the development of human resources
- Providing finance for R&D activities, and
- Stimulating the development of 'knowledge' networks and partnerships

From these successes it is hoped that employment and productivity gains will flow over the longer-term. Whilst some short-term impacts are already visible in this direction their magnitude is limited at the current time. The true impact of EU R&D policies though should be measured in terms of building a European Research Area and strong successes are visible in this area.

At the EU level the Framework Programmes are having a significant influence on stimulating the development of a European Innovation System through promoting linkages between researchers and companies located across the Union. These networks are actively stimulating knowledge exchange and innovation within their membership, with positive effects reported in home regions. EU R&D policy is making a strong contribution to building both individual skills and experience and to 'raising the game' of individual companies and organisations. The potential that these transnational networks offer in terms of wider spillover effects within home regions is substantial. However, current evidence suggests that the effects of this are in practice more limited.

Within individual regions the Structural Funds are also having significant impacts in raising absorptive capacity. They are achieving this through investing in knowledge infrastructures, improving the institutional frameworks for R&D and innovation in regions and through stimulating intra-regional knowledge exchange by supporting the development of networks of firms and their linkages with research bodies, such as universities. The raising of absorptive capacity has demonstrably succeeded in increasing the ability of particular less-favoured regions to participate more fully in EU and national R&D policy actions and so helps to achieve the wider spatial objective of encouraging territorial cohesion.

The detailed picture is, however, complex and demonstrates the distance that we have to go. In the case of the Framework Programmes the 3rd Cohesion Report recognises that Cohesion Countries accounted for around 17% of project participations in the 15 months to March 2003, equivalent to their share of the EU population and up from 16% in 2001.

However, when the 3rd Cohesion Report turned to participation amongst all Objective 1 regions it found that half of all the projects were located in 8 of the 64 eligible regions.

We find that the Structural Funds and the Framework Programmes are symbiotic in their efforts to develop the European Research Area as a territorial concept. This is apparent at two – interconnected and interdependent - levels:
The widening of the European research space, and
The strengthening of regional R&D capacity

Without widening and deepening the European Research Area the EU is unlikely to achieve its goals as set out in the Lisbon strategy. Without strengthening the capacity of individual regions the EU will not be able to widen or deepen the European Research Area. But the EU cannot strengthen the absorptive capacity of individual regions without also stimulating leading-edge excellent research. Balancing these interlocking objectives must be at the heart of any effort to promote territorial cohesion.

The Framework Programmes are contributing in a significant manner to the widening of the European research space. Whilst there is a recognised concentration of R&D activity in the core of the EU and the northern periphery the Framework Programmes provide a mechanism for institutions and enterprises in less-favoured regions to participate in high-level European research projects. This is evidenced by the disproportionately higher participation of organisations based in less-favoured regions in Framework Programme projects, allowing for factors such as GDP and R&D expenditure.

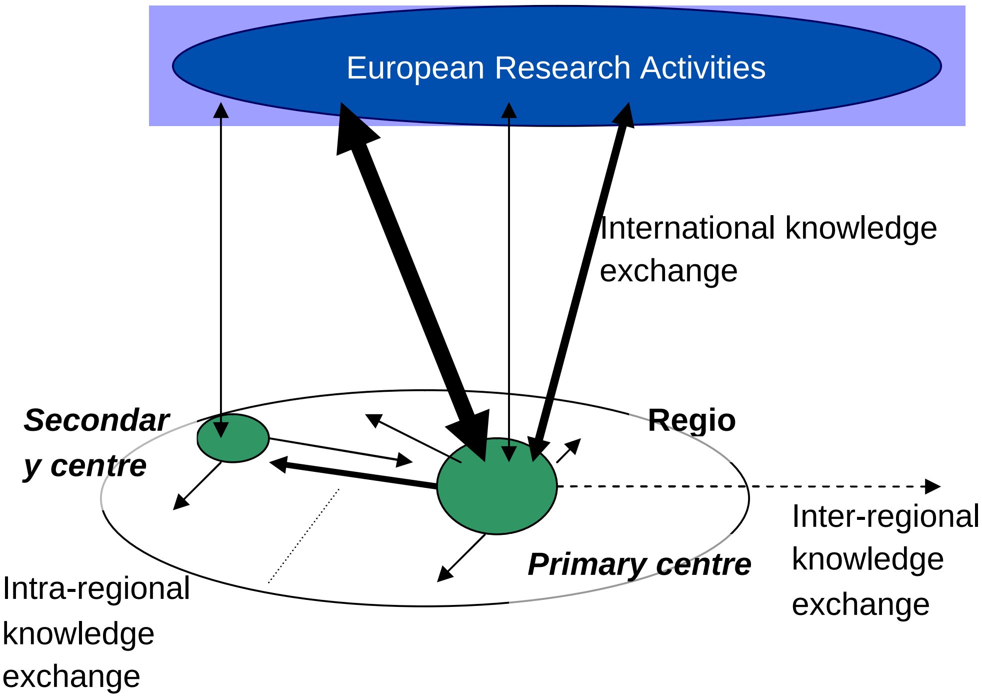
The Structural Funds make their own significant contribution to the widening of the European research space in that they provide a means by which regions are able to develop their capacity to participate in European-level research and innovation activities. Through stimulating the development of research and innovation capacity within less-favoured regions the Structural Funds are assisting firms and institutions within regions to take part in the Framework Programmes and so build their connections into the European Research Area in a very practical sense.

The second level at which this symbiosis can be seen is in the development of regional capacity for research and innovation. The important role of the Structural Funds in building this capacity has been well documented. Equally important is the role of the Framework Programmes in supporting projects that bring new knowledge and experience into a region so contributing to the building of future research and innovation capacity. In so far as the Framework Programmes are disproportionately benefiting less-favoured regions across the ERA then this will be having a positive impact on the development of the European research space.

However, we have noted that the benefits of Framework Programme participation are often highly concentrated within regions, and that the knowledge may be principally retained by the project participants themselves. Here again the Structural Funds can play an important role in developing the European research space through their actions to develop intra-regional networks and dissemination vehicles.

In essence we can view the combined effects of EU R&D policies in the following schematic manner:

Figure ES3:



Whilst the overall impact that EU R&D policies have had on the territorial balance of the European Innovation System is admittedly limited it would be wrong to underestimate the gains that have been made. EU R&D policies have contributed to the development of stronger innovation systems in a number of less-favoured regions where the innovation systems were previously weak. The spatial balance of EU R&D policies is also supportive of spatial objectives such as the promotion of territorial cohesion, although, this has to be balanced with what is sometimes seen as a competing objective of stimulating the competitiveness of the EU economy as a whole.

1.12 Key Policy Recommendations

We group our policy recommendations under three headings: those relating to the macro-scale of widening and deepening the European Research Area (developing the European research space); those related to the micro-scale of strengthening the research and innovation capacity of the EU's regions and those relating to the meso-scale of – potentially - strengthening identified trans-national research areas within the EU as a contribution to developing alternative Global Integration Zones. These are not separate objectives. They are deeply inter-connected and there is, naturally, some overlap in the recommendations for each scale owing to the symbiosis and inter-dependencies identified earlier.

1.13 Macro-scale - widening and deepening the European Research Area

The Framework Programmes should continue to focus on supporting the development of excellent research. They should continue to encourage firms and research organisations in less favoured regions to engage with these high-level research activities. These networks form conduits for knowledge exchange which boost the absorptive capacity of less-favoured regions. Together they form a functioning European Research Area. Care must be taken not to downgrade the quality of the research and innovation effort in pursuit of alternative objectives. This will not support the territorial development of the European Union in the long run.

The Structural Funds should continue to focus on strengthening the absorptive capacity of regions where this is currently underdeveloped. They should provide the means by which less-favoured regions are able to access the benefits of participating in the Framework Programmes over time. This might form one measure of regional success. This is a long-term effort and the multi-annual programmes of the EU provide a very positive framework in which this can occur.

The European Research Area will not realise its potential without a significant expansion in the level of business engagement in R&D activity. This is an accepted fact. We recommend that EU R&D policies should seek to encourage private sector participation in research and innovation activities. Constraints to engagement should be addressed and the capacity of regions with low levels of private sector activity particularly considered. The widening and deepening of the European Research Area will only occur once private sector engagement in research and innovation is more evenly distributed across the EU territory. There is a role here for both the Framework Programmes and the Structural Funds. Again this is a long-term aim, but one which must start immediately.

As a staging post towards securing the greater involvement of the private sector in R&D and innovation activities EU R&D policies should seek to energise the potential of Higher Education Institutions and public research and technology institutions within less-favoured regions. These can provide an important base for widening and deepening the European Research Area. We recommend that actions in this area are complemented by interventions to generate stronger knowledge spillovers from these actors.

One of the constraints to further widening and deepening the European Research Area is the concentration of high level research infrastructure in a limited number of regions. We recommend that EU R&D policies should continue to support the development of high-quality knowledge infrastructure across the Union. This is particularly relevant to the Structural Funds, which provide the means for this to occur.

We recommend that deeper studies are undertaken to establish the lessons that can be learnt from the different patterns of regional participation in different aspects of EU R&D policies. In particular we recommend further research in the case of Greece, Ireland and Spain. All demonstrate strong positive - but different - lessons in terms of the application of the Structural Funds or participation in the Framework Programmes.

1.14 Micro-scale - strengthening the research and innovation capacity of the EU's regions

As we have stressed the particular strengths of the Structural Funds and the Framework Programmes provide a solid base for building regional capacity in research and innovation. We recommend that these two strands of EU R&D policies maintain their focus on their individual and specific objectives within the overall context of developing the European Research Area.

That said, there is much to be said for harnessing the opportunities each offers and the advantages of this has been clearly demonstrated through the case study work for this study. We recommend that regional strategies seek to integrate all aspects of EU R&D policies in an explicit and complementary manner, working together to develop the absorptive capacity of the region.

At the regional level EU R&D policies should continue to:

- Seek to build the knowledge infrastructure of the region, in particular to use this as a means to access European knowledge networks rather than as an end in itself
- Seek to strengthen the knowledge and expertise available for research and innovation, in order that individuals can participate in European knowledge networks
- Seek to stimulate spillovers from high-level research actors, in order that participation in European knowledge networks brings benefits to the rest of the region and builds the capacity of others to then engage with European knowledge networks
- Seek to develop the ability of SMEs and large private enterprises to engage in research and innovation and to increase their levels of activity here

In seeking to spread good practice in strengthening regional innovation systems and building connections to the wider European innovation system the value of the work done by EU R&D policy in stimulating governance arrangements should be fully recognised. We recommend that EU R&D policies continue to support the strengthening of the governance arrangement for R&D policies within the regions of Europe. We recommend that one means of doing so would be to strengthen the mechanisms for the sharing of good practice between regions, in the same way as firms and research enterprises have benefited from knowledge exchange through pan-European networks.

We are clear in this study that there is scope for a stronger integration of EU Framework Programmes and Structural Fund actions on the ground, working alongside domestic policies. The mechanisms are available for this to occur, it is for the relevant authorities at a regional level to determine how best this can best be achieved. One area where the mechanism for stronger integration is in place but there has been little take up is the possibility of using Structural Funds monies, in areas eligible for support under Objective 1, to partly co-finance projects which are supported by the 6th Framework Programme. We recommend a short focused study aimed at identifying the level of take-up of the co-finance facility, the positive attributes that it offers, problems associated with it and the reasons for weak take-up should this be the case. We feel that this is the matter of some urgency as a priori there is a good case for such a co-finance arrangement in promoting the territorial dimension of the European Research Area.

1.15 Meso-scale - strengthening identified trans-national research areas within the EU

In the context of an enlarged European Union we recommend that greater attention is given to the challenges, and opportunities, that identified trans-national areas face. This is an area where the EU has an important competence that is currently underplayed.

On balance we see the strengthening of the research and innovation capacity of the meso-scale as the responsibility of the Structural Funds, in the same way as it is the Structural Funds that are best placed to strengthen the capacity of individual regions. The Framework Programmes are focused on supporting the excellence of European research, within that overall objective they are providing a valuable role in widening the European research space and bring knowledge and expertise into regions which might otherwise not have access to this. They can perform a similar role in terms of developing the meso-scale within the EU.

We recommend that the development of trans-national capacity in research and innovation is fully incorporated as an explicit objective in the reform of the Structural Funds. We recommend that this forms a key element of the proposed trans-national co-operation strand.

If strengthening the meso-scale is a desirable objective then the importance of the governance dimension cannot be stressed strongly enough. This is presently a missing dimension and actions on the ground will remain ad hoc and fragmented unless there is a shared strategic framework within which they can be set. This has been clearly demonstrated in the context of regional innovation systems and there is no reason to doubt that the same is not true at the trans-national level.

Widening and deepening of the European Research Area is dependent on the continuing development of high-level research infrastructures, as we have identified. We recommend that this is done within the context of trans-national strategies, such as those currently developed for INTERREG IIIB programme areas.

Associated with this should be actions to secure more trans-national co-operation and learning between regions in ways that encourage the complementary use of the different instruments of EU R&D policies to promote both the widening of the European research space and the on-going development of the European Research Area.

2.0 Scientific Summary

2.1 Concepts

The concepts developed in the study build upon work in the field of innovation systems, evolutionary economics and endogenous growth theory. Working within these boundaries the study starts from the perspective that innovation can promote economic growth, through the introduction of new products and by productivity increases arising from new production processes. Innovation is in turn positively influenced by the level of R&D in the economy and the extent to which the outputs of the research process are adopted commercially. The link between R&D and economic growth provides a rationale for public sector intervention.

Levels of R&D and innovation in an economy are influenced by the 'absorptive capacity' of the territory in question. Inter alia this can include the extent to which there is the physical infrastructure to undertake R&D; the level to which the skills exist to access and use available knowledge and to generate new knowledge, and the amount of resources available to finance research and innovation activities. The governance of the innovation system is a further dimension to the absorptive capacity of a region. Innovation depends upon complex interactions and iterations between players and the rules and institutions that influence these relationships can have a significant influence on the propensity of a region to successfully engage in research and innovation.

2.2 Methodologies

A variety of methodologies have been utilised within this study. Full details are set out in the Methodology Section of the report. Broadly the methodology adopted has been as follows:

- Literature review – drawing on desk based resources including internet based searches
- Analysis of R&D indicators – collection of data for agreed indicators from EUROSTAT, OECD, National Statistical Agencies and some ad hoc data sources. Mapping of indicator coverage, analysis of patterns of activity per indicator. Data analysed at the NUTS 2 scale wherever possible. Exceptions to this are identified in the analysis.
- Construction of regional R&D typologies – combination and mapping of indicators using z-score analysis and cluster analysis techniques. Typologies are constructed at the NUTS 2 scale in so far as this is possible with the available data

- EU R&D policy analysis – Locational analysis and mapping of distribution of EU R&D policy activities against identified criteria. Qualitative case study analysis of use, and territorial impacts, of EU R&D policy instruments in 21 regions. Analysis is undertaken at the NUTS 2 level for Framework Programme data and at the programme level for Structural Fund data.
- Development of a Territorial Impact Assessment Methodology – identification of a potential approach for assessing the territorial impact of EU R&D policies at the different scales.

2.3 Typologies

Two different approaches have been taken to the development of regional typologies within this study. One approach combines the results of a z-score analysis across five indicators into two composite indicators. The second approach makes use of clustering techniques (primarily analysis of the k-means) across a number of different indicators. Three combinations of indicators are reported on for this form of analysis. The indicators adopted for each approach are set out below.

Z-scores Analysis:

- R&D Scores composite– average of the Z scores for the indicators:
  - ► R&D expenditures as a percentage of regional GDP
  - ► R&D personnel as a percentage of the labour force or Employees with Tertiary level education working in a Science and Technology Occupation (HRSTC).

- Innovation scores composite – average of the Z scores for the indicators:
  - ► Employment in High Technology and Medium High Technology Manufacturing as a percentage of total employment (2000);
  - ► Employment in High Technology Services as a percentage of total employment (2000);
  - ► Percentage of the Working Age Population (aged 24-65) having successfully completed some form of tertiary education (2000).

Cluster Analysis 1

- Business R&D expenditures (BERD) as a percentage of GDP;
- Core human resources (HRSTC) as a percentage of total employment;

- Patent applications per million population;
- High-tech employment as a percentage of total employment.

Cluster Analysis 2

- Composite R&D indicator
- Business R&D expenditures (BERD) as a percentage of GDP;
- Core human resources (HRSTC) as a percentage of total employment;

Composite innovation indiator
Patent applications per million population;
High-tech employment as a percentage of total employment.

Cluster Analysis 3

- Gross expenditure on R&D (% GDP)
- HRSTC (% Labour Force)
- EPO patent applications (per million population)
- Employment in high and medium tech manufacturing (% workforce)
- Employment in high tech services (% workforce)
- Proportion of population aged 25-64 with tertiary education

In addition we report on a comparison of our Cluster Analysis 3 results with those developed by the European Innovation Scoreboard. The indicators used by the EIS are as follows:

- Public sector expenditure on R&D (% GDP)
- Private sector expenditure on R&D (% GDP)
- EPO patent applications (per million pop)
- High tech EPO patents (per million pop)
- Employment in high and medium tech manufacturing (% workforce)
- Employment in high tech services (% workforce)
- Proportion of population aged 25-64 with tertiary education
- Proportion of population aged 25-64 engaged in lifelong learning
- Sales of new-to-firm products*
- Innovative manufacturing enterprises*
- Innovative services enterprises*

- Innovation expenditure by manufacturing sector*
- Innovation expenditure by service sector*

(where indicators marked * are estimated using CIS 2 estimates (1994-96))

2.4 Indicators

The indicators used in the study are as follows:

2.4.1 Expenditure on R&D as a percentage of GDP ('R&D Intensity')

The basic measure for R&D expenditure is the "intramural expenditures", which are all expenditures for R&D performed within a statistical unit or sector of the economy, whatever the source of funds (Frascati Manual, § 335). R&D expenditure is produced separately for the Business Enterprise Sector (BES), the Higher Education Sector (HES), the Government Sector (GOV) and the Private non-profit sector (PNP).R&D expenditures as a percentage of regional GDP (in millions of national currencies, in millions of euro, and as a percentage of gross domestic product). Data has been collected for the whole economy (GERD), for the business enterprise sector (BES), government sector (GOV), higher education sector (HES), and private non-profit sector (PNP). Data source: EUROSTAT with additional material sources from National Statistical offices.

Patent Applications and High Tech Patent Applications to the European Patent Office (EPO)

The number of applications to the EPO based on region of registered address (total number of applications, number of applications per million people in population, and number of applications per million people in the labour force) for the whole economy.

The number of patents per business R&D expenditure (BERD) shows a substantial variation between EU countries (where Sweden, the Netherlands and Germany score most highly), and even more so between regions. The sectoral composition of industry strongly influences such rankings, with regions with high levels of activity in machinery, chemicals, communications equipment, and electrical components more likely to score highly in numbers of patents. The results are also influenced by the headquarters location of a firm, as this often determines the location recorded for the patent. Without taking into account the detailed specialisation patterns of regions, it is not possible to fully interpret the data available (for more on this please see "Benchmarking S&T Productivity", EC 2002).

Data source: EUROSTAT with additional material sources from National Statistical offices.

2.4.2 R&D personnel as a percentage of the labour force

R&D personnel data measure the amount of resources going directly into R&D activities. This includes all persons employed directly in R&D plus persons supplying direct services to R&D, such as managers, administrative staff and office staff (Frascati Manual § 279). R&D personnel data is collected in Headcount (total number of persons who are mainly or partially employed on R&D) and Full Time Equivalent (FTE). Not all countries collect R&D personnel by headcount.

For the EU-15, this indicator is calculated on the basis of R&D personnel measured in headcount (the total number of people actually employed). As comparable data for R&D personnel measured in headcount are not available for the Candidate countries, the study team has calculated percentages on the basis of personnel measured in Full Time Equivalent (FTE). This means that the data for the proportion of R&D personnel in the labour force in these countries are underestimated in comparison to the EU-15 and that, as a result, direct comparisons between the EU-15 countries and Candidate countries should be made with great caution. Data source: EUROSTAT with additional material sources from National Statistical offices.

2.4.3 Employees with Tertiary level education working in a Science and Technology Occupation as a percentage of total employment.

Human resources in science and technology (HRST) are people who fulfil one or other of the following conditions:

successfully completed education at the third level in an S&T field of study (including natural sciences; engineering and technology; medical sciences; agricultural sciences; social sciences; humanities; other fields, where the first five are “core” fields and the last two “extended”)I
not formally qualified as above but employed in a S&T occupation where the above qualifications are normally required

[I] Manual on the Measurement of Human Resources devoted to S&T Canberra Manual, OECD, Paris 1995, p.22 (see http://www.oecd.org/dataoecd/34/0/2096025.pdf)

Human Resources in Science and Technology Core (HRSTC) are those people who have a third level education and work in a S&T occupation. Examples include:

- university professor with a PhD in economics;
- computer system designer with a degree in computer science;
- dentist practising in his/her own dental surgery

The Codes are as follows:

- HRSTE: those people who have successfully completed third level education
- HRSTO: those people working in a S&T occupation
- HRSTC: the core HRST (those people who have a third level education and working a S&T occupation).
- HRST = HRSTO + HRSTE - HRSTC

For further information, see OECD and Eurostat (1995), "Manual on the Measurement of Human Resources Devoted to S&T – Canberra Manual", Paris

Data source: EUROSTAT with additional material sources from National Statistical offices.

2.4.4 Employment in High Technology and Medium High Technology Manufacturing as a percentage of labour force

The medium-high and high technology sectors include chemicals NACEI (24), machinery (NACE 29) office equipment (NACE 30), electrical equipment (NACE 31), telecom equipment (NACE 32), precision instruments (NACE 33), automobiles (NACE 34), and aerospace and other transport (NACE 35). The total workforce includes all manufacturing and service sectors.

Data source: EUROSTAT with additional material sources from National Statistical offices.

2.4.5 Employment in High Technology Services as a percentage of labour force

This indicator focuses on three leading edge sectors that produce high technology services: post and telecommunications (NACE 64); information technology including

[I] Nomenclature statistique des Activités économiques dans la Communauté Européenne" - Statistical classification of economic activities in the European Community software development (NACE 72); and R&D services (NACE 73). The total workforce includes all manufacturing and service sectors.

Data source: EUROSTAT with additional material sources from National Statistical offices.

2.4.6 Population with Tertiary Education

The percentage of the total working age population (25-64 years age classes) with some form of post-secondary education (ISCED 5 and 6). Data source: EUROSTAT with additional material sources from National Statistical offices.

Science Parks

Science Parks that are members of the International Association of Science Parks (IASP). Data source: membership list on the IASP website 2003: http://www.iaspworld.org/

Business Innovation Centres

Centres that are registered as members of the EU's Business Innovation Centre network. Data source: European Commission Services 2003

2.4.7 Most Actively Publishing Universities and Public Research Institutes in the EU 15

Most actively publishing universities and public research institutions in the EU-15 member states (universities and public research institutions appearing in the top 20 most actively publishing research institutions in D,E, F, I, NL, S, UK and top 10 most actively publishing institutions in B, DK, FIN, AT, GR, P, IRE). Obtained from Third European Report on Science and Technology Indicators 2003, DG Research 2003 pp.310-314. Private Organisations appearing in the original ranking have been excluded

Number of project participations in the Framework Programmes

Data for the Framework Programmes is based upon the number of projects undertaken in the 4th Framework Programme (1994-1998) and the 5th Framework Programme (1998-2002). In each case the number of participants in Framework Programme projects has been calculated for each region, separately identifying the number of Lead Partners (Prime Contractors) and the number of secondary partners (Other Contractors). The data for regional participation in the Framework programmes has been obtained from the Projects database maintained by the European Commission's CORDIS service. The total number of project participations in a given Framework Programme in a region measures the number of projects with at least one participant in the region concerned. The figure includes all project (contract) types in all sub programmes, including research support actions, such as Accompanying Measures, which do not involve direct involvement in Research and Development activities.

Planned and actual expenditure on R&D through the Structural Funds

Data on Structural Funds expenditure was obtained from DG Regional Policy in 2002 (relating to the outset of each agreed programme) and July 2005 (relating to the updated position in July 2005). Data from these two time points provided details of:
Planned spend at the outset (2000) of the programme complement for each Structural Fund programme
Revised planned spend for each programme at July 2005
Planned spend on FOI 18, 181, 182, 183, 184 at the outset of the programme period
Revised planned spend on FOI 18, 181, 182, 183, 184 at July 2005
Actual certified expenditure on FOI 18, 181, 182, 183, 184 at July 2005

3.0 Networking Undertaken

Networking activities were carried out in the context of the ESPON Programme's activities. This involved attendance at various joint events and meetings each year throughout the life of the project. These events stimulated and facilitated strong informal networking with a number of ESPON projects. Formal networking with other ESPON projects outside of the Programme events has been limited. This is regarded as due to the specificities of this particular study. In support of this, there has been strong networking with other relevant projects – outside of the ESPON family - in this field, including the European Innovation Scoreboard and work led by Cambridge Econometrics for DG Regional Policy examining the factors of regional competitiveness. In addition there has been some external networking and dissemination activity. This includes invitations to present the findings of the study to DG Research's High Level Expert Group on Constructing Regional Advantage and to present the findings to the European Union Research Advisory Board's Working Group 3 exploring the issue of Stimulating the Regional Potential for Research and Innovation.

4.0 Further research issues and data gaps

Any study such as this will throw up a range of areas where additional research and analysis is merited. Such an ambitious project also highlights areas where gaps in the data available have restricted the possible analysis. We do not list all of the areas where the research project might fruitfully be extended, each reader is likely to have their own ideas here, but focus on one or two areas where significant added value is identifiable.

The first and most significant area for further research is to assess the value of the co-financing facility whereby the Structural Funds in areas eligible for Objective 1 can be used to partly co-finance projects funded through the 6th Framework Programme. There is little evidence of this facility being used to any significant extent. Yet, a priori, the ability to do so would seem to be a positive contribution to evening the territorial balance of EU R&D policies in the EU. We believe that research which seeks to identify the extent to which the facility is being used in practice and the positive and negative features associated with this should be an immediate priority to inform the future development of the Structural Funds and the 7th Framework Programme.

We welcome the commitment of EUROSTAT to make regional date for the 4th Community Innovation Survey available in 2006. We believe that this will provide a rich source of material for studies of the European Innovation System and of the strengths and weaknesses of regional innovation systems within this broader context. We believe that further research using this particular dataset should be a strong priority. In particular we would suggest that the research focus on exploring the geography of different innovation 'cultures' and the implications this may have for EU R&D policies.

We do not wish to highlight individual gaps in the data series used for this study. There will always be a partial coverage with some data missing for individual regions, indicators and years. However we are concerned by the lack of consistency in data reporting for a number of key indicators. There are signs that the position is improving but we recommend that EUROSTAT work with national statistical agencies to agree a core set of consistent and comparable indicators for which data will be provided on an annual basis. We suggest that this should include a comparable measure of human resources engaged in R&D either by focusing on HRSTC or on measures of R&D personnel.

Data availability also varies by geographic scale. There is very little data available on a comparative basis at the NUTS 3 level. There is a debate to be had as to whether this is an important scale for regional R&D and innovation indicators in the context of EU policy.

However, there is also some inconsistency between Member States as to whether data is reported at the NUTS 2 or NUTS 1 level. We suggest that EUROSTAT work with national statistical agencies to agree a consistent reporting framework for research and innovation statistics. This may involve one Member State reporting relevant statistics at the NUTS 1 level and another Member State reporting at the NUTS 2 level. The key point is that any arrangement should be agreed and the rationale should be publicly available.

ESPON 2.1.2

The Territorial Impact of EU Research and Development Policies

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ECOTEC

Priestley House
12-26 Albert Street
Birmingham
B4 7UD
United Kingdom

T **+44 (0)121 616 3600**
F **+44 (0)121 616 3699**
www.ecotec.com

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This report represents the final results of a research project conducted within the framework of the ESPON 2000-2006 programme, partly financed through the INTERREG programme.

The partnership behind the ESPON programme consists of the EU Commission and the Member States of the EU25, plus Norway and Switzerland. Each partner is represented in the ESPON Monitoring Committee.

Information on the ESPON programme and projects can be found on www.espon.lu”

The web site provides the possibility to download and examine the most recent document produced by finalised and ongoing ESPON projects.

Foreword

The Trans-national Project Group (TPG) for ESPON project 2.1.2 comprises the following members:

ECOTEC Research and Consulting Ltd.
Avenue de Tervuren 13b
B-1040 Brussels
Belgium

TAURUS Institut an der Universität Trier
Universitätsring 15
Postkasten DM 20
54286 Trier
Germany

Cardiff University
Department of City and Regional Planning
Glamorgan Building
King Edward VII Avenue
Cardiff CF10 3WA
UK

MCRIT
Salvador Espriu 93
08005 Barcelona
Spain

MERIT Maastricht University
Tongersestraat 49
P.O.Box 616
6200 MD Maastricht
The Netherlands

Politecnico di Milano
Dipartimento di Architettura e Pianificazone
Via Bonardi, 3
20133 Milano
Italy

Further details of the ESPON Programme can be found on the ESPON website at: www.espon.lu

1.0 Introduction

This report is the final report for ESPON Project 2.1.2 : The Territorial Impact of European Union R&D Policy. ECOTEC Research and Consulting Ltd is the lead Partner for this ESPON Project. The project is aimed at supporting policy development by providing new knowledge, concepts and indicators on territorial trends and policy impacts related to an enlarged European Union in the field of Research and Development policy. In this respect, the project uses the EU 27 as the territorial unit of analysis and as far as possible includes Norway and Switzerland, where relevant. The ESPON studies are intended to inform:

- Those factors relevant for a more polycentric European territory.
- The development of territorial indicators and typologies, capable of identifying and measuring development trends as well as monitoring the political aim of a better balanced and polycentric EU territory;
- The development of tools supporting diagnosis of principal structural difficulties, as well as potentialities. This should include disparities within cities and regenerating deprived urban areas;
- The investigation of territorial impacts of sectoral and structural policies, such as the Structural Funds;
- The development of integrated tools in support of a balanced and polycentric territorial development.

The objectives for this study were wide-ranging and include the following general objectives:

- To develop methods for territorial impact assessment of sectoral policies
- To develop territorial indicators, typologies and concepts, establish a database and map-making facilities and sustain the project by empirical, statistical and/or data analysis.
- To analyse territorial trends, potentials and problems deriving from the policy, at different scales, and in different parts of the European territory.
- To show the influence of the policies on spatial development at relevant scales
- To show the inter-play between EU and sub-EU spatial policies and best examples for integration
- To recommend further policy developments in support of territorial cohesion and a polycentric and better balanced EU territory

- To find appropriate instruments to improve the spatial co-ordination of EU sector policies and the ESDP
- To consider the provisions made and to provide input for the achievement of the horizontal projects under priority 3.

In addition, the study is expected to:

- Identify and gather existing territorial indicators to measure and display the state, trends and impacts of R&D policy and propose new indicators where necessary.
- Operationalise the policy options of the ESDP relevant for a territorial impact analysis of R&D policy, and development of a methodology for impact analysis at a EU scale.
- Conceptualise and elaborate a territorial impact analysis for R&D policy with special consideration of the following points:
  - ► How far R&D policy addresses emerging border and integration problems, taking into account the variety of regions and enlargement. Does EU R&D policy provide adequate accessibility in the regions of Europe?
  - ► What spatial effects are expected in terms of current and future R&D policy?
  - ► How far does EU R&D policy support the concentration of development corridors and polycentric development and what other spatial effects are emerging?
  - ► How far does EU R&D policy affect the spatial diffusion of innovation and knowledge in Europe?
- Consider what kind of resources are available at EU level to conduct R&D policy and whether the necessary co-ordination take place with national policy;
- Consider what the territorial conditions that allow regions to take best advantage R&D policy are, in terms of innovation and economic development;
- Consider how R&D policy at EU and Member State level should be designed and co-ordinated to promote an equal access to knowledge infrastructures for all European territories;
- Consider how the Structural Funds and R&D policy could develop a more coherent and effective approach in promoting R&D capacities and territorial cohesion.

We attempt to address these objectives in the following report. The report builds upon the previous Interim Reports, produced in October 2002, April 2003 and August 2003 and takes into account comments made by the European Commission, the ESPON Co-ordination Unit and discussions at ESPON meetings. More specifically it addresses the concerns expressed by the Monitoring Committee concerning the draft Final Report of August 2004. Certain amendments were agreed with the Monitoring Committee, as set out in correspondence with the ESPON Co-ordination Unit in September 2005. These amendments have been incorporated in the revised text of this report. A list of those amendments and their location in the text is included in a covering letter, as requested by the Co-ordination Unit.

The report is structured as follows:

- Section 2 sets out the background to an assessment of the territorial impacts of EU R&D policy drawing on a wide-ranging review of relevant literature.
- Section 3 explores the components of EU R&D policy and describes the main policy instruments
- Section 4 presents the methodology adopted for the study, setting out in some detail the approach used for different aspects of the work and information relating to definitions and sources of data.
- Section 5 outlines the present geography of R&D and innovation in the EU drawing upon agreed indicators to map existing strengths and weaknesses
- Section 6 presents different typologies for characterising the geography of R&D and innovation across the EU
- Section 7 explores the territorial dimension to EU R&D policies, both through distributional analysis and by consideration of the effects of these policies
- Section 8 presents the conclusions of the study and provides a number of broad policy recommendations.

In addition, the report includes a number of annexes. Many of these contain supplementary information which support the material presented in the main body of the report. As part of the Annexes we also include a suggested approach for undertaking the territorial impact assessment of EU sectoral policies, of which EU R&D policies are one example. This is included as Annex 6.

2.0 R&D, Innovation and Growth

2.1 Linking R&D and innovation

There is universal agreement in the innovation literature that the biggest error one can make in this field is to confuse R&D with innovation. Major advances have been made in recent years, in both the theoretical and statistical literatures, in distinguishing between R&D and innovation - the means and the end so to speak. A large part of the innovation literature aims to analyse the innovative performance of units – be they firms and industries or countries and regions – through proxy indicators such as R&D expenditure, patents, technology balance of payments and trade in high-tech products. While each of these is useful, they all have their limitations and need to be used in conjunction to give a more satisfactory account of innovative performance. In considering the link between R&D and innovation there is growing recognition that the organisational dimension is becoming ever more essential to an understanding of innovation. Models of innovation have become more sophisticated in recent years, moving away from the simplistic 'technology push' and 'market pull' models towards a less linear and more interactive understanding of the innovation process.

The remainder of this chapter is structured as follows:

- Firstly, we provide a definition of our terms
- We then examine briefly the evolution of thinking away from linear models of the relationship between R&D activity, innovation and economic development to more sophisticated conceptualisations of the innovation system;
- The section then looks at, in turn, the concept of Knowledge Transfer and the factors affecting supply of and demand for knowledge;
- We then examine the institutional dimension of the innovation process, introducing the concept of the Regional Innovation System, before looking briefly at the spatial dimension to the R&D-Innovation relationship.

All references and a full bibliography are to be found in Annex 1.

2.2 Definition of terms

Research and Development (R&D) and innovation are related but distinct concepts. R&D is defined by the OECD[1] as "any purposeful activity that adds to the stock of scientific and technical (S&T) knowledge". It refers to the full spectrum of S&T research activities (e.g. pure basic, strategic basic, applied, experimental and development) in universities, industry, public research institutes and the non-profit sector. Agreed definitions of innovation are more illusive.

The OECD Oslo Manual describes innovation as "technologically new or improved products and processes that have been introduced onto the market (product innovation) or used within a production process (process innovation)". However, this formulation ignores the non-technological dimensions of innovation, such as organisational or managerial change, and focuses on the outputs (new products and processes) of a complex and often poorly understood *process* of innovation.

Similarly, in the field of management, innovation is generally defined as "an internally generated or externally purchased device, system, policy, process, product or service that is new to the adopting organisation" (Damanpour, 1991). Among numerous typologies of innovation advanced in the extant literature, three have gained wide recognition: technical vs. administrative innovations; product vs. process innovations, and radical vs. incremental innovations (Wolfe, 1994). Each centres on a different set of generic characteristics:

- *Technical innovations* pertain to products, services and production process technologies; they are related to basic work activities and can concern either products or processes. *Administrative innovations* refer to organizational structure and management processes; they are indirectly related to the basic work activities and directly related to the management core of a firm.
- *Product innovations* are new products or services introduced to meet an external user or market need. In contrast, *process innovations* are new elements into an organization's production or service operations - input materials, task specifications, devices, information and knowledge mechanisms.
- *Radical innovations* are those that produce fundamental changes in the activities of an organization and represent clear departures from existing practices. *Incremental innovations*, on the other hand, refer to relatively minor departure from established rules and norms.

[1] Oslo Manual (1997)

To the extent that innovation relies upon novelty – ie a new product or process – it provides the link between the outputs of R&D and economic growth. A crucial question remains how new devices, systems, policies, processes, products and services are identified and adopted by organisations. The processes through which knowledge, from a variety sources, including R&D, is converted into innovations, which may in turn impact on the productivity, growth rates and wealth in a given territory, have been the subject of much academic research. We examine some of this work below.

Another important debate, of particular relevance to this study, concerns the measurement of R&D and innovation performance within a given unit of analysis, be this territorial (for regions or countries), sectoral (for industries) or at the firm level. Indicators of R&D, as defined above, are well established and include expenditure on and personnel employed in R&D activities. However, as with the basic definition, measuring innovation and the processes involved in the innovation system has proved more difficult.

Many studies use proxy indicators, such as R&D expenditure, patents, technology balance of payments and trade in high-tech products. While such measures are useful, they all have their limitations and need to be used in conjunction with other information to give a satisfactory account of innovative performance. According to the Community Innovation Survey, a breakdown of innovation expenditure by firms showed the following proportions: R&D accounted for 41% of total expenditure, trial production, training and tooling up (27%), product design (22%), market analysis (5%), acquisition of patents (3%), with 2% devoted to other activities (EC, 1997). To overcome these limitations the European Union, through EUROSTAT and National Statistical Offices have carried out a regular survey of innovation behaviour of firms. Known as the Community Innovation Survey (CIS) there have been three such surveys published since 1994. The Fourth CIS is due to report in 2006. Based upon a sampling methodology the CIS provides robust results at the Member State level around qualitative indicators of innovation activity.

2.3 R&D in the innovation system

There is an increasing level of importance attached to the extent to which R&D is being undertaken in the EU and the degree to which this is being transformed into new products and more efficient production processes through innovation. The 3rd Report on Economic and Social Cohesion (EC 2004) for example makes much of the gap between the proportion of GDP spent on R&D in the EU compared to the USA and Japan.

The reason for this increasing interest is the link that is perceived between R&D activity, innovation and economic growth. Evolutionary theories of economic growth stress the role of R&D and innovation in securing sustained and lasting growth trajectories. The incorporation of 'technology' into economic growth models as an endogenous variable highlights the fact that the accumulation of knowledge generates increasing returns. Thus regions with strong R&D endowments are likely to attract more of these factors. Conversely those regions that do not have existing endowments may continue to lag behind and may indeed see the gap widen.

It is not enough though to undertake R&D, the outputs of the R&D exercise must be exploited by firms through innovation. Firms have an incentive to engage in innovative activities because of the expectation that new technologies will generate monopoly profits – at least until the new technology becomes public knowledge. Equating innovation with the development of new products that are of higher quality than similar products that are on the market, Grossman and Helpman (1991) introduce the notion of the "quality ladder": by a process of product upgrading and imitation developed and then less developed countries climb up the quality ladder. Firms, and consequently countries, that climb up the quality ladder can afford higher wages by offering higher quality.

Traditionally the process of innovation has been conceptualised as a linear flow from basic research through product and process development; production and finally to marketing and diffusion. In this environment simply increasing the level of R&D undertaken should lead to a corresponding increase in technological innovation and higher levels of economic growth. Correlations between levels of R&D inputs, particularly expenditure, and output, as measured by GDP, seemed to support this model.

Over time this model has lost credibility as the complex process of technological change has become better understood, albeit still only partially (Rosenburg 1982, 1994). Interacting and iterative models of technological change are now the preferred description of how the process of innovation operates, although we are still some way off understanding the process as a whole.

Numerous feedbacks occur as solutions are sought to production problems, as new products are developed to meet a customer's needs and as learning and process innovation take place during production (Shaw 1994). Some learning involves generic knowledge, such as new scientific findings; other knowledge is firm specific. As Cook and Brown (1999) suggest, the true spark of innovation lies in the 'generative dance between possessed and practiced knowledge' ie knowledge that we have and that we use mimicking Nonaka and Takeuchi's (1995) view of knowledge conversion as an iterative and spiral-like process of collective learning. In this respect knowledge generation and, hopefully, innovation should be seen as 2-way street and not unidirectional from researchers to producers but also as an intensely social process. The unpredictability of R&D stems from its inherent complexity and from the fact that it involves a high degree of tacitness. In contrast to codified knowledge, which can be standardised and disseminated quite easily, tacit knowledge is person-embodied and context-dependent, hence it requires more face-to-face contact to be exchanged effectively. Crudely speaking, this is how a lot of theoretical literature explains the phenomenon of spatial clustering.

As there are many routes to innovation aside from undertaking R&D the question thus becomes one of how firms make use of knowledge (regardless of source) and how they access that knowledge. The focus of attention has, then, gradually shifted from the inputs into the R&D process to the flows of knowledge emanating from R&D activities; to the means by which firms process knowledge and to how that knowledge is harnessed (Amin and Cohendet 2004).

One way to summarise the results of a great deal of recent research in the cognate spheres of learning, knowledge transfer and innovation is to say that the most critical aspects 'are *not* dependent upon frontier research, doctoral graduates, gross expenditures and so on, but on spillovers, linkages, networks, inter-dependencies, synergies etc' (de la Mothe and Pacquet, 1998). Developing this robust line of reasoning other experts have argued that the 'technological and market knowledge which underpins innovation is often tacit and idiosyncratic, and therefore learned by doing, using and interacting with customers, suppliers and related industries' (Utterback and Afuah, 2000).

In the evolutionary economic literature which has made the running in innovation studies in recent years, one of the greatest challenges for firms, and indeed for other organisations too, is how to strike a balance between *routines,* which help to steer and regularise organisational practices, and *creativity,* which is the lifeblood of innovation (Dosi et al, 1988). Learning is what helps firms to strike this balance and the capacity to learn depends in no small way on their *absorptive capacity*. In other words a firm's ability to recognise, assimilate and exploit knowledge, both from within and without, is largely a function of the level of prior-related knowledge (Cohen and Levinthal, 1990). To put it another way, to be able profit from the technological expertise of research centres, universities or private R&D labs, local firms have to perform a modicum of R&D themselves and this capability helps to keep them attuned to the commercial possibilities of R&D performed elsewhere.

This critically important concept of absorptive capacity refers to much more than technical skills; rather it underlines the need for a shared cognitive framework within the firm and the ability to transfer knowledge across departmental boundaries. The concept also highlights the significance of organisational learning, which is much more than the sum of individual learning (Nonaka and Takeuchi, 1995)

The concept of absorptive capacity has been employed to explain why regional technology policies often fail. Animated by a linear model of innovation, such policies were traditionally biased towards supply-side infrastructures. In one of the very best reviews of RTD policy in the EU it was argued that the problem now is that ‘enterprises often lack the internal motivation and organisational resources to develop entrepreneurial and organisational (‘learning’) competences’, and therefore there is a need for ‘a new balance between measures supporting the science and technology infrastructure and measures supporting absorptive capacity, ie the resources available *inside* the enterprise’ (Dankbaar et al, 1993).

2.4 Knowledge transfer

Knowledge transfer can be defined as the process by which knowledge, expertise and skilled people transfer between the science base and its user communities to contribute to the economic competitiveness of a region, State or the EU, the effectiveness of public services and policy and the quality of life. This is viewed as extending to the following forms of knowledge: that normally presented in scientific papers/meetings; that which can be commercialised; that which is tacit and concerned with methodologies; and, small observations that could be key pieces of information for others.

The transfer of codified knowledge, based upon shared codes and language is simpler than that of tacit knowledge which, by its very nature has to be learnt by doing and can often only be transferred on a one-to-one basis. Whilst a little simple this does have the benefit of opening up the question as to who has access to this knowledge. We reproduce David and Foray’s (1995) characterisation of the relationship between types of knowledge and knowledge products in Figure 2.1 below.

Figure 2.1 : Types of knowledge and knowledge products

Completely codified	Patents and copyrights Trade secrets	Scientific papers	Fully disclosed
Completely tacit	Private know-how	Shared expertise	Restricted access
	Privately-owned	Public	

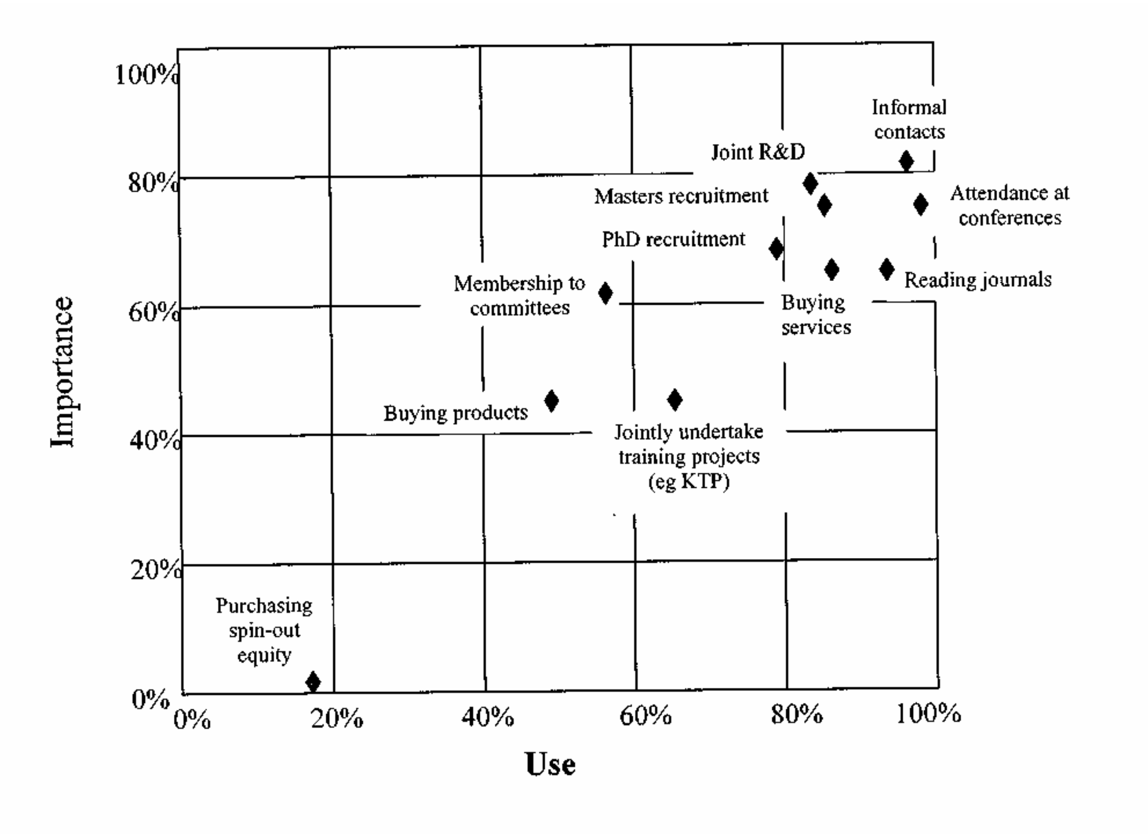
Source: David and Foray (1995: 33 Fig 1)

Five primary routes for knowledge transfer can be identified. This does not include the internal routes from in-house R&D activities to production although many of the routes remain pertinent.

- Co-operation in education and training (such as academic training or, increasingly, provision of courses for employees of firms)
- People and knowledge flows (through the exchange of staff for example)
- Collaborative research projects
- Commercialisation of R&D outputs (through licensing or spin-out enterprises for example)
- Publication of scientific papers and the training of scientists

Although the most tangible forms of knowledge transfer are licensing and the establishment of start-up companies around intellectual property generated from R&D activity, these form a very small part of real benefits of knowledge transfer. Figure 2.2 illustrates the importance attached to different sources of knowledge by a sample of users in the UK. This demonstrates the significant intangible element to knowledge transfer and the difficulty of assigning benefits to particular activities, either in space or in time.

Figure 2.2 Correlation between use and importance of KT mechanisms



Source: internal NERC paper

2.5 Factors affecting the supply of knowledge

The majority of R&D is performed by the private sector, followed by the university sector (OECD 2000). Universities also represent the largest pool of scientists and researchers and produce a stock of skilled human capital through their educational functions. Numerous studies have demonstrated a positive relationship between R&D activity and economic growth, but they have not explained the link between these (Nelson 1998).

Factors affecting the supply of knowledge are broadly related to the capacity of different bodies (firms or research organisations) to undertake R&D. That is the stock of scientists and researchers, the financial resources available for R&D and presence of adequate technical resources are all seen as an important attribute contributing to the supply of knowledge. However, there is no guarantee that this will lead to additional levels of innovation or economic growth. Far from being a predictable process R&D is best conceived as 'a groping, searching, uncertain process', the success of which can only be established ex post (Freeman, 1982). A truism that is apposite here is that funding more science results mostly in more science. As the linear model of R&D through to innovation is no longer seen as a valid model so it would be wrong to replicate such thinking by taking too strong a science-push perspective.

There is no better illustration of this conception than the innovation paradox in today's pharmaceutical industry, one of the most R&D intensive sectors of all. In 2001 the leading pharma companies invested some $35 billion in R&D but the results have been disappointing because in that year only 24 new drugs were approved in the US, compared with 27 in 2000, 35 in 1999 and 53 in 1996. This declining rate of product innovation has been attributed to the fact that 'large pharmaceutical companies, with several thousand of research scientists and annual budgets in the billions of dollars, have become so large that innovation is stifled' (Dyer, 2002).

It is equally true though that without the resources for scientific and technological research firms and regions are reliant upon others to undertake R&D on their behalf. This may be an appropriate strategy where there is an element of economic 'catch-up' occurring. However, knowledge acquisition is not costless, and to the degree that transaction costs increase over distance or through insufficient resources to interpret available knowledge, so regions without an R&D base may be impeded in their economic development. Access to a research orientated infrastructure can thus have an important bearing on regional development patterns over time (Beeson et al 1994). It is important to recognise though that not all research outputs are equally useful to industry.

A significant factor then in the supply of knowledge is the extent to which knowledge is disseminated and available. In this respect accessibility (both physical and virtual) can be an important consideration, with initiatives such as GEANT in the EU seeking to improve the communications infrastructure accessible to the public research sector.

Access to knowledge is an important component in considerations around knowledge transfer and is one which we return to when considering spatial dimensions. It is sufficient to say at this point that the availability of knowledge to firms within a region can be a factor of the work undertaken, and placed in the public arena, by research bodies, and their staff, based there; as well as a function of the ability and willingness of local firms to acquire and implement knowledge created elsewhere, a point we turn to below.

2.6 Factors affecting the demand for knowledge

A range of factors appears to influence the propensity of a firm to appropriate knowledge and innovate. Unfortunately many of these relate to the internal structures and organisation of the firm. It is thus difficult to assess the extent to which different regions may be more likely to adopt and adapt the outputs of R&D through innovation from available data. Factors commonly cited include: the competitive strategy of the firm, the extent to which decision-making is decentralised, horizontal and where roles and responsibilities are not tightly defined are all likely to increase the level of innovation. Equally, firms that employ a high proportion of scientists or engineers and regularly scan for opportunities and threats from competitors or emerging technologies are more likely to be innovators (Lefebvre 1997; Roper et al 2000

Firm size is also argued to influence the propensity of a firm to innovate. Evidence suggests that large firms are more likely to be innovative than small firms (Arundel and Steinmueller 1998, Premkumar et al 1997). However, in practice the evidence base is mixed. Others have found that although innovation generally increases with firm size, R&D intensive SMEs tend to be more innovative than large firms (Felder 1996, Arvanitis and Hollenstein 1996). It may not therefore be sufficient to argue that regions with a high proportion of small firms are less likely to benefit from R&D policies than those with a base of larger firms.

Similarly, research on firm structure has also produced mixed results. In some circumstances market concentration has been shown to promote innovation, whilst in others it is seen as a limiting factor. Equally, some sectors are more likely to appropriate the results of R&D activities than others, although this is not uniform across space as new multi-national production processes are increasingly leading to specialisation and dispersed multi-site operations. Roper et al (2000) have demonstrated that, at a firm level, being in an R&D intensive sector, along with internal capacity, is the most important determinant of innovation within a firm.

One area where there does appear to be consensus is on the value of inter-organisational networks. A range of studies in different contexts (Premkumar and Roberts 1999; Cooke and Willis 1999; OECD 2000) have confirmed the positive relationship between networking and innovation in so far as this increases the capacity available for innovation through additional resources, joint learning and knowledge flows. Again, though Roper et al (2000) argue that the influence of such networks is stronger where there is a pre-existing R&D capacity within a firm.

The availability of resources for undertaking R&D is increasingly coming under scrutiny as fundamental inputs into the innovation process. The existence of tangible inputs in terms of financial spending; skilled and committed employees and technical resources have all been found to have positive effects on innovation, as might be expected. More intangible resources that have also been found to be influential include market knowledge – so called sense and response capabilities (Quinn 2000) - and the capacity of a firm to put acquired knowledge to productive use (ie the process of transforming information into useful knowledge). Entrepreneurship and institutional learning capabilities are both positive features in this regard (Cohen 1995, Teece et al 1997).

It is now accepted that R&D expenditure contributes substantially to the growth of output in a variety of industries, with a positive relationship between the stock of R&D and productivity at the firm level (Griliches 1984, Nadiri 1993, Mansfield 1996). However, private rates of return to investment are generally below the social rate of return suggesting that firms find it difficult to capture all of the benefits of the investment made. Reasons for this include the existence of various spillovers, with work by Mansfield and others suggesting that detailed information on new products and processes are available to competitors within a year of introduction.

Academic research certainly underpins innovation in many science-based industries. The main sectors benefiting from such research appear to be agriculture and medical research (Steinmueller 1996). This is reflected in assessments of the most R&D intensive sectors, as set out in Table 2.1 below. It is worth noting that only the top 6 sectors manage a research intensity (R&D expenditure as a percentage of production) of more than 3%. In each case a high research intensity is positively related to productivity growth whilst low research intensive industries exhibited low productivity growth. Regions with a stronger representation of such sectors might be expected to benefit more from EU R&D policy (although not all sectors will be eligible) and from higher productivity growth.

Table 2.1 Top 10 research intensive sectors in the EU

Radio, TV and communication equipment
Other transport equipment
Medical, precision and optical instruments, watches
Office machinery and computers
Chemical and chemical products
Motor vehicles, trailers and semi-trailers
Electrical machinery and apparatus n.e.c
Machinery and equipment n.e.c
Coke, refined petroleum and nuclear fuel
Rubber and plastic products

Source: adapted from the EC Competitiveness Report 2001

However, the importance of academic-led research is modest in comparison to other sources. Mansfield (1991) estimated that some 10% of innovations by large firms would not have been possible without academic research whilst the Community Innovation Survey suggests that the figure is less than 4% (2000, 1997, 1993).

In the case of certain science-based industries the input of academic knowledge is stronger with studies of patent citations demonstrating that between half and three-quarters of these emanate from public research bodies such as universities (Narin 1973; Malo and Geuna 2000; Verspagen 1999). The time-lag between the research and industrial innovation is, though, quite long with Mansfield (1991) estimating the mean to be 7 years.

2.7 Introducing the institutional dimension

The recognition of the role of institutions in innovation has entered the mainstream in recent years and it has been predicated upon a number of developments in evolutionary political economy, innovation theory and economic development policy. Innovation is conceived of as an interactive - collective and iterative - process involving actors from diverse sectors and in different functions (Cooke, 1998; Braczyk & Heidenreich, 1998; Cooke & Morgan, 1998). It involves both institutions in terms of organisations, and institutions as norms, rules and behaviour; crucially, institutions may thus be both the medium and the outcome of collective action (Morgan, forthcoming). The latter further reflects acceptance of the mutual compatibility of collaboration and competitiveness (Cooke, 1998).

The acknowledgement of the role of actors (both collectively and individually conceived) beyond the firm and conventional R&D institutions coincides with conceptions of contemporary, associational, networked governance, as compared to the polar opposition of the market and the state (Grabher, 1993; Morgan, 1997, Morgan & Cooke, 1998).

Lastly, a move to focus on outcomes and processes rather than inputs and outputs in economic development theory and policy is discernible (Oughton et al. 2002). At one level this dictates the desirability of unpacking the black box to reveal the linkages between inputs, processes and outputs, and how these are sustained and broadened/deepened to produce outcomes with greater effect. The language of institutions may thus be seen as a simplification or at least summary of these complexities.

One way to understand the role of institutions has been through national comparative analysis, based on the acknowledgement of differences in national technological trajectories (Dosi, 1988; Oughton et al, 2002). This reveals considerable variation across several types of institution between countries, which conceivably affect patterns of innovation to the extent that they together may be conceptualised as a system. The following dimensions of a National Innovation System (NIS) emerge from the literature (Dosi et al, 1988; Lundvall, 1992; Nelson, 1993; Cooke and Morgan, 1998):

i) The organisation of R&D - the role of government funding, and large firms. National technological specialisation may reflect this, as may mechanisms of diffusion, giving rise to particular key arenas of interaction

ii) The ensemble of education and training institutions - providing particular skill configurations within the workforce, influenced to a greater or lesser extent by industry. There may also be significant differences in the way in which these skills are organised within the firm - for example, the extent to which vertical hierarchies as opposed to horizontal relations prevail

iii) The financial system - the time-scale of investment, price of borrowing, financial regulations, accounting practices, corporate ownership rules and relations with industry

iv) The network of user-producer relations - the intensity and stability of feedback relations and hence learning. This may also however vary with product type

v) Intermediate institutions - both sectoral (such as trade associations) and territorial (such as local chambers) may be key institutions of diffusion

vi) Social capital - features of social organisation, such as norms, networks and trust, particular configurations of which may prevail on a national basis, which may relate to particular national historical political-economic trajectories

Together these can affect the world view of actors and organisations, their calculation of risk and opportunity, who they seek to interact with, flows and nodes of communication and so on (Morgan forthcoming; Cooke & Morgan, 1998). For instance, the German configuration has until recently been based on amongst other things, a strong system of intermediate vocational qualifications, intimate finance-industry relations based on long term investments, stable and intense user-producer relations marked by trust, voice and loyalty, strong intermediate organisations and wider societal relations more open to collaboration for mutually beneficial ends. This may be contrasted with Anglo-American configurations with their elitist educational system, loose and short-termist relations with the financial sector and between users and producers, weaker intermediate organisations and a societal emphasis on individualism (Cooke & Morgan, 1998). The former may be more generally dynamic, with greater potential for interactive innovation; the latter, myopic (Patel and Pavitt, 1994).

However, a number of authors note certain pressures upon the coherence of these systems, in particular associated with the 'deregulatory bias of globalisation' (Cooke & Morgan, 1998). In some earlier work referring to the mid-late 20th Century for instance, Nelson (1993) considers the effect of macroeconomic policy and protectionism on national systems, which would appear to be less relevant now. Those that persist may perhaps be termed institutionalised conventions as opposed to those subject to the vagaries of policy and politics, including shifts to supranational regulation and integration. Key case studies in this respect appear to be transition economies in Eastern Europe and China (Malecki et al. 1999). However, perhaps national institutional robustness is not so easy to define - complex feedbacks seem possible, affecting the will to change or preserve.

Although a major step forward, the NIS literature suffers from a number of limitations: first, it has failed to integrate the macro and micro dimensions of its analysis; second, it tells us little as to how firms actually utilise the NIS infrastructure; third, it says little about the possible emergence of a post-national, European innovation system; and finally, it is remarkably silent about the growth of sub-national, regional innovation systems.

2.8 Regional Innovation Systems (RIS)

Recent research suggests that national systems do not exclusively determine the fate of firms or aggregates of firms in their country, with wide and persistent inter-regional performance variations, implying that some other institutional forces operate on a more focused regional basis (Morgan, 1997; Braczyk et al, 1998; Cooke et al, 1998; Cooke et al, 2000; Howells, 1999; Oughton et al, 2002). Others argue that although there may be national commonalities, from a bottom-up perspective, regional institutions effectively filter these - affecting their delivery and the response of firms - with a regional focus also enabling a more micro-level analysis of actual beneficial mechanisms (Howells, 1999).

One institutional filtering mechanism may be the policy-action of regional government, including tax incentives, and other forms of budget allocation, to the extent that such governments have power devolved to them. For example, German Länder governments have their own ministries of technology, giving rise to proactive regional development policy, with for instance, the provision of state technology transfer institutions, and various other business support mechanisms (as intermediaries); concurrently, they have funding discretion for the universities which they can use to direct particular specialisms (Howells, 1999). This is some ways corresponds to a territorially focused national innovation system, which conceivably comprises a tighter, more intense network of institutions, with more tangible outcomes, given the specific regional strategic focus. Indeed, Oughton et al, (2002) suggest institutions can operate at both national and regional levels, albeit differently.

At this level however, the critical role of softer institutions is also evident, a factor deducible from failed policy interventions that have merely provided hard institutions - such as public R&D labs - in areas in which they were lacking (e.g. Lowland Scotland - MacLeod, 1997 cit. in Malecki et al. 1999). From this situation, derives the notion of the importance of institutional connectivity, through networks of people, based on two-way learning processes, lubricated by shared traditions of trust and co-operation, which promote embeddedness (Oughton et al. 2002, Oinas & Malecki, 1999).

Institutions are thus both actors, more intangible convergences, and regulatory mechanisms. Such co-ordination permits both knowledge flows and synergies - in particular, the re-combination of knowledge to produce new orders of innovation, and in order to adapt it to enable assimilation (Oughton et al, 2002; Howells, 1999; Braczyk & Heidenreich, 1998). Ashiem & Cooke (1999) summarise this as innovation comprising learning, creativity and tutoring. Etzkowitz & Leydesdorff (1997, 2000 cit. in Oughton et al 2002) propose that a 'triple helix' of government-university-industry relations is critical, the conceptualisation of helix-as-nexus capturing the complexities and mutual-dependencies of the interrelations - a 'nestedness' of institutions. This serves to emphasise that the above configurations of regional governance must also be receptive to learning feedbacks in order to for example, better co-ordinate supply- and demand-side processes (Oughton et al, 2002). Thus the systemic element is revealed as a team-like orientation amongst regional actors (Asheim & Cooke, 1998).

The spatial link is also clarified in this way, given that such softer institutions are usually built up on the basis of face-to-face interactions, which continue to be more likely and frequent, particularly in more informal settings, (complementing formal ones) on a localised basis (Oughton et al, 2002; Howells, 1999; Asheim & Cooke, 1999). Such interactions combine socialisation processes with the evolution of relations and regional vision in a spatial, path-dependent process (Morgan, forthcoming; Howells, 1999; Braczyk & Heidenreich, 1998). The spatial agglomeration of different institutions, including different industrial functions thus becomes important beyond the traditional conceptions of external economies in terms of 'collective economies' which require extra-market, co-ordinated and active involvement of actors, a certain amount of solidarity (Oughton et al, 2002; Lundvall, 1999). The distinctiveness of this territorial assemblage may be further reinforced by national processes pertaining to core-periphery structures, with centralisation and funding based on excellence rather than need, contributing to institutional paucity elsewhere (Morgan forthcoming; Oughton et al, 2002; Howells, 1999).

However, it would also appear that the extent to which territorialisation is essential to innovation systems has gone largely uninterrogated (Morgan, forthcoming). Asheim & Cooke (1998) suggest that the orientation of firms will affect the extent to which a system is territorially integrated as opposed to a regionalised national innovation system. They also suggest that the triple-helix can be stretched across space, that links with for instance, universities outside the region may be important to overcome local limitations. Overall it is unclear which processes and activities associated with institutionalised innovation are constrained to regional spaces (Morgan, forthcoming; Malecki et al. 1999) - for example, whether regional identity is crucial and whether this is compromised by excessive external linkages. From another perspective, Florida (2002) for instance, proposes that key mobile innovation actors are attracted to put down their roots by particular cultural configurations.

Turning the lens back to key innovation institutions themselves however, it can equally be shown that even softer institutions or institutional thickness are not sufficient to drive regional success, and may conversely, act as constraints (Howells, 1999; Cooke & Morgan, 1998). This reflects the dialectic referred to above - the tension between creativity and routinisation, or inertia. Thus it is possible to conceive of shared visions becoming overly normative and closed to alternatives, including the participation of new actors and organisations (Oinas & Malecki, 1999; Braczyk & Heidenreich, 1998). Indeed, it remains unclear as to what extent institutional reproduction is based on particular personalities and interpersonal contact (e.g. the role of mobile individuals) rather than wider cultural socialisation and inter-organisational contact. A dynamic perspective would further suggest the importance of fluidity - changing flows and linkage patterns (Archibugi et al, 1999) implying that institutions must both reproduce and evolve, ebb and flow, involving a certain amount of creative destruction, assimilation of old and new. Cooke and Morgan (1998) propose that institutional learning transcends this dialectic, but this should not elide the fine balancing acts involved, the containment of what could conceivably disintegrate into raw power struggles.

Overall these nuances to regional innovation strategies highlight the importance of more qualitative research looking at more abstract integrative mechanisms, rather than relying on simplistic inventories of institutions (including networks) as indicators of potential (Morgan, forthcoming). Several authors suggest that there are still gaps in the understanding of these processes, particularly how individual firms learn, what is the crucial knowledge that they learn, to what extent roles are substitutable by different organisations, and how all this activity feeds into improved economic performance, as well as crucially, to what extent policy can create particular institutional dimensions, as opposed to just following and supporting them (Morgan, forthcoming; Oughton et al, 2002; Malecki et al 1999). As various authors remind us however, the focus on institutions must not marginalise the role of firms themselves (Morgan, forthcoming; Howells, 1999; Asheim & Cooke, 1999; Nelson & Rosenberg, 1993).

2.9 Linking national and regional innovation systems

Having identified institutions of relevance to innovation at both the regional and national levels, it still remains unclear how these levels are linked, particularly the national components and firms themselves (Morgan, forthcoming; Archibugi et al, 1999). It is suggested that there have been two separate realms of analysis - macro and micro - without an explicit consideration of interaction between them - for example, how firms use national systems as we noted above.

To some extent theories of governance and multi-level polity are helpful, in suggesting that actors may be part of various circuits of action and interaction, and proposing that learning needs to be extended from the bottom up to the top, both through the institutionalisation of devolution and mutual reflexivity (Cooke et al, 2000; Oughton et al. 2002; Healey, 1997; Morgan, 1997).

Indeed, referring back to the issue of which parts of the system need to be localised, some authors have in fact suggested that non-local links are an important dimension to learning and a means of overcoming local limitations (Oinas & Malecki, 1999; Asheim & Cooke, 1999). Perhaps bridging institutions are important fora to access such links, although the role of MNCs could also be clarified (Morgan, forthcoming; Malecki et al, 1999). Howells (1999) conceives of smaller systems being more 'open' to non-local interaction, but it seems somewhat myopic to subsequently ignore potential interaction between any other types of system, especially given the aforementioned 'global' level pressures, and sometimes tangential trends in sectoral systems (Morgan, forthcoming; Nelson & Rosenberg, 1993).

There is some tentative suggestion that a concerted action at multiple levels of governance is needed to counteract the powerful forces pertaining to regional inequality. It is conceivable that a bold strategic role for national and supranational governments is waiting should these linkages be clarified, to re-allocate funding to where it can have most impact, and in framing policy so that it takes these diverse institutional interactions (which from a bottom-up perspective vary from place to place) into account rather than taking a limited, simplistic view, aiming to capture, rather than be dependent on them.

2.10 Introducing the spatial dimension

The work undertaken by authors exploring National and Regional Innovation Systems is valuable in that it highlights the fact that institutional geography remains an important consideration when examining the territorial implications of EU R&D policies.

The spatial dimension is also important in so far as transaction costs increase with distance. There are those that hold that geography is dead and that geographical proximity is no longer an issue for the transfer of knowledge (Martin 1996, Cairncross 1997). Whilst this may be true in principle, in practice proximity is still seen to be a positive factor in the acquisition of knowledge, particularly for locally-focused SMEs. For example, evidence from the CIS in the UK (Table 2.2) suggests that as market-focus increases so the location of university collaborations becomes less significant.

Table 2.2 UK business university collaborations

	Location of University		
Type of firms' largest market	***Local***	***National***	***Overseas***
Local	88%	12%	0%
Regional	47%	53%	0%
National	37%	47%	16%
International	26%	48%	26%
All	**36%**	**46%**	**18%**

Source: CIS UK - quoted in Lambert Review (2003: p.71 Fig 5.2)

This supports many of those in private industry who assert that it is not the location of the research that is important but rather its quality. It also demonstrates clearly that larger firms are able to draw upon a wider range of potential sources of knowledge transfer. Finally, we suggest that it may be constructive to consider the public research sector not as a single source of knowledge transfer but as offering differing potentials to reach different audiences depending upon the standing of the institution itself.

The proximity argument is reflected in attention currently focused upon the local dimension to regional economic development. We see this in the promotion of clusters and the support provided to strengthening local networks. One of the key assumptions that the theoretical literature makes when examining the link between knowledge spillovers and spatial clustering is that 'knowledge externalities are more prevalent when new economic knowledge plays a greater role' (Audretsch and Feldman, 1996). The burgeoning literature on learning and innovation seems to point to the following as a rough rule of thumb: the greater the complexity, uncertainty and tacitness of an activity, the more it will require physical as opposed to virtual proximity to be transacted (Morgan 2004).

According to Porter (1990), to be competitive, firms must continually improve operational effectiveness in their activities while simultaneously pursuing distinctive rather than imitative strategic positions. His argument is that the existence of geographical clusters encourages both of these requirements for firm competitiveness, by encouraging the formation of regionally-based relational assets external to individuals firms but of major benefit to their competitive performance. Initially this leads to economies of scale, which result in low transactions costs, resource exchange, and transfer of knowledge, enabling positive innovation performance. However, as an homogeneous culture emerges innovation can be suppressed. The long-term effects of clustering on innovation are thus uncertain.

Whilst it is difficult to argue against strengthening local networks there is just a faint suggestion that too strong a focus in this area may be overlooking the important inter-regional dimension to knowledge transfer, over-looking the benefits of extra-local connections both in terms of economic stimulation and preventing lock-in. As Oinas and Malecki identify, the theme of extra-local relations which is recurrent in concepts such as innovative milieu, industrial districts and clusters is “mainly paid lip service rather than fully discussed” (1999 p.11).

In considering the spatial dimension to R&D dissemination and knowledge transfer it is important to consider, again, the nature of the knowledge that is being produced and the capabilities that exist to process this. In so far as knowledge transfer and generation is largely dependent upon proximity then the potential benefits of HEI knowledge transfer activities will be predominantly local. However, to the extent that relational learning predominates then the benefits will potentially reach more widely and policy initiatives supporting the development of communities of practice (as well as the current epistemic communities) could prove fruitful. In practice the picture is complex. As Archibugi and Michie identify (1997: p.122):

To understand technological change it is crucial to identify the economic, social, political and geographical context in which innovation is generated and disseminated. This space may be local, national or global. Or, more likely, it will involve a complex and evolving integration at different levels of local, national and global forces.

3.0 EU R&D policy instruments

3.1 The nature of intervention

Support for R&D has long been a feature of public policies. In the past this has largely been justified owing to the divergence between social and private returns on investment. It has also been a feature of other policy objectives, particularly those related to defence policies. More recently recognition of the longer-term economic benefits that can accrue to both firms and territories through R&D dynamism has led to R&D policies being promoted for reasons of economic development. In turn this has led to policy-makers questioning whether disparities in economic well-being are, at least in part, related to observed disparities in R&D capacity and activity. As our understanding of this complex area increases, so the policy focus is shifting from a simple 'science-push' towards a more complex mix of activities designed both to improve levels of innovation in firms (through supporting institutional and firm-level changes) and the amount and quality of R&D being undertaken.

The European Union's role in the field of R&D is set out in Article 163 (ex 130f) of the Treaty establishing the European Community [2] and in subsequent articles up to Article 173. The immediate objectives of EU R&D actions are broadly targeted towards the following types of activity:

- Promoting International R&D collaboration
- Establishing networks of SMEs
- Creating mechanisms to stimulate and support innovation
- Increasing EU wide human capital

[2] Article 163:
a. *The Community shall have the objective of strengthening the scientific and technological bases of Community industry and encouraging it to become more competitive at international level, while promoting all the research activities deemed necessary by virtue of other Chapters of this Treaty.*
b. *For this purpose the Community shall, throughout the Community, encourage undertakings, including small and medium-sized undertakings, research centres and universities in their research and technological development activities of high quality; it shall support their efforts to cooperate with one another, aiming, notably, at enabling undertakings to exploit the internal market potential to the full, in particular through the opening-up of national public contracts, the definition of common standards and the removal of legal and fiscal obstacles to that co-operation.*
c. *All Community activities under this Treaty in the area of research and technological development, including demonstration projects, shall be decided on and implemented in accordance with the provisions of this Title*.

- Building up knowledge infrastructure in less favoured regions and links to more advanced regions

At present the principal tools to achieve these objectives are the EU Structural Funds and the EU RTD Framework Programmes. In considering EU R&D policy instruments a useful distinction can be made between *sectoral* interventions, on one hand, and *territorial* interventions on the other[3].

- *Sectoral interventions* are directly addressed at the R&D sector, through the provision of direct support to R&D projects and researchers. In the EU context, the main instrument of direct sectoral support for R&D is the RTD Framework Programme. This is coordinated by DG Research and designed to promote cooperation in the field of R&D and the dissemination of research results and stimulate the training and mobility of researchers in the Community[4].
- The EU's *territorial interventions* in the field of R&D are addressed to specific geographical areas, through cohesion policies and specifically the Structural Funds. The main instrument is the European Regional Development Fund, available in areas eligible for support under Objectives 1 and 2 of the Structural Funds, and, to a lesser extent, the European Social Fund. ERDF actions are coordinated by DG Regional Policy, these interventions have generally focused on indirect support for R&D, such as the creation of networks for innovation, and worked alongside national and regional activities.

In addition to the Framework Programmes and the R&D-related actions funded under the mainstream Structural Funds, the Commission has also operated a number of pilot actions or limited initiatives in support of R&D development. During the 1994-1999 funding period, these took the form of Regional Innovation Strategies (RIS) and Regional Technology Transfer (RTT) actions. Under the current programming period (2000-2006), the first of three strands of Innovative Actions funded through the ERDF aims to support regional competitiveness on the basis of innovation. DG Research also administers a pilot programme called Regions of Knowledge, established on the initiative of the European Parliament. In each case, regions apply to the Commission for selection though open competitions.

All these different aspects of Community policy in the field of R&D now operate in the context of a strategic goal, on the part of the EU, to create a European Research Area

[3] This distinction is made in *Study on the Construction of a Balanced and Polycentric Development Model for the European Periphery: Research and Development and Innovation*.
[4] Objectives set out in Article 164 of the Treaty

(ERA). The concept of the European Research Area (ERA) was established in the Commission communication *Towards a European Research Area*, published in January 2000, in advance of the Lisbon Summit of March that year. The basic idea underpinning the ERA is that the issues and challenges of the future cannot be met without much greater integration of Europe's research efforts and capacities. At present European research is fragmented along national lines, with the result that efforts are duplicated and valuable resources wasted.

The ERA project is seen as means to improve coordination and, in the longer term, to achieve greater co-operation between Member States' research strategies and a mutual opening up of programmes. This approach is seen as key, if Europe is to meet the aim, set out in the conclusions of the Lisbon summit, of becoming 'the world's most competitive and dynamic economy by 2010'.

In practical terms, the Sixth Framework Programme (see below) is the Commission's main instrument for achieving the goals of the ERA. In addition, however, it is recognised that the overarching nature of the ERA's objectives implies a greater co-ordination between the different strands of EU policy in the field of R&D[5].

The rest of this section will now go on to examine the different element of EU R&D policy in more depth. The following sections will provide:

- A brief overview of the successive RTD Framework Programmes (FPs) from the Fourth FP (1994-1998) onwards, followed by initial analysis of patterns of participation in the FPs across the European territory;
- An overview of the R&D component of the Structural Funds, including the territorial distribution of these actions and;
- A description of the Innovative Actions conducted under Article 10 of the ERDF (RIS, RIS+) and the subsequent Innovative Actions for the period 2000-2006.

3.2 The RTD Framework Programmes

3.2.1 Overview

The RTD Framework Programmes (FPs) are the most important mechanism for EU funding of R&D. As set out in the Treaty (art.166), these multi-annual Programmes fix the objectives and priorities for activities to promote cooperation in the field of R&D, the

[5] See, for example, *The Regional Dimension of the European Research Area* COM(2001) 549 final, Brussels, 03.10.2001

dissemination of research results and the training and mobility of researchers in the EU. The First Framework Programme (FP1), launched in 1984, ran until 1987 and was succeeded by FP2 (1987-91), FP3 (1990-94), FP4 (1994-1998) and FP5 (1998-2002), until the recent launch of the Sixth Framework Programme (FP6) in November 2002.

Research and training activities in all sectors, funded under the FPs, are implemented through project-based contracts between the European Commission and participants. Until the end of FP5, a substantial proportion of Framework Programme funding went to "shared-cost" research actions. These are research projects put into effect by multinational consortia made up of firms (including Small and Medium-sized Enterprises, SMEs), research centres and universities, eligible to receive 50% of their basic project funding costs from the Commission. The new instruments (contract types) introduced with the launch of FP6 have altered this picture slightly[6], although the co-operative, multinational projects remain the core focus for funding.

A significant part of FP funding is also allocated for the direct activities of the Joint Research Centre (JRC). The JRC is an integral part of the European Commission, made up of seven research institutes in five separate locations[7], and provides scientific advice and technical expertise to support EU policies. The majority of JRC activities, in both the nuclear and non-nuclear field, are explicitly set out in the FPs (the "direct activities"), although the institution is also able to participate in other competitive FP projects with other partners or engage in external contracts ("indirect" activities).

3.2.2 Framework Programme 4 and Framework Programme 5

The Fourth Framework Programme was launched in 1994, with an overall budget allocation of € 13 100 million. As shown in Table 3.1 below, it was structured into four main activity areas (reflecting the structure set out in the Treaty), of which RTD and demonstration projects in seven thematic areas accounted for the vast majority of funding. The main innovative features of FP4, compared with previous Programmes, were the integration of two new research themes (transport and targeted socio-economic research), the definition of substantive activities concerning internal cooperation and dissemination of results and the introduction of a more tailored approach to stimulating research by SMEs. Activity four, the "stimulation of the training and mobility of researchers" continued to

[6] The main new instruments introduced in FP6 are Networks of Excellence and Integrated Projects. The former are eligible for a maximum of 25% funding, while Integrated Projects can receive between 35% and 100% funding depending on the type of project. Specific Targeted Research and Innovation Projects follow the traditional "shared cost" model and are eligible for 50% funding.

[7] In Geel (B), Ispra (I), Karlsruhe (D), Petten (Nl) and Seville (E).

include Marie Curie Fellowships for individual researchers, first introduced under the Second Framework Programme.

Table 3.1 Structure and Budget of FP4 (1994-1998)

Structure	***Budget***
ACTIVITY 1	
❑ *Information and Communication Technologies*	€ 3 626 million
❑ *Industrial Technologies*	€ 2 125 million
❑ *Environment*	€ 1 150 million
❑ *Life Sciences and Technologies*	€ 1 674 million
❑ *Energy (including nuclear activities)*	€ 2 403 million
❑ *Transport*	€ 256 million
❑ *Targeted socio-economic research*	€ 147 million
Subtotal	**€ 11 381 million**
ACTIVITY 2 ❑ *Cooperation with third countries and international organisations*	€ 575 million
ACTIVITY 3 ❑ *Dissemination and exploitation of results*	€ 352 million
ACTIVITY 4 ❑ *Stimulation of the training and mobility of researchers*	€ 792 million
TOTAL	**€ 13 100 million**

Source: Global Budget FP4

The Fifth Framework Programme introduced a simplified structure based on four “thematic programmes” (Activity 1), addressing defined problems, and three “horizontal programmes”, designed to respond to common needs across all research areas. The Structure and budget distribution for FP5 is shown in Table 3.2.

Each Thematic Programme was subdivided into so-called “Key Actions”, conceived as clusters of specifically targeted research projects of different sizes, “directed towards a common European challenge or problem"[8]. In all, there were 22 Key Actions under the Thematic Programmes of FP5, complemented by "Research and technological development activities of a generic nature" (in a limited number of areas not covered by the Key Actions) and support for research infrastructures.

Table 3.2 Structure and Budget of FP5 (1998-2002)

Structure	Budget
ACTIVITY 1 ❑ *Quality of life and management of living resources* ❑ *User-friendly Information Society* ❑ *Competitive and Sustainable Growth* ❑ *Energy Environment and Sustainable Development*	€ 10 843 million
ACTIVITY 2 ❑ *Confirming the international role of Community research*	€ 475 million
ACTIVITY 3 ❑ *Promotion of Innovation and encouragement of SME participation*	€ 363 million
ACTIVITY 4 ❑ *Improving human research potential and the socio-economic knowledge base*	€ 1 280 million
❑ *Joint Research Centre (non nuclear)*	€ 739 million
EURATOM Programme	€ 1 260 million
TOTAL	**€ 14 960 million**

Source: Global Budget FP5

3.2.3 The Current Framework Programme: FP6

The Sixth Framework Programme, launched in November 2002, contains many features in common with previous FPs, but, as noted above, is now conceived as the main tool to further the development of the European Research Area. FP6 has been structured with the main objectives of better integrating research across Europe in seven thematic areas

[8] CORDIS: Introduction to FP5 http://www.cordis.lu/fp5/src/struct.htm

and "structuring" and "strengthening" the ERA. The structure and budget for FP6 are set out in Table 3.3 below.

One of the most significant innovations brought by FP6 is the introduction of two new "instruments", or project types. Firstly, "Networks of excellence" are large-scale projects, designed to strengthen scientific and technological excellence in a particular research field, with the ultimate aim of producing a durable structuring and shaping of the way research is conducted on that topic in Europe. This long-term structuring effect is seen as a means to bolster cooperation and reduce the current fragmentation between different national research programmes.

Table 3.3 The Structure and Budget of FP6 (2002-2006)

Structure	*Budget*
Focusing and Integrating Community Research *Thematic Priorities* ❑ *Life Sciences, genomics and biotechnology for health* ❑ *Information Society Technologies* ❑ *Nanotechnologies* ❑ *Aeronautics and Space* ❑ *Food quality and safety* ❑ *Sustainable Development, Global Change and Ecosystems* ❑ *Citizens and Governance in a Knowledge Based Society* *Specific Activities covering a wider field of Research* ❑ *Policy support & anticipating S&T needs* ❑ *Horizontal research activities involving SMEs* ❑ *Specific Measures in support of international cooperation* *Non nuclear activities of JRC*	€ 13 345 million

Structuring the European Research Area ❑ *Research and Innovation* ❑ *Human Resources* ❑ *Research Infrastructures* ❑ *Science and society*	€ 2 605 million
Strengthening the Foundations of the ERA ❑ *Support for Coordination of activities* ❑ *Support for coherent development of policies*	€ 320 million
EURATOM Framework Programme	€ 1 280 million
TOTAL	**€ 17 500 million**

Source: DG Research

The second major new instrument is "Integrated Projects". These are multi-partner projects to support objective-driven research, where the primary deliverable is knowledge for new products, processes and services. They are designed to increase the average size of research projects under the FPs, to develop the critical mass necessary to make a real impact and thus help achieve the ambitious goals set out for the Programme.

Despite these significant developments, many features of previous FPs are continued under FP6, albeit in modified form. Specific Targeted Research Projects and Coordination Actions continue in the tradition of previous shared-cost projects, while the horizontal actions to encourage the participation of SMEs and Innovation related activities also continue. The budget for Research mobility and training, in particular through the Marie Curie Actions, has been increased significantly, compared with FP5.

In terms of the thematic areas covered by the Programme, FP6 concentrates on fewer priorities than FP5, with a particular focus on areas where it is felt co-operation at a European level presents real added value. Nanotechnologies are included as a thematic priority for the first time.

3.2.4 Towards FP 7

The proposals for the 7th Framework Programme are intended to drive the "internal market of knowledge" (Science and Research Commissioner Potočnik 6 April 2005 to European Parliament ITRE Committee) in the EU and so contribute to the development of the European Research Area. The 7th FP will differ from its predecessors in so far it will last for 7 years rather than 4 and will follow the EU's financial perspective 2007-13). It is intended that FP7 will be organised into 4 specific themes:

- Co-operation: supporting co-operative research between firms, universities and research centres and public authorities across the EU and with the rest of the world. It is intended that nine areas for co-operative research will be identified
- Ideas: the development of an autonomous European Research Council to fund ground-breaking research
- People: strengthening the training, career prospects and mobility of European researchers
- Capacities: developing and fully exploiting the EU's research capacities through large-scale research infrastructure, regional co-operation and innovating SMEs.

In addition, support will continue for the Joint Research Centre and obligations under the Euratom Treaty.

It is proposed that the 7th FP should have a budget of around €67billion over the 7 year programme.

At the time of writing the precise scope and scale of the 7th Framework Programme remains under negotiation.

3.3 R&D Actions under the Structural Funds

3.3.1 The Mainstream Funds

Actions in the area of Research, Technological Development and Innovation financed by the Structural Funds have become comparable in size, although different in nature, to those financed by the Framework Programmes. R&D related actions have received a significant share of funding in Objective 1 and Objective 2 regions, under both the 1994-

1999 and the 2000-2006 Programming Periods. The current distribution of Objective 1 and Objective 2 regions is shown in Map 3.1 below.

"R&D related actions" under Objective 1 include RTD infrastructure; technology transfer and demonstration; support for the scientific and technological system; support for innovation; advanced training of human resources. For Objective 2, measures mostly concern:

- The stimulation of interaction between scientific bodies and the productive fabric
- The promotion of capabilities for absorption and exploitation of technology and the financing of innovation in SMEs
- The establishment of transfer structures, training programmes and consultancy services.

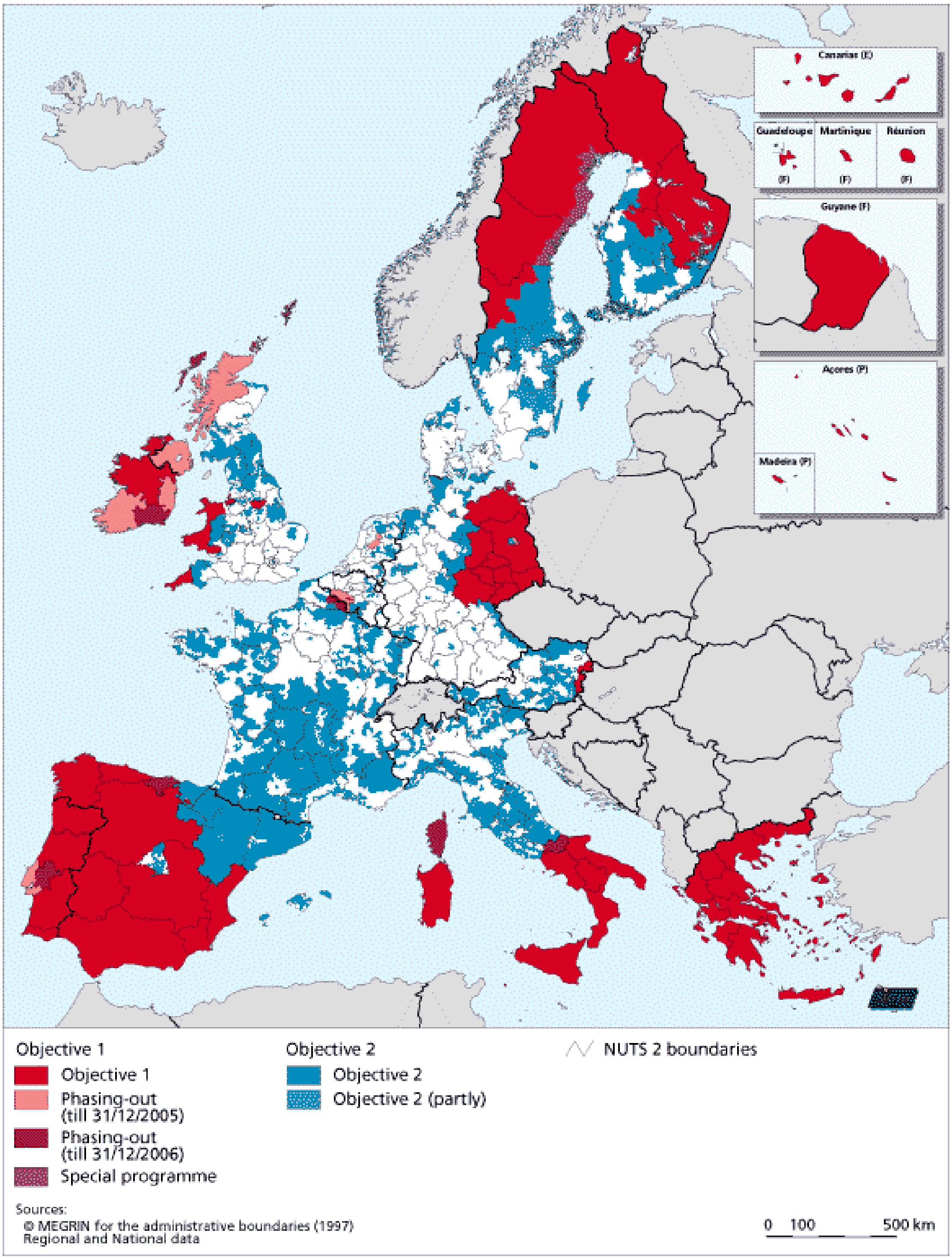
The tradition of academic and industrial research and relatively important and high quality research and technological development infrastructure, characteristic of Objective 2 regions, means that fewer Structural Funds have been allocated to 'pure' R&D projects than in Objective 1 regions. More emphasis has been placed on increasing the level of co-operation between existing R&D "infrastructure" and industrial firms with a view to product and process innovation[9].

In the current programming period (2000-2006) the distribution of Structural Funds between activities is recorded through the use of codes assigned to different Fields of Intervention. One of these codes (number 18) relates to actions in support of RTDI. The relevant intervention codes for current programming period are:

18 *Research, technological development and innovation (RTDI)*
181 *Research projects based in universities and research institutes*
182 *Innovation and technology transfers, establishment of networks and partnerships between businesses and/or research institutes*
183 *RTDI Infrastructure*
184 *Training for researchers*

[9] Notably: technology and innovation centres; university transfer and spin-off interfaces; graduate placement schemes; new technology-related training.

Map 3.1 The Structural Funds 2000-2006



Source: DG Regio

Other actions

To help overcome problems caused by a lack of absorptive capacity, and to redress the supply-side bias of earlier programmes like STRIDE, the European Commission launched one of its most innovative programmes under the aptly named Innovative Actions, which was financed under Article 10 of the ERDF during the period 1994-99. The programme was called RIS (Regional Innovation Strategies) and this was complemented by RITTS (Regional Innovation and Technology Transfer Strategies), which was financed under the Innovation Programme of FP4.

The objectives of the RIS-RITTS exercises were threefold:

- To improve the capacity of the regional actors to develop policies which match the demands of the private sector and the supply capability of the RTD infrastructure

- To provide a framework within which the regional, national and Community authorities might be able to optimise their RTD investment policies at the regional level

- To build a consensus in the region about the problems and the prospectus for addressing them

Through RIS-RITTS, over 100 regions have been assisted to develop regional strategies for innovation. These projects led to the establishment of the Innovating Regions of Europe (IRE) network, a joint platform for collaboration and exchange of experiences in the development of regional innovation policies and schemes: (http://www.innovating-regions.org/index.cfm). RIS was followed up by RIS+ projects in the period 2000-2002, designed to help implement the strategies developed in the RIS[10].

For the period 2000-2006, one of the three new Innovative Actions programmes covers RTD issues[11]. It aims to help regions develop competitive assets based on innovation, rather than leave them to base their regional competitive advantage on costs, an advantage which can be quickly eliminated in a globalised economy[12]. Actions under this theme focus on improving cooperation between business, RTDI bodies and others to establish an environment and a regional institutional framework, which will promote the creation, dissemination and integration of knowledge within the productive fabric.

[10] See *Regional Innovation Strategies under the ERDF: Innovative Actions 2000-02* for detailed project descriptions

[11] *Regional Economies based on knowledge and technological innovation: helping less-favoured regions to raise their technological level;*

[12] *The Regions and the New Economy: Guidelines for Innovative Actions Under the ERDF in 2000-06*

All regions eligible in whole or in part under Objective 1 and Objective 2 and those receiving transitional support under these objectives are eligible to apply for Innovative Action funding. The entire region, including those areas not covered by Objectives 1 and 2, is considered eligible.

Examples of projects include:

- creation or reinforcement of co-operation networks between firms or groups of firms, research centres and universities, organisations responsible for improving the quality of human resources, financial institutions and specialist consultants, etc.;
- staff exchanges between research centres, universities and firms, particularly SMEs;
- dissemination of research results and technological adaptation within SMEs;
- establishment of technological strategies for the regions, including pilot projects;
- support for incubators for new enterprises which have links with universities and research centres; encouragement for spin -offs from university centres or large companies oriented towards innovation and technology;
- schemes for assisting science and technology projects carried out jointly by SMEs, universities and research centres;
- contribution to the development of new financial instruments (venture capital) for business start-ups[13]

3.3.2 Towards the new programming period

In 2004 the European Commission published its proposals for the future of the Structural Funds in the programming period 2007-2013. This is based upon three new priorities:

- A convergence objective that will provide support for regions with a per capita GDP of less than 75% of the EU average (including temporary support to 2013 for those regions with a GDP of less than 75% of the EU-15 average)
- A competitiveness and employment objective designed to help regions across the EU, which are not eligible for support under the convergence objective, deal with economic and social change, globalisation and the transition to a knowledge economy
- A territorial co-operation objective to stimulate cross-border and trans-national co-operation.

[13] *The Regions and the New Economy: Guidelines for Innovative Actions Under the ERDF in 2000-06: 7*

The final form of the future programmes for the Structural Funds remain under negotiation at the time of writing. Within the published draft Regulation for the ERDF actions in support of research, technological development and innovation are heavily emphasised as key areas where it is intended that assistance should be concentrated for each of the three proposed objectives. A range of potential actions are identified in the Regulations, which are familiar from the current programming period.

3.4 Other actions

The most recent initiative in the field of R&D was launched at the request of the European Parliament. "Regions of Knowledge" has a budget of €2.5m and is administered by DG RTD. It applies only to the Member States of the EU-15 owing to legal constraints at the time of its introduction in 2003. It consists of three strands covering:

- Technology audits and regional foresight exercises;
- Universities as drivers of regional development (regional innovation systems) and
- Mentoring initiatives supporting the development of less favoured regions (especially Objective 1) through collaboration with more technically advanced regions.

The ethos of this pilot action demonstrates the increasing convergence of EU policy towards R&D through its emphasis on supporting the development of regional innovation systems as well as R&D infrastructure and individual R&D projects.

3.5 Towards territorial cohesion

An emerging priority of EU policies has been to promote R&D and innovation activities in areas where these have traditionally been less present, in order to promote territorial cohesion. This is evident in the Structural Funds and the work of DG Regional Policy but increasingly so in the actions of DG Research as well. The concept of territorial cohesion adds to, and reinforces, the twin notions of economic and social cohesion. The objective is to:

"help achieve a more balanced development (of the European territory) by reducing existing disparities, preventing territorial imbalances and by making both sectoral policies, which have a spatial impact, and regional policy more coherent" (European Commission, 2004: p.27)

The 3rd Report on Economic and Social Cohesion published by the Commission identifies territorial disparities at a number of different levels, of which the following are of particular relevance:

- At an EU level - with a high concentration of activity in the central area
- At a national level – with pronounced imbalances between the main metropolitan areas and the rest of the country
- At a regional level
- Specific areas constrained by the geographical features (islands, sparsely populated areas and certain mountain areas)

It is argued that the problems that these areas experience can set in train a cumulative process in which difficulties of accessing centres for research and innovation can further reduce the economic development potential of regions which are already lagging. Conversely, encouraging the development of knowledge-based economic activities and innovation is assumed to support the development of the economic and employment potential of less-favoured regions. To this end the 3rd Report on Economic and Social Cohesion also asserts that a number of urban regions located outside of the core have the potential to attract research activity and to link up over time with the main European, and even international, centres of decision-making.

This is strongly supportive of the Lisbon Goals (2000) which, inter alia, identified the need to prioritise innovation and enterprise, particularly through developing conditions favourable to R&D and creating closer links between research institutes and industry.

Focusing more directly on the spatial dimension, the concept of polycentric development appears to be particularly important for strengthening territorial cohesion, despite its ambiguity when applied at different scales. Drawing on the work of TPG 3.1, polycentric development generally concerns functional urban areas, their functional specialisation, the links and interaction between them and the morphological urban system. The application of the concept and importance of the single elements differ depending on the geographical scale, i.e. European, national and regional or even urban. At the European level e.g., the main emphasis is on stimulating the development of regions beyond the so-called Pentagon into becoming global integration zones. A more polycentric structure, with several strong urban regions of European and global significance, can contribute to the competitiveness of Europe as well as to cohesion between different territories. In order to achieve territorial cohesion and polycentric development this however needs to be made more explicit in the context of the necessary policies and implementation instruments.

The ESPON work has shown that the policy aims of territorial cohesion and polycentric development can be applied at various geographical levels, i.e. European/trans-national, national or regional/local (three level approach). The meaning and implication of the concepts change depending on the level in question and can even contradict each other, e.g. strengthening polycentric development at the European level may weaken polycentric development at the national level, and vice versa. Fundamentally, it is not possible to have an equal distribution of activity across the EU territory where the goal is polycentric development.

3.6 Trends in national policies

EU R&D policies do not operate in isolation. Indeed the funds available are only a small proportion of total expenditure on R&D by other public sector bodies, which, in turn are exceeded by private sector expenditure. EU policies must therefore be set in the national and regional context in which they apply.

It is beyond the scope of this report to set out this policy framework for each Member State in detail. Much valuable work has been undertaken in this area in recent years and we reproduce the findings from the Commission's recent benchmarking exercise examining trends in national research policies in Box 3.1 below. This clearly demonstrates the common challenges being addressed by Member States. Nevertheless, we should not underplay the importance of national and regional policies, as recognised by North (1993), in his seminal work on path dependency where he recognises that the difficulty of turning economies around is "a function of the nature of political markets and, underlying that, the belief systems of the actors".

Box 3.1: National research policies in the EU

There is evidence that Member States are trying to face the challenge of an increased and more effective RTD investment, although actions taken recently may not yet have produced all desired effects, and there remains room for further action. In fact, while the level of RTD investment is an issue of main concern, more efficient spending has acquired almost equal importance. In every Member State, policy makers are putting into practice schemes, which will optimise the use of whatever resources are made available for RTD. Whereas national objectives have been dictated by each country's specific situation, several common trends have been observed:

- Direct public funding to large companies has been substantially cut, with the notable exception of Ireland and Greece, which are using structural funds to pay for such support. The rationale for this evolution is strongest in countries where the share of private funding of RTD is largest: the resources spent by the private sector on applied RTD dwarf the allocation that the public sector can make available for this purpose; therefore using public funds to subsidise research in the private sector can only have minor effects. This is why policymakers have moved away from straightforward subsidy mechanisms and contemplate ways of funding the private sector RTD only if additionality, leverage or catalytic effects are demonstrated.
- Direct public support to SMEs continues in all Member States. Because of their limited size, these companies often cannot support all the necessary functions needed to innovate. Many SME-specific programmes aim at addressing these barriers, and favourable access conditions are designed for companies under a certain size in general support programmes.
- In addition, several governments have developed programmes to create a venture capital market and provide seed capital and start-up funds. They can take very different forms. For example, on seed and venture capital (VC) fund, measures range from direct state funding to companies (France and Denmark), to providing funds to VC funds (United Kingdom and Ireland). The objective is to build a private venture capital market and to phase out public funds, but this has proved difficult in many EU countries.
- Policies which support the creation of new technology based firms (NTBF) have flourished in recent years. Various types of subsidies, soft schemes, transfer programmes, seed capital funds, academic entrepreneurship promotion programmes, changes in IPR rules, etc. are set up with public intervention, in order to create a better environment for new firm creation, notably for those firms founded on the exploitation of research results.
- Public funding is increasingly targeted at science-enterprise and enterprise-enterprise collaboration. It is made available through, inter alia, competitive programmes or indirect measures, such as loans or tax incentives. There are a number of positive national and European experiences. Successful examples include support to research consortia and creation of centres of excellence, creating critical mass of research activities in specific areas. The so-called "cluster programmes" promote networking within business for innovation purposes. Joint business RTD activities are also receiving support, not least from the European level. Finally, the promotion of enterprise-science relationships is a long standing focus of national policies, and many programmes are designed with such an objective in mind: creation of intermediaries, of bridging and collaborative programmes, etc. This is a fundamental part of an overall policy to improve the connection between Europe's relative strengths in research and the exploitation and commercialisation of discoveries.
- At the same time public research institutes are being encouraged (if not required) to direct their research efforts to areas of interest to private firms. All EU Member States have taken part in this characteristic trend of the 1990s. In

some of them, it has been expressed through a focus on specific domains such as biotechnology or information and communication technologies.

– A renewed commitment to fund long-term scientific research has been observed in several cases, including in areas of a basic nature or of high social value but no immediate return. This is complemented by a reform of the science base structure to support such reorientation. The reform can, for example, incorporate more autonomy of research organisations along with more accountability, more competition in funds allocation and accommodation of the growing demand for linkages with users of research results.
– Regional involvement becomes an important issue in several countries, allowing for the concentration of investments in dedicated areas as well as an overall increase of private sector involvement. A popular form is science parks. These developed in the 1980s in the northern EU countries. They then spread to southern Europe, with the help of European regional development funding.

Source: Benchmarking National RTD policies (EC 2002 p.xi)

4.0 Methodology

4.1 Method of Approach

In addressing the objectives for this study we have focused on four principle areas of activity:

- Firstly we have examined the capacity of regions in the EU in terms of R&D and innovation activity
- Secondly we have sought to examine the value of developing different typologies of regions based upon this analysis
- Thirdly we have examined the distribution of EU R&D policies and their spatial effects
- Finally we have drawn upon the findings of these three areas of work to reflect on the lessons to be learnt.

In the following section we set out in more detail the methodology adopted to address each of the three principal areas of activity. The conceptual basis for the study has been based upon an extensive review of existing literature in this field, which, together with the knowledge of the expert team, assisted in identifying key areas for analysis.

4.2 Assessing regional capacity for R&D and innovation

4.2.1 Indicator selection

One of the objectives of the study has been to identify and gather existing territorial indicators to measure and display the state, trends and impacts of R&D policy. The identification of relevant indicators was based upon the review of literature in this area. This identified appropriate areas of coverage – which indicators might be relevant - and where data was likely to be consistently available at a common territorial scale. The indicators identified can be grouped into four principal categories:

R&D activity
R&D expenditures as a percentage of regional GDP
Patent Applications and High Tech Patent Applications to the European Patent Office

Human resources for R&D
R&D personnel
Employees with Tertiary level education working in a Science and Technology Occupation

Human resources for innovation more generally
Employment in High Technology and Medium High Technology Manufacturing
Employment in High Technology Services
Percentage of the Working Age Population (aged 24-65) having successfully completed some form of tertiary education

Infrastructure for R&D and innovation
Science Parks
Business Innovation Centres
Research active Universities and Public Research Institutes

4.2.2 Normalising the data

EU regions differ significantly in geographical size and in their size of population. To enable robust analysis data must be expressed in comparable units. Indicators for R&D activity and human resource capacity have been combined with GDP, population and labour force indicators, as identified below, in order to enable robust comparisons to be drawn. Data was drawn from EUROSTAT datasets and is always the relevant year for each indicator ie R&D expenditure for 1997 is normalised using GDP data for 1997, expenditure in 2000 uses GDP data for 2000.

4.2.3 Indicator specification

The source and specification of the indicators is as follows.

Expenditure on R&D as a percentage of GDP ('R&D Intensity')

The basic measure for R&D expenditure is the “intramural expenditures”, which are all expenditures for R&D performed within a statistical unit or sector of the economy, whatever the source of funds (Frascati Manual, § 335). R&D expenditure is produced separately for the Business Enterprise Sector (BES), the Higher Education Sector (HES), the Government Sector (GOV) and the Private non-profit sector (PNP).R&D expenditures as a percentage of regional GDP (in millions of national currencies, in millions of euro, and as a percentage of gross domestic product). Data has been collected for the whole economy (GERD), for the business enterprise sector (BES), government sector (GOV), higher education sector (HES), and private non-profit sector (PNP). Data source: EUROSTAT with additional material sources from National Statistical offices.

Patent Applications and High Tech Patent Applications to the European Patent Office (EPO)

The number of applications to the EPO based on region of registered address (total number of applications, number of applications per million people in population, and number of applications per million people in the labour force) for the whole economy.

The number of patents per business R&D expenditure (BERD) shows a substantial variation between EU countries (where Sweden, the Netherlands and Germany score most highly), and even more so between regions. The sectoral composition of industry strongly influences such rankings, with regions with high levels of activity in machinery, chemicals, communications equipment, and electrical components more likely to score highly in numbers of patents. The results are also influenced by the headquarters location of a firm, as this often determines the location recorded for the patent. Without taking into account the detailed specialisation patterns of regions, it is not possible to fully interpret the data available (for more on this please see "Benchmarking S&T Productivity", EC 2002).

Data source: EUROSTAT with additional material sources from National Statistical offices.

R&D personnel as a percentage of the labour force

R&D personnel data measure the amount of resources going directly into R&D activities. This includes all persons employed directly in R&D plus persons supplying direct services to R&D, such as managers, administrative staff and office staff (Frascati Manual § 279). R&D personnel data is collected in Headcount (total number of persons who are mainly or partially employed on R&D) and Full Time Equivalent (FTE). Not all countries collect R&D personnel by headcount.

For the EU-15, this indicator is calculated on the basis of R&D personnel measured in headcount (the total number of people actually employed). As comparable data for R&D personnel measured in headcount are not available for the Candidate countries, the study team has calculated percentages on the basis of personnel measured in Full Time Equivalent (FTE). This means that the data for the proportion of R&D personnel in the labour force in these countries are underestimated in comparison to the EU-15 and that, as a result, direct comparisons between the EU-15 countries and Candidate countries should be made with great caution. Data source: EUROSTAT with additional material sources from National Statistical offices.

Employees with Tertiary level education working in a Science and Technology Occupation as a percentage of total employment.

Human resources in science and technology (HRST) are people who fulfil one or other of the following conditions:

- successfully completed education at the third level in an S&T field of study (including natural sciences; engineering and technology; medical sciences; agricultural sciences; social sciences; humanities; other fields, where the first five are "core" fields and the last two "extended")14
- not formally qualified as above but employed in a S&T occupation where the above qualifications are normally required

Human Resources in Science and Technology Core (HRSTC) are those people who have a third level education and work in a S&T occupation. Examples include:

- university professor with a PhD in economics;
- computer system designer with a degree in computer science;
- dentist practising in his/her own dental surgery

The Codes are as follows:

HRSTE: those people who have successfully completed third level education
HRSTO: those people working in a S&T occupation
HRSTC: the core HRST (those people who have a third level education and working a S&T occupation).
HRST = HRSTO + HRSTE - HRSTC

For further information, see OECD and Eurostat (1995), "Manual on the Measurement of Human Resources Devoted to S&T – Canberra Manual", Paris

Data source: EUROSTAT with additional material sources from National Statistical offices.

[14] Manual on the Measurement of Human Resources devoted to S&T Canberra Manual, OECD, Paris 1995, p.22 (see http://www.oecd.org/dataoecd/34/0/2096025.pdf)

Employment in High Technology and Medium High Technology Manufacturing as a percentage of labour force

The medium-high and high technology sectors include chemicals NACE15 (24), machinery (NACE 29) office equipment (NACE 30), electrical equipment (NACE 31), telecom equipment (NACE 32), precision instruments (NACE 33), automobiles (NACE 34), and aerospace and other transport (NACE 35). The total workforce includes all manufacturing and service sectors.

Data source: EUROSTAT with additional material sources from National Statistical offices.

Employment in High Technology Services as a percentage of labour force
This indicator focuses on three leading edge sectors that produce high technology services: post and telecommunications (NACE 64); information technology including software development (NACE 72); and R&D services (NACE 73). The total workforce includes all manufacturing and service sectors.

Data source: EUROSTAT with additional material sources from National Statistical offices.

Population with Tertiary Education

The percentage of the total working age population (25-64 years age classes) with some form of post-secondary education (ISCED 5 and 6). Data source: EUROSTAT with additional material sources from National Statistical offices.

Science Parks
Science Parks that are members of the International Association of Science Parks (IASP). Data source: membership list on the IASP website 2003: http://www.iaspworld.org/

Business Innovation Centres

Centres that are registered as members of the EU's Business Innovation Centre network. Data source: European Commission Services 2003

[15] Nomenclature statistique des Activités économiques dans la Communauté Européenne" - Statistical classification of economic activities in the European Community

Most Actively Publishing Universities and Public Research Institutes in the EU 15

Most actively publishing universities and public research institutions in the EU-15 member states (universities and public research institutions appearing in the top 20 most actively publishing research institutions in D,E, F, I, NL, S, UK and top 10 most actively publishing institutions in B, DK, FIN, AT, GR, P, IRE). Obtained from Third European Report on Science and Technology Indicators 2003, DG Research 2003 pp.310-314. Private Organisations appearing in the original ranking have been excluded

Direct indicators of firm-level innovation

Many indicators of innovation rely upon proxy measures (such as patent applications or various labour force measures). These proxy indicators have known deficiencies although they are widely accepted as valuable measures of activity. Since the 1990s, the EU has undertaken a direct survey of firms to establish the level of innovation activity in Member States. This is the Community Innovation Survey (CIS). Results for the CIS are published at a Member State level but not for individual regions.

Despite exploring the potential offered by the CIS the study was unable to make use of this data to provide detailed figures on the propensity of firms within EU regions to engage in innovative activity. Unfortunately the survey has not been designed to provide a reliable sample at the regional scale. There does exist an estimation of regional innovation activity based on the CIS data for 1994-1996 but this exercise has not been repeated. We sought access to the original data files from this work but were informed that this was not possible owing to confidentiality restrictions. The European Innovation Survey has extrapolated regional figures on the basis of the estimates developed from the original work, which are included as part of our typology assessment.

We made enquiries of National Statistical Offices and EUROSTAT to ascertain whether data might be made available from more recent CIS returns. This is unfortunately not possible. We reproduce below the response of EUROSTAT to our request for regional data emanating from the most recent CIS (CIS 3) in Box 4.1 below. The response of individual National Statistical Offices is contained in Annex 2.

Box 4.1 : Regional availability of CIS 3 data: Response by EUROSTAT

We (EUROSTAT) disseminated the aggregated CIS 3 data already some time ago on our web. This data is at national level and does not contain regional data. This is based on the fact that most countries carrying out the CIS 3 did not include the region when stratifying the sample with the effect that no production of regional data at acceptable data quality is possible (there might be exceptions for some countries which we did not pursue at EU level).

We are currently also working on the creation of a method for anonymising the CIS 3 micro-data and hope to make this anonymised micro-data file available at the beginning of 2006. This micro-data file will however not contain a regional identifier neither.

Thirdly we have already created the CIS 4 which is currently implemented at national level and for which we expect the aggregated results from countries in the first half of 2006 (legal deadline: 30/6/06). This next CIS covers however also some regional data, we made a regional tabulation per country which we already sent to them some months ago. Based on an enquiry with countries, we can expect for the CIS 4 regional data on NUTS 1 or 2 level for about 15 countries (please note that a number of those countries are a whole NUTS 2 region anyhow).

Source: EUROSTAT October 2005

4.2.4 Territorial coverage of indicators

Data was collated for regions at the NUTS 2 level wherever possible. In some instances data was not available at this level and NUTS 1 data has been made use of in those cases. The territorial coverage of key indicators at the time of the data collection (Jan 2003) is illustrated in Table 4.1 below.

Table 4.1 Territorial coverage for key indicators16

Country	R&D expenditure (All sectors)	R&D personnel (All sectors)	HRSTC	Employment in High & Medium High Tech Manufacturing	Employment in High Tech Services	Working Age Population with Tertiary Education
Austria (AT)	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II
Belgium (BE)	NUTS 0	NUTS 0	NUTS II	NUTS II	NUTS II	NUTS 0/I17
Bulgaria (BU)	NUTS II	NUTS II	NA	NUTS 0	NUTS 0	NUTS 0
Cyprus (CY)	NUTS II	NUTS II	NA	NUTS II	NUTS II	NUTS II
Czech Republic	NUTS II	NUTS II	NA	NUTS 0	NUTS 0	NUTS 0
Germany (DE)	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II
Denmark (DK)	NUTS II	NUTS II	NA	NUTS II	NUTS II	NUTS II
Estonia (EE)	NUTS II	NUTS II	NA	NUTS II	NUTS II	NUTS II
Spain (ES)	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II
Finland (FI)	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II
France (FR)	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II
Greece (GR)	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II
Hungary (HU)	NUTS II	NUTS II	NA	NUTS 0	NUTS 0	NUTS 0
Ireland (IE)18	NUTS I	NA	NUTS I	NUTS II	NUTS II	NA
Italy (I)	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II
Lithuania (LT)	NUTS II	NUTS II	NA	NUTS II	NUTS II	NUTS II
Luxembourg	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II	NA
Latvia (LV)	NUTS II	NUTS II	NA	NUTS II	NUTS II	NUTS II
Malta (MT)	NA	NA	NA	NA	NA	NUTS II
Netherlands	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II
Poland (PL)	NUTS II	NUTS II	NA	NUTS 0	NUTS 0	NUTS 0
Portugal (PT)	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II
Romania (RO)	NUTS 0	NUTS 0	NA	NA	NA	NUTS 0
Sweden (SE)	NUTS 0/I	NUTS II	NUTS II	NUTS II	NUTS II	NUTS II
Slovenia (SI)	NUTS II	NUTS II	NA	NUTS II	NUTS II	NUTS II
Slovakia (SK)	NUTS II	NUTS II	NA	NUTS 0	NUTS 0	NUTS 0
UK	NUTS I	NA	NUTS II	NUTS II	NUTS II	NUTS II

[16] We do not include Patent data in this table. For a full assessment please see the related ESPON database.
[17] Population with Tertiary Education data is only available for the *Brussels-Capital* region..
[18] Until the end 1999, the Republic of Ireland was one NUTS 0,I and II region, at which point it was divided into two NUTS II regions. R&D data is not available for the new NUTS II regions.

Data for all indicators was collected from 1994 (where available) to the most recently available data (at the time data collection ended in January 2003). The latest available date ranged from 1999 to 2002, with the most common datapoint being the year 2000. Table 4.2 below, illustrates endpoint availability at the time of the study's data collection exercise for each of the study's principal indicators. Where data was not available for the NUTS 2 level we have indicated availability at the next available level.

Table 4.2 Latest available dates for principal indicators by country for NUTS II

		R&D Expenditure (Total)	R&D Expenditure (BES)	R&D Personnel % Labour Force (Total)	HRSTC as % Employment	Population with Tertiary Education	Hi Tech Manufact-uring % total employment	Hi Tech Services % total employment
	NUTS							
AT	0							
	I							
	II	1998	1998	1998	1997	2000	2000	2000
BE	0	1999	2000	1998				
	I	na	1999	na				
	II	na	only BXL (99)	na	2001	BXL only (00)	2000	2000
DE	0							
	I							
	II	1999	1999	1997	2001 (mp)	2000	2000	2000
DK	0, I, II	2000	2000	1997	na	2000	2000	2000
ES	0							
	I							
	II	1999	2001	1999	2001	2000	2000	2000
FI	0							
	I							
	II	1999	1999	1999	2000	2000	2000	2000
FR	0							
	I							
	II	1999	1999	1998	2001 (not overseas depts)	2000	2000	2000
GR	0							

		R&D Expenditure (Total)	R&D Expenditure (BES)	R&D Personnel % Labour Force (Total)	HRSTC as % Employment	Population with Tertiary Education	Hi Tech Manufact-uring % total employment	Hi Tech Services % total employment
	I							
	II	1999	1999	1997	2001	2000	2000 (mp)	2000 (mp)
IE	0,I	1999	1999		2001	1997		
	II	na	na	na	na	na	2000	2000
IT	0							
	I							
	II	2000	2000	2000	2001	2000	2000	2000
LU	0, I, II	2000	2000	na	2001	na	2000	2000
NL	0							
	I							
	II	1999	1999 (mp)	1998	2001	2000	2000	2000
PT	0							
	I							
	II	1999	1999	1999	2000 (mainland)	2000	2000	2000 (mp)
SE	0, I	1999						
	II	na	1999	1999	2000	2000	2000	2000
UK	0	2002	2002					
	I	1999	1999					
	II	na	na	na	2000	2000	2000	2000
BG	0, I				na	2000	2000	2000
	II	2000	2000	2000	na	na	na	na
CY	0,I, II	2000	1999	2000	na	2000	2000	2000
CZ	0, I				na	2000	2000	2000
	II	2000	2000	2000	na	na	na	na
EE	0,I,II	2000	2000	2000	na	2000	2000	2000
HU	0, I				na	2000	2000	2000
	II	2000	2000	2000	na	na	na	na
LT	0,I,II	2000	2000	2000	na	2000	2000	2000
LV	0,I,II	2000	2000	2000	na	2000	2000	2000
MT	0,I,II	na	na	na	na	2000	na	na
PL	0, I				na	2000	2000	2000

		R&D Expenditure (Total)	R&D Expenditure (BES)	R&D Personnel % Labour Force (Total)	HRSTC as % Employment	Population with Tertiary Education	Hi Tech Manufact-uring % total employment	Hi Tech Services % total employment
	II	2000	2000	2000	na	na	na	na
RO	0, I	2000	1999	2000	na	2000	na	na
	II	na	na	na	na	na	na	na
SI	0,I,II	2000	2000	2000	na	2000	2000	2000
SK	0, I				na	2000	2000	2000
	II	2000	2000	2000	na	na	na	na
CH	0, I	2000	2000	2000	na	2002	na	na
	II	na	na	na		2002	na	na
NO	0, I				na			
	II	n.i	n.i	n.i	n.i	n.i	n.i	n.i

Na – not available, n.i – no information provided

4.2.5 Sourcing data

The principal source for this material has been EUROSTAT data. Where gaps were detected in the data available from the REGIO database, the project team attempted to fill these, by contacting statistical agencies at a national level and through further contact with EUROSTAT (both directly and through TPG 3.1). National statistical agencies were in some cases able to provide more recent comparable data than that available from EUROSTAT, but in some cases referred to or supplied non-compatible data. Many also advised us to refer directly to the European statistical body stating that this was the source of the most complete statistical record available.

The activities undertaken by the project team to address gaps in the EUROSTAT data and the responses received from the organisations contacted are summarised in Annex 2.

4.2.6 Core indicators

TPG 2.1.2 was asked to collate information for three core indicators. These, along with other data, were submitted to the common ESPON database. The core indicators are:

- R&D personnel
- R&D Expenditure
- Patents

4.3 Typology development[19]

4.3.1 Considerations

In constructing a typology of regions for this study we have sought to identify indicators that reflect regional strengths in R&D, together with indicators of levels of innovation activity. In doing so we have focused on the following aspects:

Levels of R&D activity within a region. The best proxy for levels of R&D activity within a region is currently the level of R&D expenditure. This has the advantage of being commonly measured across the EU and is a key target of the Lisbon agenda. In order to control for the effects of the different size of NUTS regions across the EU we have focused on R&D intensity, that is the level of R&D expenditure relative to GDP. In constructing the typology we have analysed gross expenditure on R&D. We distinguish elsewhere in this work between expenditure by government, business and the higher education sectors. Level of patent applications is another commonly used indicator of R&D activity and we consider this in one of our typology calculations. Whilst this indicator is an accepted measure of R&D strength it has recognised deficiencies for regional level analysis. Firstly it assumes that R&D activity results in patents and, secondly, that the address for which the patent is registered relates to the address at which the research took place. There is evidence that in the EU, at least, patents may be registered at the Head Office of an organisation, regardless of where the research took place.

Level of R&D capacity. The capacity of a region to undertake R&D is crucial to its ability to access research opportunities. The strongest indicator in this area is the proportion of the labour force engaged in R&D activities. There are two measures commonly applied here. Firstly the number of people employed in R&D occupations (R&D personnel) as a proportion of the labour force and secondly the number of employees with tertiary education who are working in a science and technology occupation (Human Resources in Science and Technology Core). In both cases the numbers are usually expressed as a percentage of the labour force. Different Member States choose to measure either one of these indicators, or both. There is no consistent indicator as yet for the whole of the EU. For this reason we have chosen to use both.

Firm profile. The profile of firms within a region will influence levels of R&D and innovation activity. Two indicators that are accepted proxy measures of innovation performance are the proportion of firms which are engaged in high technology, or medium technology, sectors in the economy and the proportion of firms engaged in high technology

[19] Note: the broad points of the following methodological note have also been included in the Typology section of the report.

service. In both cases evidence suggests that these are the sectors that are most likely to be engaged in innovative behaviour, particularly the introduction of new products.

General skills of the resident population. The overall level of education within a population is judged to be a good guide to the potential for innovation to occur within an economy. The higher the level of education the more likely is innovation to occur. A commonly accepted measure of this is the proportion of the population of working age (aged 25-64) which has received tertiary education.

Other aspects that the study might have focused on include:

Actual innovation activity. In recent years attempts have been made to measure the actual level of innovation activity present in an economy through the use of company level surveys. The most wide-ranging of these is the CIS. Designed to provide robust statistics at the national and European Union level, sample sizes are generally too small to provide robust measures at a regional level. This study has not made use of CIS data (see Box 4.1) but measures that have been used by others using estimates taken from the CIS 2 (1994-1996) include: share of turnover due to products new-to-firm; sales of new-to-firm products; proportion of innovative manufacturing enterprises; proportion of innovative service enterprises; innovation expenditure by manufacturing enterprises; innovation expenditure by service enterprises.

Levels of co-operation and collaboration. There is some evidence that economies that have higher level of co-operation and collaboration tend to have a higher level of innovation. This collaboration may be between firms and universities; firms and other research organisations, or between different firms. Again there are, as yet, no good measures of levels of co-operation consistently available across the EU. The partial exception to this is again the CIS which does contain an indicator based on the proportion of firms with co-operation agreements. However, this indicator also suffers from issues of robustness and availability.

4.3.2 Analysing the data.

Two methods were used to construct the typologies for this study.

Firstly, we used an approach based on z-score analysis. This provides a measure of the distribution from the European average (based upon the standard deviation from the mean) for each region.

Secondly, a k-means cluster analysis was also undertaken. This is a form of nearest neighbour analysis which uses statistical techniques to identify clusters of regions with similar attributes based upon the data used.

We set out the method used for each in more detail below.

i) Z-score analysis

In the first approach the method adopted is based upon assigning Z scores for each indicator- relative to the European average. On the basis of this score, regions were graded into a high, medium or low category (top, middle and bottom third of scores) for R&D and for innovation. In each case (R&D and innovation) regions were only included in the final assessment if at least 2 indicators were available. The indicators (with dates) were as follows:

- R&D Scores – average of the Z scores for the indicators:
  - ► R&D expenditures (1999) as a percentage of regional GDP (1999)
  - ► R&D personnel as a percentage of the labour force (1999) or Employees with Tertiary level education working in a Science and Technology Occupation (HRSTC) (2001).

- Innovation scores – average of the Z scores for the indicators:
  - ► Employment in High Technology and Medium High Technology Manufacturing as a percentage of total employment (2000);
  - ► Employment in High Technology Services as a percentage of total employment (2000);
  - ► Percentage of the Working Age Population (aged 24-65) having successfully completed some form of tertiary education (2000).

All regions could thus be located within a 3x3 matrix of the form:

R&D Score	Innovation score: High	Innovation score: Medium	Innovation score: Low
High			
Medium			
Low			

A typology was then produced on the basis of the combined scores for the two categories of R&D and innovation. The typology is based upon 5 'types' of region.

- Type 1 regions are those that present a low score (ie significantly below the EU average) against both R&D indicators and innovation indicators.
- Type 2 regions are those achieve a medium score (ie around the EU average) against either the R&D indicators or the innovation indicators and a medium or low score in the other set of indicators
- Type 3 regions are those that exhibit strengths against innovation indicators but are not so strong in terms of R&D indicators.
- Type 4 regions are those that exhibit strengths in terms of R&D indicators but perform less strongly with respect to innovation indicators.
- Type 5 regions are those regions that score highly both in terms of R&D indicators and innovation indicators.

This is summarised in Table 4.2.

Table 4.2 Typology of regions

Type	Description
Type 1 (Lacking capacity)	Low R&D capacity and low innovation capacity
Type 2 (Average capacity)	Medium R&D capacity and medium innovation capacity
Type 3 (Innovation rich)	Low or medium R&D capacity but high innovation capacity
Type 4 (R&D rich)	High R&D capacity but low or medium innovation capacity
Type 5 (Knowledge hubs)	High R&D capacity and high innovation capacity

Essentially, Types 4 and 3 are special cases in the context of regions that perform well either as producers of R&D or as users of R&D that is produced elsewhere. They reflect the potential reality of the EU as an area of transnational and transregional knowledge flows but may also suggest asymmetries in the regional innovation systems in these places. Types 1 and 2 should not necessarily be seen as the 'worst cases' as not all regions will find a high R&D capacity a desirable objective.

ii) Cluster analysis

The second approach is based upon cluster analysis. The analysis has been run twice combining the indicators in a different manner. The first quick cluster uses 4 indicators to determine the 5 clusters: business R&D, HRSTC, patents and high-tech employment. The second quick cluster combines these to create 2 composite indicators: research and innovation capacity.

Cluster analysis is widely used in research to determine clusters of similar objects[20]. Clustering objects means classifying a set of different objects into smaller groups of more similar objects. Cluster analysis uses mathematical techniques to sort objects with similar descriptions into the same cluster. For exploratory purposes only, we have used the K-means clustering technique as available in SPSS. The first cluster analysis determines 5 clusters using data on four widely available indicators[21]. The second cluster analysis determines 5 clusters using data on the two composite indicators on research and innovation capacity.

For the first cluster analysis, re-scaled data[22] for the following four indicators were used to determine 5 clusters:

- Business R&D expenditures (BERD) as a percentage of GDP[23];
- Core human resources (HRSTC) as a percentage of total employment;
- Patent applications per million population;
- High-tech employment as a percentage of total employment.

These clusters can be described as follows:

- Cluster 1: worst R&D performance, lowest share in high-tech employment;

[20] For an introduction into cluster analysis, see e.g. H. Charles Romesburg, "Cluster Analysis for Researchers", Lulu Press, 2004.
[21] The *assumption* of 5 clusters was taken based on the information contained in the dendrogram of a comparable hierarchical cluster analysis.
[22] Re-scaled data were used to make sure that data for all indicators were in the same range. By first subtracting the highest regional value and then dividing by the difference between the highest and lowest regional value, all regional scores are converted between 0 and 1, where the worst performing region will have a score of 0 and the best performing region a score of 1.
[23] Total R&D expenditures (or GERD) as a percentage of GDP was not used as this indicator could be "biased" by the fact that some governments plan their R&D expenditures in *backward* regions.

- Cluster 2: mediocre R&D performance, strong HRSTC base;
- Cluster 3: mediocre R&D performance, average share of high-tech employment;
- Cluster 4: 2nd best R&D performance, average share of high-tech employment;
- Cluster 5: top R&D performers, strong HRSTC base, highest share of high-tech employment.

For the second cluster analysis, we used data from two composite indicators. The composite indicator on research capacity is calculated as the average score of the re-scaled data for the indicators on business R&D expenditures and core human resources. The composite indicator on innovation capacity is calculated as the average score of the re-scaled data on patents and high-tech employment.

These clusters can be described as follows:

- Cluster 1: low R&D capacity, low innovative capacity;
- Cluster 2: medium R&D capacity, low innovative capacity;
- Cluster 3: medium R&D capacity, medium innovative capacity;
- Cluster 4: high R&D capacity, medium innovative capacity;
- Cluster 5: high R&D capacity, high innovative capacity.

Finally we undertook a third cluster analysis. The clusters have been calculated on the basis of the mean for each variable, these calculations have been produced using a statistical software package called GenStat. We explored data availability for both R&D personnel and HRST(C), with the better coverage of HRST(C) in the EU-15 leading us to focus on this indicator of R&D capacity. For each region the distance from the EU mean has been calculated for each indicator. All data was taken from the most recent version of the ESPON database available on the ESPON intranet (dated March 2004). Where gaps in the ESPON data were present we made use of the data collected for the ESPON study by TPG 2.1.2 as provided to TPG 3.1.

Table 4.3 demonstrates to which years the appropriate indicator data is attached for the reference areas (country), used within the cluster analysis.

Table 4.3 Available indicators by reference year and country

Country Code	Country	Gross Expenditure on R&D (% of GDP)	*Proportion of Population with Tertiary Education*	EPO Patent Applications (Per million - population)	*Employment in Med & High Tech Manufauring*	Human Resource in Science and Tech (core)	*Employment in High Tech services (% of workforce)*
AT	Österreich	1998	*2000*	2000	*2000*	1997	*2000*
BE	Belgique-België	1999	*2000*	2000	*2000*	2001	*2000*
DE	Deutschland	1999	*2000*	2000	*2000*	2000	*2000*
ES	España	1999	*2000*	2000	*2000*	2001	*2000*
FI	Suomi/ Finland	1999	*2000*	2000	*2000*	2000	*2000*
FR	France	1999	*2000*	1999	*2000*	2001	*2000*
GR	Ellada	1999	*2000*	1999	*2000*	2001	*2000*
IE	Ireland	1999	*2000*	2000	*2000*	2001	*2000*
IT	Italia	2000	*2000*	2000	*2000*	2001	*2000*
LU	Luxembourg	2000	*2000*	2000	*2000*	2001	*2000*
NL	Nederland	1999	*2000*	2000	*2000*	2001	*2000*
PT	Portugal	1999	*2000*	2000	*2000*	2000	*2000*
SE	Sverige	1999	*2000*	2000	*2000*	2000	*2000*
UK	United Kingdom	1999	*1999*	2000	*2000*	2000	*2000*

Table 4.4 highlights those regions and indicators for which alternative years had to be used. For a small number of regions for each indicator a proxy variable had top be used where there was no data available for a particular indicator. The list of proxies used are set out in Annexe 3.

Table 4.4 Alternative data points for identified gaps

Missing Data and Alternative Dates used

		Gross Expenditure on R&D (% of GDP)	*Proportion of Population with Tertiary Education*	EPO Patent Applications (Per million - population)	*Employment in Med & High Tech Manufauring*	Human Resource in Science and Tech (core)	*Employment in High Tech services (% of workforce)*
DK	Danmark					Not available	
DEE2	Halle						*1997*
ES13	Cantabria			1998			*1998*
ES53	Islas Baleares			1998			
GR11	Anatoliki Makedonia, Thraki				*1999*		
GR14	Thessalia						*1998*
GR25	Peloponnisos				*1998*		
IT52	Umbria			1999			
PT14	Alentejo			1997			
UKM	Scotland			1999			

Denmark has been excluded from the final analysis owing to the fact that data for Human Resource in Science and Technology (core) is not available.

4.4 EU R&D policy analysis

EU R&D policy has been taken to consist of actions undertaken through the EU's RTD Framework Programmes and actions financed through the R&D targeted elements of the Structural Funds. Regional-level data has been constructed and analysed for both the Structural Funds and the Framework Programmes to provide an aggregate picture of EU R&D policy activity on a region-by-region basis across the EU. As far as we are aware this is the first occasion of such an analysis. The aggregate data has been complemented by a series of regional case-studies to provide a qualitative perspective.

4.4.1 Structural Fund data

For the programming period 2000-2006 expenditure on R&D activities through the Structural Funds is classified under the Field of Intervention Code 18. This is further subdivided into four categories, as follows.

181	Research projects based in universities and research institutes
182	Innovation and technology transfers, establishment of networks and partnerships between businesses and/or research institutes
183	RTDI Infrastructure
184	Training for researchers

All programmes must categorise their planned and actual expenditure according to given Field of Intervention codes. This forms the basis for DG Regional Policy's financial monitoring of programme performance.

Data on Structural Funds expenditure was obtained from DG Regional Policy in 2002 (relating to the outset of each agreed programme) and July 2005 (relating to the updated position in July 2005). We include relevant data in Annex 10. Data from these two time points provided details of:

- Planned spend at the outset (2000) of the programme complement for each Structural Fund programme
- Revised planned spend for each programme at July 2005
- Planned spend on FOI 18, 181, 182, 183, 184 at the outset of the programme period
- Revised planned spend on FOI 18, 181, 182, 183, 184 at July 2005
- Actual certified expenditure on FOI 18, 181, 182, 183, 184 at July 2005

The distribution of activity can thus be related to each programme and patterns of activity by Member State and by programme area analysed. We discuss this more fully in Section 7.

We then took each programme and sought to relate it to a geographical area. We did so by linking programme reference codes to NUTS regional identifiers as available from EUROSTAT. Whilst this is straightforward in many cases, for a number of regions it proved to be more complex. In a small number of cases it proved not to be possible. Further enquiries with DG Regional Policy as to the possibility of making a direct link between programmes and NUTS identifiers led to the following response:

"Concerning the NUTS CODE, the data that we have are not full reliable. Paradoxically, (this) is not a mandatory field for us."

The same level of analysis is not possible for the 1994-1999 programming period. FOI data was not reported in the same comprehensive manner for the ERDF. There is thus no comparable, comprehensive, source of data on actual and planned expenditure at a regional level for this period.

4.4.2 Framework Programme Data

Data for the Framework Programmes is based upon the number of projects undertaken in the 4th Framework Programme (1994-1998) and the 5th Framework Programme (1998-2002). In each case the number of participants in Framework Programme projects has been calculated for each region, separately identifying the number of Lead Partners (Prime Contractors) and the number of secondary partners (Other Contractors).

The data for regional participation in the Framework programmes has been obtained from the Projects database maintained by the European Commission's CORDIS service24. This database records the details of all partners participating in research activities funded under the Framework Programmes, including the region in which they are located.

The total number of project participations in a given Framework Programme in a region measures the number of projects with at least one participant in the region concerned. The figure includes all project (contract) types in all sub programmes, including research support actions, such as Accompanying Measures, which do not involve direct involvement in Research and Development activities.

The figure for total number of project participations can be sub-divided into "Prime Contractors" and "Other Contractors":

Prime Contractors are those participants responsible for co-ordinating the research (or research-related) activity in question. This group of participants includes individuals who

[24] Available online at http://dbs.cordis.lu/search/en/simple/EN_PROJ_simple.html

are awarded fellowships of other support grants and are not part of a larger research project network.
Other Contractors are secondary contractors, who participate in research (or research-related) projects, but do not have responsibility for co-ordinating the action in question.

Data is available at NUTS II level for most regions in the EU-15. In some cases, often where NUTS boundaries have been altered, data is only available at NUTS I level (for example for Wales or Ireland). Data is available at national level for other countries, including the New Member States, the Candidate Countries, Norway, Iceland and Switzerland.

4.4.3 Case Study approach

The quantitative data analysis has been supplemented with qualitative evidence of the spatial effects of EU R&D policy drawn from 21 case study regions. Data has been collected for all regions on the nature of EU R&D activities in the region. The overall objective of the regional case studies is to explore the ways in which EU policy initiatives in the field of R&D have a territorial impact at the regional level and beyond. The case study regions, selected to give coverage of a range of EU R&D policy interventions, regional economic performance levels and RTDI intensity, are designed to help us answer the following core questions:

- What are the expected spatial effects of current and future European R&D policy?
- How accessible are EU R&D policy instruments in different types of region?
- How far do EU R&D policies support polycentric development?
- How do the policies affect the spatial diffusion of innovation and knowledge?
- How coherent are the different strands of EU R&D policy, in terms of territorial impact?
- What are the territorial conditions which allow regions to take best advantage of EU R&D policy (economic conditions and structure, regional and national policy context)?

In practical terms, each case study provides data and analysis allowing us to gain an insight into the following questions:

- Which EU R&D policies directly affect the region, in terms of programme (RTD Framework Programmes, mainstream Structural Funds, RIS, RITTS, RIS+, Innovative Actions) and budget allocation (where possible)?
- Who is affected by these interventions? This includes identifying the direct beneficiaries of policy interventions and those who are affected indirectly, downstream from direct beneficiaries

- Where are these effects felt (i.e. what is the territorial dimension of these effects)?
- What factors influence the territorial reach of these policies?

The following areas formed the case study regions:

Liguria (Italy)
Puglia (Italy)
Calabria (Italy)
Cologne (Germany)
Mecklenburg-Pomerania (Germany)
Overijssel (the Netherlands)
Castilla y León (Spain)
Comunidad De Madrid (Spain)
Aragón (Spain)
West Wales and The Valleys (UK)
West Midlands (UK)
East Anglia (UK)
Auvergne (France)
Uusimaa (Finland)
Stockholm (Sweden)
Vienna (Austria)
Limburg (Belgium)
Lisbon (Portugal)
Algarve (Portugal)
Ireland
Luxembourg

The criteria on which this selection was based was discussed in the Second Interim Report and reflected comments from the Commission. The case studies were selected on the basis of whether regions benefit or not from the following:

- Objective 1
- Objective 2
- RIS/RITTS or Innovative Action 2000-2006
- R&D Framework Programmes

Other indicators that were taken into consideration included economic strength and R&D capacity, based on:

- GDP % EU Average - 1999
- BES R&D expenditure % GDP 1999
- GOV R&D expenditure % GDP 1999
- High-tech patents (no. applications per million population) 1999

5.0 R&D and innovation in the EU

5.1 The Approach

The following section identifies the regional distribution of strengths in R&D and innovation across the EU. Using the identified indicators – set out in the Methodology section - it illustrates the state of R&D activity across the Union and illustrates trends and problems at different scales.

We illustrate our analysis through examining the following facets of regional R&D and innovation potential:

- Levels of R&D activity - through analysis of R&D intensity - and the engagement of the private sector in this activity
- The human capital available to R&D in the EU's regions
- The distribution of high-level R&D infrastructures
- The overall quality of human resources in the EU's regions as a basis for innovation activities

The broad EU picture is one of a strong 'heartland' closely approximating to the central 'pentagon' traditionally identified in core-periphery analysis. However, strengths outside of the pentagon are identifiable in the northern periphery, where regions in Sweden and Finland are amongst the most significant EU players in R&D and innovation, the south-western fringe of the pentagon, where regions of France and northern-Spain perform strongly on certain key indicators and, to a lesser extent, the western periphery. Many of the strongest growth rates in key indicators are to be found in more peripheral regions, demonstrating that a process of catch-up for some is visible.

5.2 Distribution of R&D activity

5.2.1 R&D Intensity

When expressed as a percentage of GDP, Gross Domestic Expenditure on R&D (GERD) is used as an indicator of the overall R&D intensity of a country or region. This is a very useful measure of the relative emphasis placed on R&D activities within a given economy, but does not tell us about the absolute level of R&D expenditure. A high R&D intensity does not necessarily indicate a high R&D effort in absolute terms, merely that a comparatively high proportion of GDP is accounted for by Research and Development activities.

Current strengths, weaknesses and disparities

When viewed on a European scale, the regional figures for R&D intensity demonstrate the weaker positions of the periphery of the EU. Map 5.1 shows R&D intensity across the EU-27 against the EU average, based on current data availability. The strong performance of Sweden, Finland and parts of the UK, Netherlands, Germany, France and Austria is clearly visible.

The analysis of the most recent available data to a large extent confirms the familiar pattern of R&D strengths in Europe. Five of the European regions with the highest R&D intensity came from Germany25, of which the top three were Braunschweig, Stuttgart and Oberbayern, with an R&D intensity for 1999 of 6.34%, 4.84% and 4.76% respectively, compared with a EU-15 average of 1.93%. The regional top ten also includes two Finnish regions (Pohjois-Suomi and Uusimaa), Midi-Pyrénées and Sweden (where no regional expenditure data is available).

A small number of regions from the new Member States also feature strongly. In the Czech region of Stredni Cechy (the area surrounding Prague), R&D expenditure accounts for 3.3% of GDP, placing it third in the regional ranking. The Prague region itself, the Polish region of Opolskie and the Hungarian region of Kozep-Magyarorszag (which includes Budapest) also feature in the top 25 regions, along with more traditionally recognized research centres such as Berlin, the East of England and Ile de France.

These high R&D intensity figures in key candidate country regions are significant, but should be interpreted with care, as the absolute levels of R&D expenditure in these areas remains low by Western European standards. As an illustration, although total expenditure on R&D in Stredni Cechy in 1999 accounted for 3.3% of GDP, it amounted to € 165.9 million or just 1.24% of total R&D expenditure in Ile de France, where the R&D intensity is at a comparable level.

In contrast to these areas, the average R&D intensity for regions in Greece, Spain and Portugal and all the New Member and Accession States except Slovenia and the Czech Republic26 remains below 1% of GDP. In 2000, the average R&D intensity for the 12 New EU Members and accession countries (excluding Malta, for which no data is available)

[25] This is in line with previous analyses of EU-15 regions: see *Statistics in Focus Theme 9: R&D expenditure and personnel in European regions 1997-99*, EUROSTAT, February 2003
[26] With average R&D intensities of 1.52% and 1.33% respectively

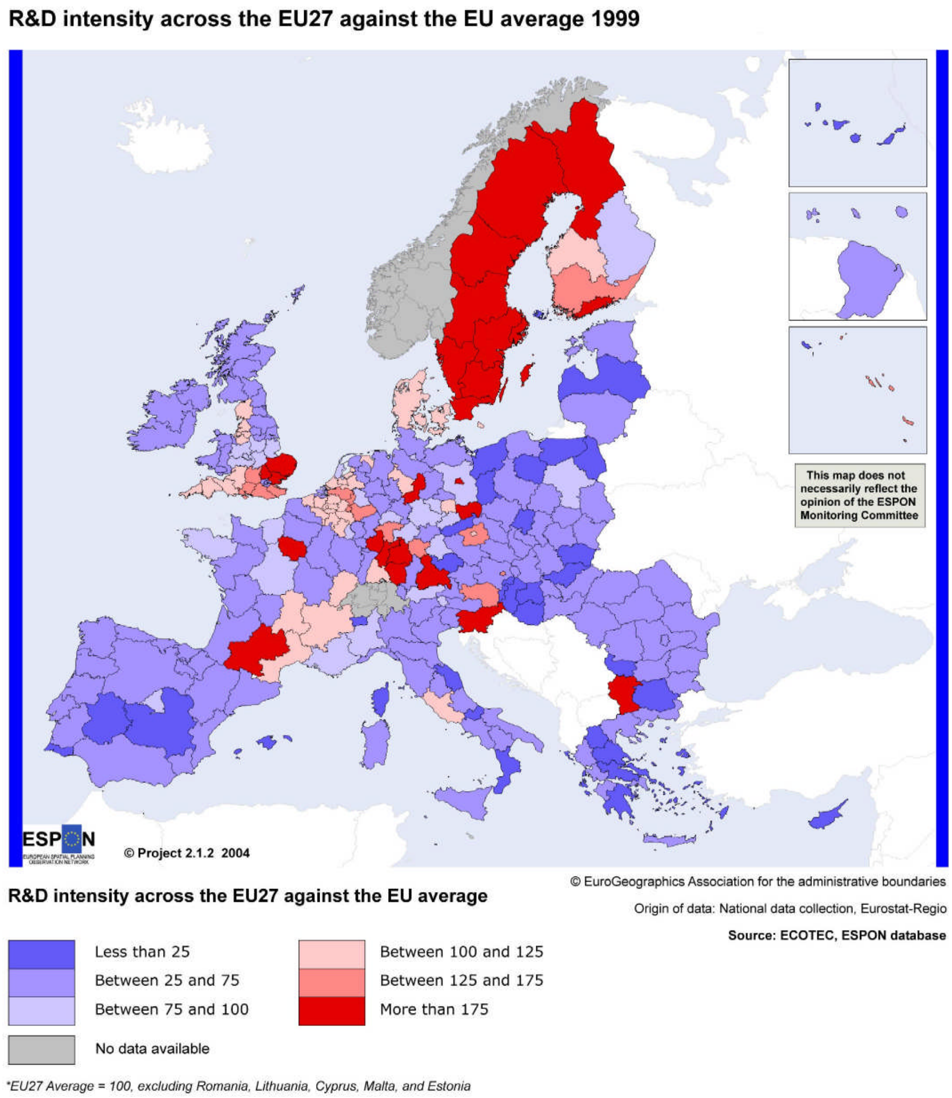
was 0.77%, compared with an EU-15 average for the same year of 1.93%. Cyprus, Romania and Latvia display the lowest R&D intensities (0.26%, 0.37% and 0.48%).

Disparities within countries

R&D intensity varies considerably between regions within individual countries and is often concentrated at a national level in a small number of regions, often near capital cities. In the old EU-15, regional variation in R&D intensity is particularly high in Germany and Finland. However, this is largely explained by the regional characteristics of the sparsely populated regions of Finland and the exceptionally high R&D intensity figure for Braunschweig (the highest figure in Europe), which is significantly above the average for the German regions. Regional disparities are also pronounced in several of the New Member and Accession States27, particularly in the Czech Republic and Poland.

[27] It is only possible to consider this type of variation for the countries with NUTS II subdivisions and for which data is available (Bulgaria, Czech Republic, Hungary, Poland and Slovakia)

Map 5.1 R&D intensity across the EU-27 against the EU average



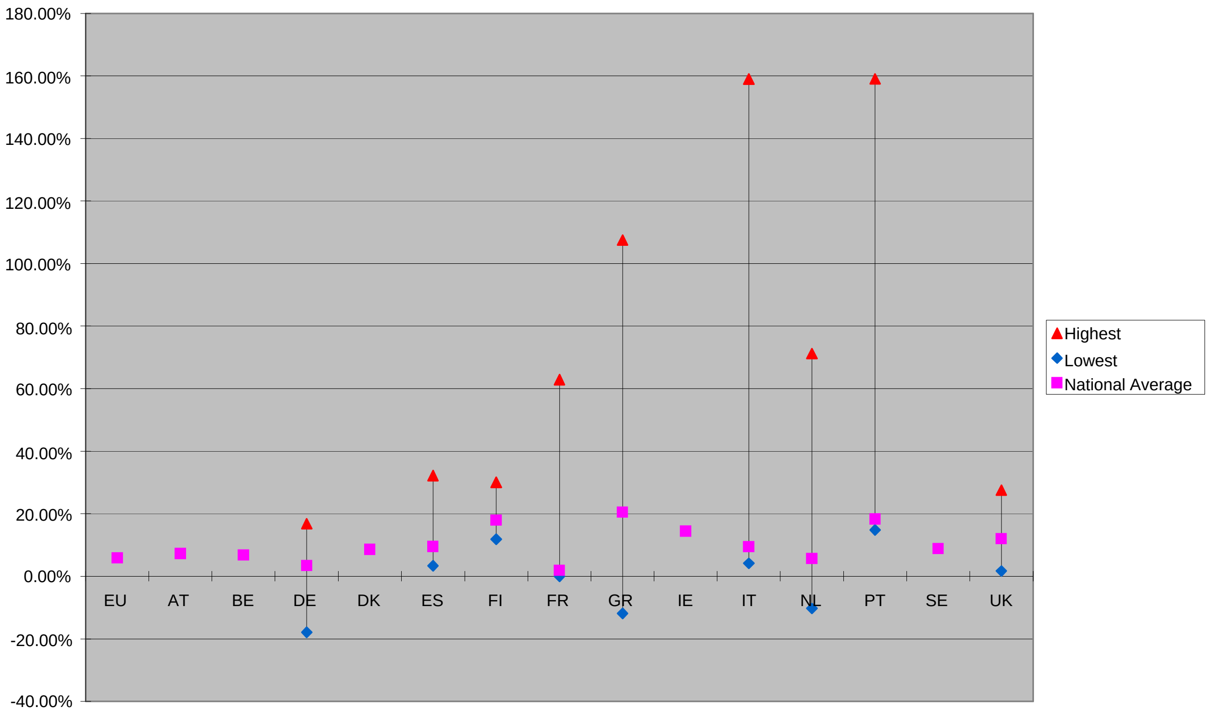
Data for CZ, HU, SK and LU corresponds to the year 2000
Data used for IE and SE are from NUTS1
Data used for BE, CY, EE, LT, LV and RO are from NUTS0
CH, MT and NO: no data

The concentration of R&D expenditure in capital regions is a particular aspect of this internal regional variation in several countries. This phenomenon is evident in Austria, the Czech Republic, Finland, France, Hungary, Greece and Portugal, where the top spending regions all account for around half of national R&D spending. In France, 45% of national R&D expenditure is concentrated in Ile de France (the region with the highest R&D expenditure of any European region in absolute terms), compared with a figure of 10% for Rhône-Alpes, the region with the second highest levels of R&D expenditure in France.

Trends in R&D expenditure

Overall expenditure on R&D in the EU increased on average by 5.9% a year between 1995 and 1999. However, some strong disparities in growth rates are apparent. Greece, Finland and Portugal all registered growth in excess of 15% per year, whilst in France it was less than 2% over the same period. Strong disparities are also evident within countries, particularly Greece, Italy, Portugal and the Netherlands, as illustrated in Figure 5.1 below.

Figure 5.1 Regional Disparities in Annual Change in R&D Expenditure between 1995-1999: old EU-15



An examination of the distribution of regions with the greatest increase in annual R&D expenditure over the same period suggests that strong growth is being promoted in those regions with the weakest levels of R&D expenditure. Table 5.1 and Map 5.2 illustrate the 20 regions with the strongest growth in R&D expenditure. The strong showing of peripheral regions is evident.

Table 5.1 Top 20 regions with highest growth rates in overall R&D Expenditure during the period 1995-1999: Old EU-15

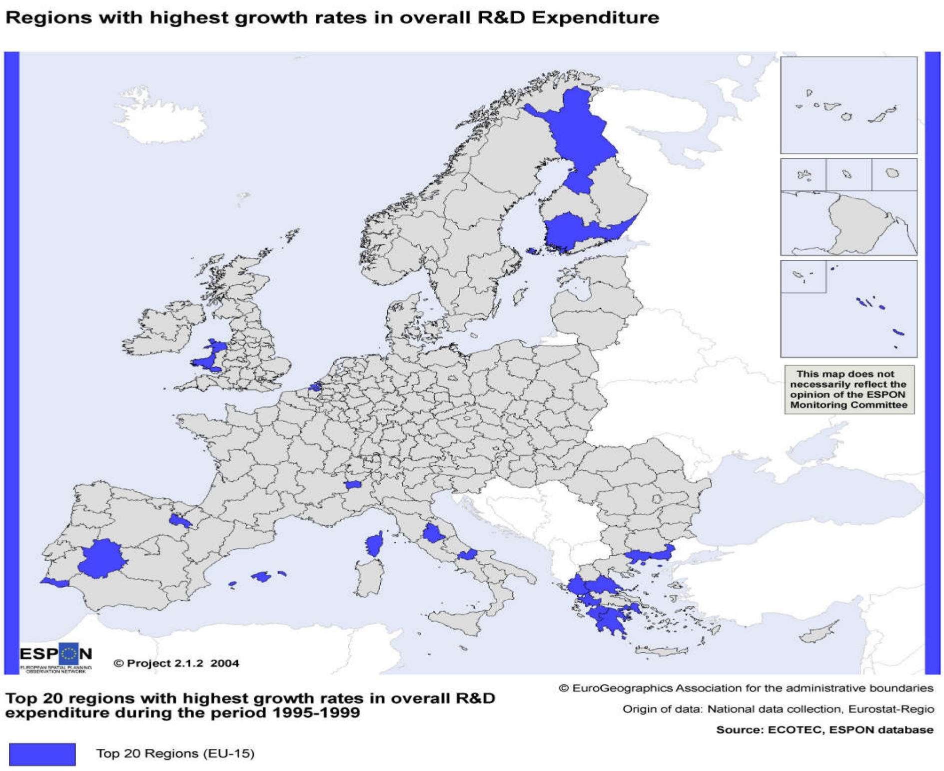
NUTS	Region
ES23	La Rioja
ES43	Extremadura
ES53	Islas Baleares
FI15	Pohjois-Suomi
FI17	Etelä-Suomi
FI2	Åland
FR83	Corse
GR11	Anatoliki Makedonia. Thraki
GR14	Thessalia
GR21	Ipeiros
GR23	Dytiki Ellada
GR25	Peloponnisos
GR3	Attiki
IT12	Valle d'Aosta
IT52	Umbria
IT72	Molise
NL34	Zeeland
PT15	Algarve
PT2	Açores (PT)
UKL	Wales

5.2.2 The Role of the Business Sector

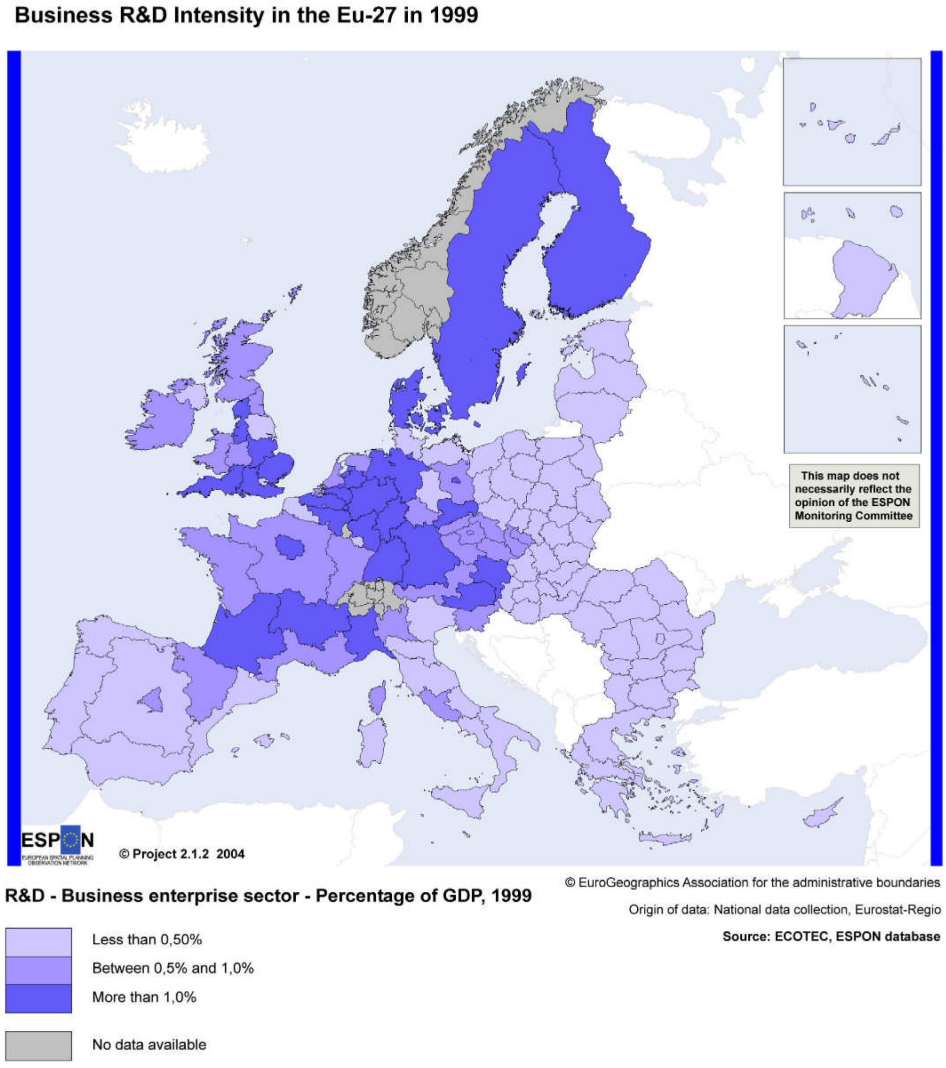
The R&D sector as a whole is routinely sub-divided into the Business Enterprise Sector (BES), the Government Sector (GOV), the Higher Education Sector (HES) and the Private, Non Profit Sector (PNP). The relative importance of these sectors also varies between regions, generally reflecting different economic structures and research traditions. The percentage of R&D performed by the Business Enterprise Sector (BERD) is considered as one indicator of the innovative capacity of a regional economy, although it should not be interpreted in isolation. The distribution of BES R&D in Europe in 1999 is shown in Map 5.3. Whilst the overall pattern remains similar to that reported for GERD it is apparent that a number of high expenditure regions are dependent on the public funding of R&D. Business expenditure is rather more concentrated in a limited number of regions than Gross expenditure as a whole.

In 2000, BERD accounted for 65% of Gross Expenditure on R&D in the old EU-15, representing 1.26% of GDP. The highest intensities of BES expenditure were found in German, Swedish, Finnish and UK regions. Braunschweig and Västsverige stand out with particularly high levels. In absolute terms, Ile de France again has the highest levels of BES spend, while BES accounted for over 70% of total R&D spending in Sweden, Germany, Ireland and Belgium in 1997.

Map 5.2 Regions with the highest growth rates in R&D expenditure (1995-99)



Map 5.3 Business R&D Intensity in the EU-27 in 1999



Data: NUTS II except UK (NUTS I) Belgium, Ireland (NUTS 0) Year: 1999 (At 1998)

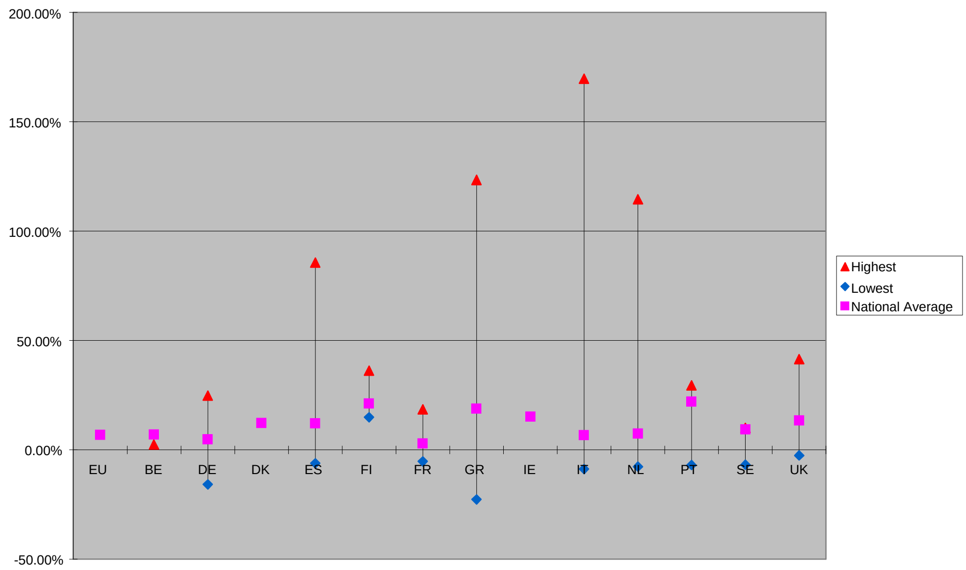
In the New Member States and Accession countries, the level of business expenditure on R&D is significantly lower. For the same year, BERD accounted for only 46% of total R&D spending across the N12 (excluding Malta) and amounted to just 0.36% of GDP. Slovenia and the Czech Republic both have levels of business R&D expenditure significantly above the candidate country average (0.83% GDP in Slovenia (1999), 0.81% GDP in the Czech Republic (2000)), although these figures are still well below the old EU-15 average.

BERD as a proportion of GERD is also among the highest in Slovenia and the Czech Republic (56% and 60% respectively), but even higher proportions are registered in Slovakia and Romania (66% and 70%), two countries with amongst the lowest levels of overall R&D intensity. These figures demonstrate the comparative weakness of the publicly-funded R&D sectors (government and higher education) in these countries.

Trends in Business R&D expenditure

Over time, business expenditure has been increasing slightly more rapidly than total expenditure on R&D (on average 6.9% per year in the old EU-15), with the highest increases (albeit from a low base in some cases) recorded in Finland, Portugal, Greece and Ireland. Figure 5.2 below demonstrates the strong regional disparities in annual growth rates over this period, particularly in Italy, Greece and the Netherlands.

Figure 5.2 Regional Disparities in Annual Change in Business R&D Expenditure 1995-1999: old EU-15



An examination of the 20 leading growth regions suggests that public policy interventions are having some effect on business expenditure, as strong growth is again noticeable in many of the weaker regions. At the same time, the attraction of the stronger regions of the EU, particularly Oberpfalz, can still be seen (see Table 5.2 and Map 5.4 below).

Table 5.2 Top 20 regions with highest annual growth rates in Business R&D Expenditure during the period 1995-1999: Old EU-15

NUTS	Region
DE23	Oberpfalz
ES12	Principado de Asturias
ES13	Cantabria
ES43	Extremadura
ES53	Islas Baleares
ES62	Région de Murcia
FI15	Pohjois-Suomi
GR23	Dytiki Ellada
GR25	Peloponnisos
GR43	Kriti
IT12	Valle d'Aosta
IT92	Basilicata
ITA	Sicilia
NL11	Groningen
NL34	Zeeland
PT11	Norte
PT13	Lisboa e Vale do Tejo
PT15	Algarve
UKL	Wales
UKN	Northern Ireland

5.3 Distribution of human resources for R&D

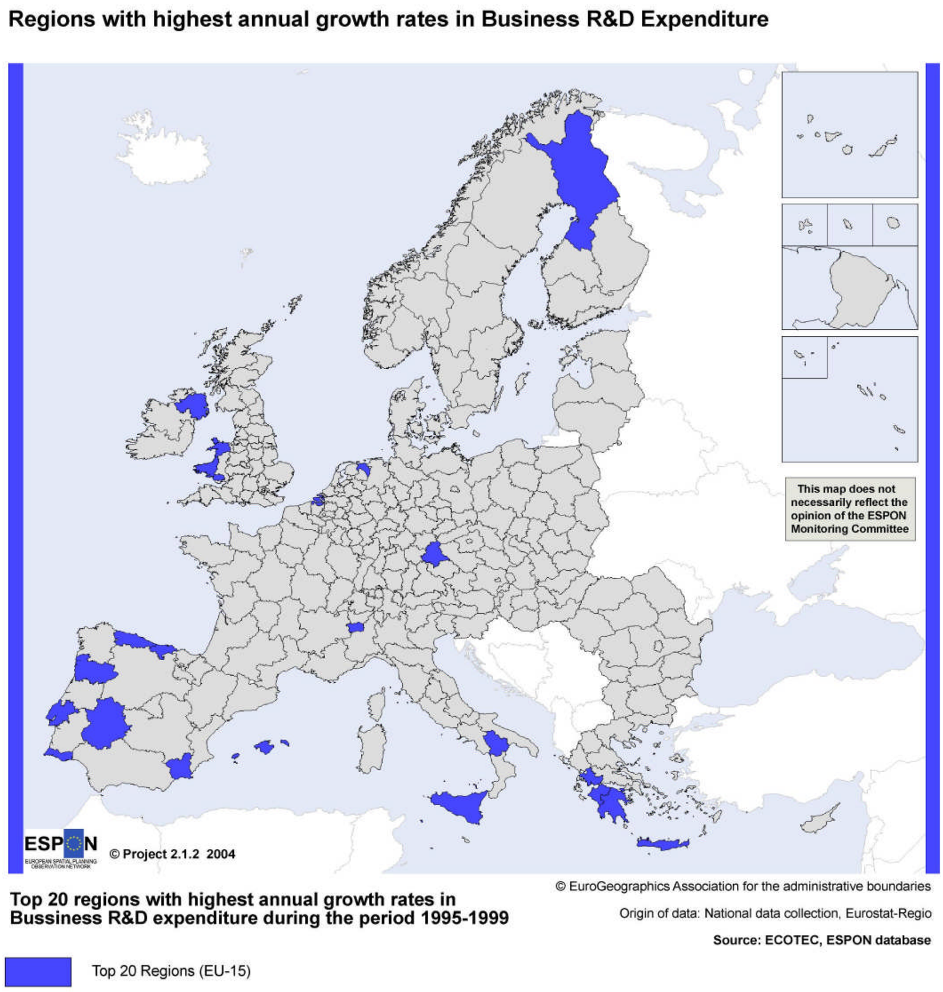
5.3.1 R&D Personnel

R&D personnel as a percentage of the total labour force is a measure of the number of individuals directly employed in R&D activities, as well as those providing direct services in the R&D sector, such as R&D managers, administrators and clerical staff. Evidence demonstrates that in Italy, Spain, Greece and Portugal R&D personnel are predominantly employed in the Higher Education sector, whilst elsewhere in the old EU-15 the private sector is the main employer of researchers.

Current strengths, weaknesses and disparities

In the EU-15, the levels of R&D employment as a percentage of the labour force largely mirror the pattern of R&D expenditure, with many of the highest regional concentrations of total R&D personnel located in the Northern part of the European territory (Map 5.5). The average level of total R&D employment in the old EU-15 in 1999 was 1.36% of the labour force, although analysis highlights a number of core regions with rates considerably above this.

Map 5.4 Regions with highest growth rate in business R&D expenditure (1995-99)



On the basis of available data 9 of the top 25 regions in terms of total R&D employment were located in Germany (the top three again include Oberbayern, Braunschweig, and Stuttgart with 3.72%, 3.41% and 3.04% of the labour force respectively28), three in Sweden and two in Finland. This said, core R&D regions, in terms of research personnel, are also evident in many other countries, in particular Slovakia (where Bratislavsky gains the highest overall score of any region), Hungary, the Czech Republic, Austria, France and Bulgaria. It should be noted that comparable total R&D employment figures are not available at regional level in the UK.

As highlighted above, direct comparison of New Member State and Accession country scores with EU-15 levels of R&D employment are unwise, but the strong performance of key candidate country regions is noteworthy, particularly as the FTE measure in the calculation used tends to underestimate the total number of personnel.

Once again reflecting the pattern of R&D expenditure, more peripheral regions of the EU-27, particularly in the cohesion countries and parts of Eastern Europe, exhibit the lowest levels of R&D employment. There is also considerable variation in the proportion of R&D personnel in the labour force between the N12 countries. While in Slovenia and Hungary, the levels of R&D employment are very close to the EU-15 average29, R&D personnel account for a much smaller proportion of the workforce in many other countries, particularly in Bulgaria (0.48%) and Romania (0.39%).

Disparities within countries

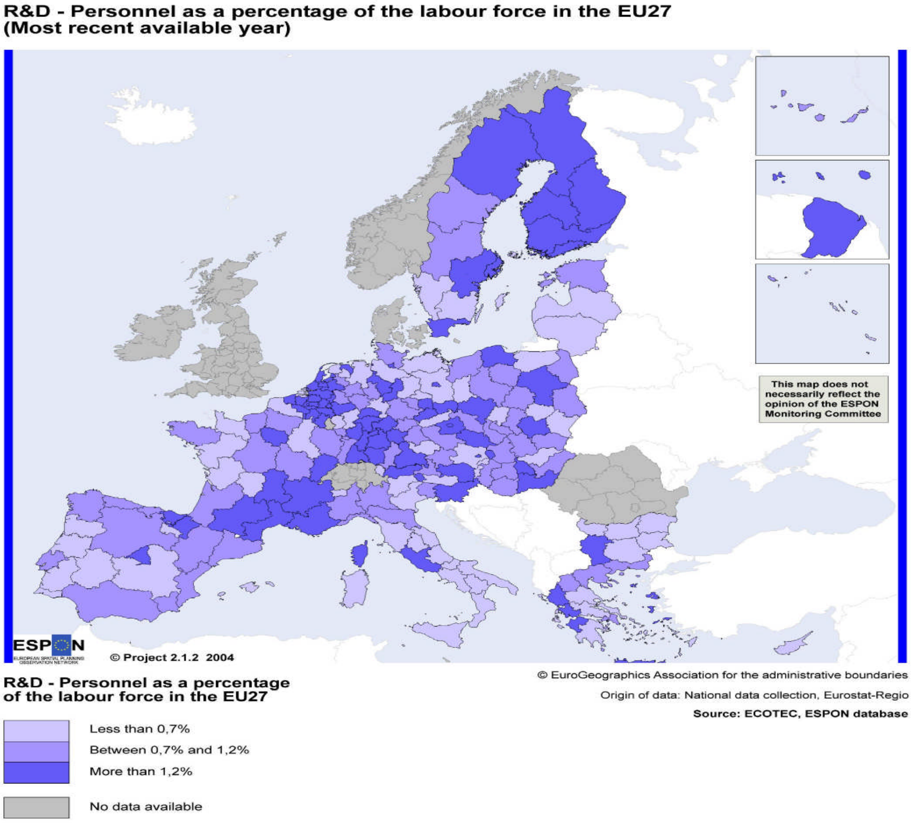
As with R&D expenditure, there is considerable variation in the level of regional R&D employment in many EU-27 countries. Indeed, the pattern of national “core” regions in and around capital cities is even more marked when R&D personnel data is considered. The regions with the highest levels of R&D employment in the New Member States are all in capital regions. Bratislavasky, Közép-Magyarország (Budapest), Prague, Yugozapaden (Sofia), Mazowieckie (Warsaw) all appear in the top 25 EU-27 regions for this indicator. In contrast, peripheral regions in Bulgaria, the Czech Republic and Poland appear in the bottom 50 European regions for R&D personnel.

This core-periphery pattern is also very striking in France, Austria, Italy and Spain, although large disparities in terms of R&D employment appear to exist in nearly all

[28] Figures for 1997, the most recent year for which data is available
[29] 1.36% and 1.11 % of the labour force respectively – Eurostat National figures

European countries. Even in Germany, which has the largest number of regions in the top 25, there are also regions which appear in the bottom quartile of the R&D employment ranking.

Map 5.5 R&D Personnel as a Percentage of the Labour Force in the EU-27 (Most recent available year)

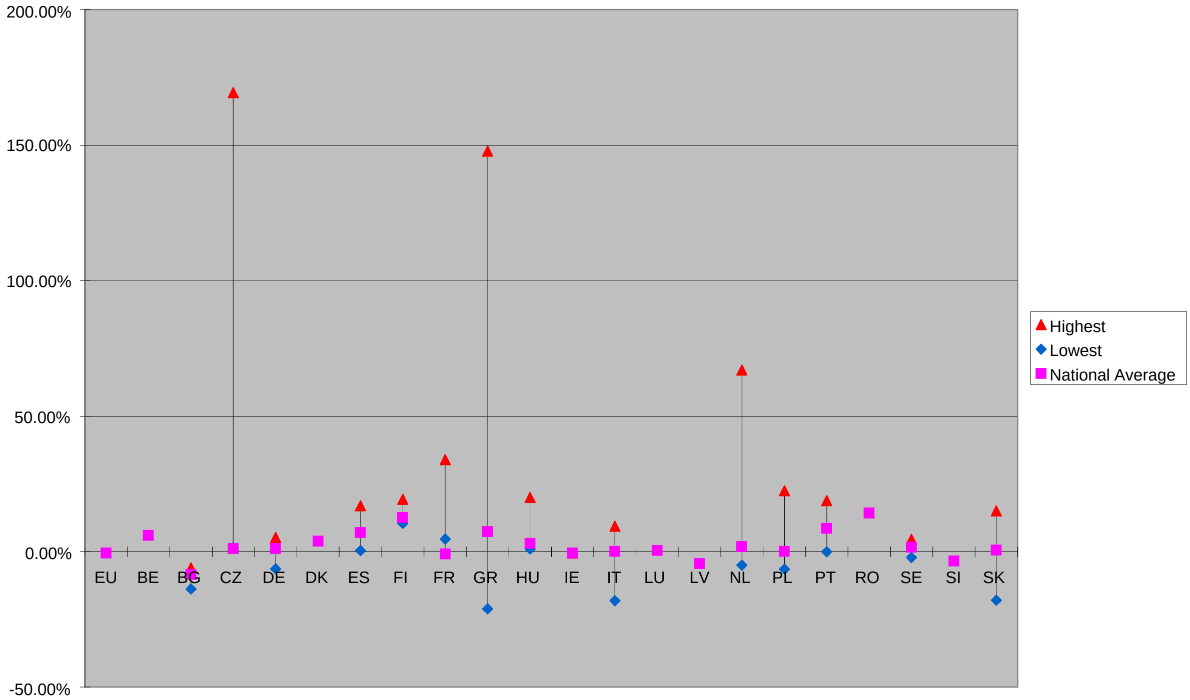


1997: Germany, Greece, Netherlands
1998: Austria, France
1999: Spain, Finland, Sweden, Portugal, Slovenia
2000: For the rest of the countries

Trends

Between 1995 and 1999 the number of personnel employed in R&D in the EU was largely static. Most countries recorded modest gains, although this often disguised inter-regional disparities, with Finland and Romania30 posting the largest gains. The disparities in growth rates between regions within EU-27 countries are clearly evident in Figure 5.3 below.

Figure 5.3 Regional Disparities in Annual Change in R&D Employment 1995-1999: EU-27



Examining the EU patterns more closely we can see that growth in personnel has been concentrated in a small number of countries (Table 5.3 and Map 5.6). Again we should be cautious, in that growth in some regions is from a very small base. A single consistent pattern is not evident, reflecting the variety of trends and forces at work, but the presence of several capital regions is noteworthy for future spatial distributions.

[30] This result should be treated with care as it is based upon only one region.

Table 5.3 Top 20 regions with highest growth rates in R&D Personnel during the period 1995-1999

NUTS	Region
CZ02	Stredni Cechy
CZ03	Jihozápad
CZ04	Severozápad
CZ06	Jihovýchod
CZ07	Stredni Morava
FI16	Uusimaa (suuralue)
FR22	Picardie
FR41	Lorraine
FR61	Aquitaine
FR71	Rhône-Alpes
FR91	Guadeloupe (FR)
GR14	Thessalia
GR22	Ionia Nisia
GR23	Dytiki Ellada
GR3	Attiki
GR42	Notio Aigaio
HU04	Dél-Dunántúl
NL12	Friesland
NL41	Noord-Brabant
PL05	Lódzkie

5.3.2 Human Resources in Science and Technology

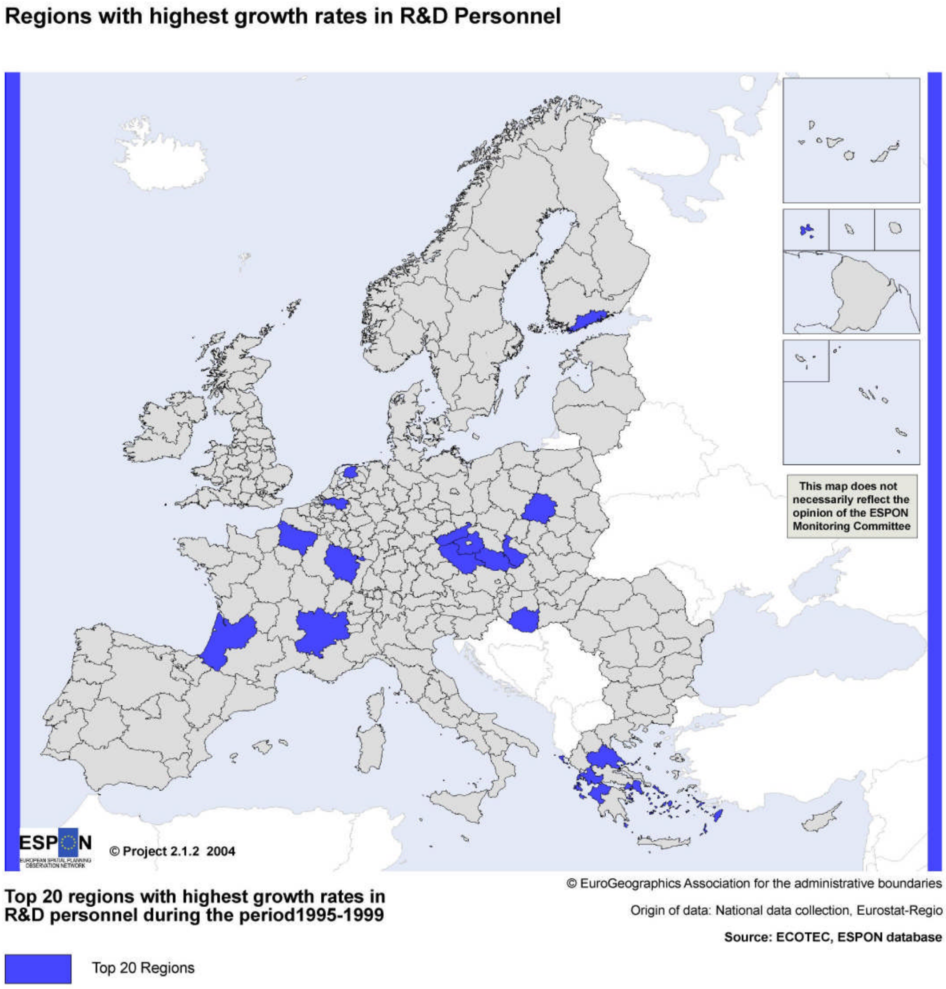
HRSTC (Human Resources in Science and Technology Core) is a measure of the skilled human resources, actively engaged in some of the most dynamic sectors of the economy, including engineering, pharmaceuticals and information technology. While HRSTC is not an equivalent to R&D personnel, which is much more tightly defined and concerns only research activities, it does have the advantage of including only highly qualified individuals (whereas R&D personnel also includes lower qualified administrative staff). As such, it is a good measure of the number of individuals in a position to engage in innovative activities in the wider economy. It can be viewed as an indicator of “knowledge creation potential” in a broader sense than pure R&D.

Current strengths, weaknesses and disparities

The pattern of HRSTC, as a percentage of total employment in EU-15 regions is shown in Map 5.7 below. It illustrates a slightly different picture to that portrayed simply by R&D Based indicators.

The pattern of distribution of HRSTC as a proportion of total employment across the regions of the old EU-15 produces interesting results. Two countries come out as clear leaders: Sweden (6 out of the top 25 regions, including Stockholm with the highest overall figure) and Belgium (7 out of the top 25 regions). This is largely explained by the fact that both these countries have high levels of the working age population with tertiary education and important concentrations of high technology sectors (both countries perform particularly well in terms of total employment in High Technology Services.

Map 5.6 Regions with the highest growth rates in R&D personnel (1995-99)



Other leading regions in the old EU-15 include core or capital regions in Finland (Uusimaa, Manner-Suomi), the UK (Inner London), Germany (Berlin), France (Ile de France) and the Netherlands (Utrecht). The lowest scoring regions against this indicator are found in Portugal, Greece, Italy and Austria. Italy and Austria also record comparatively low levels of tertiary level education, even in core economic areas. This most probably reflects differences in the exact classification of the educational qualifications used and demonstrates one of the problems associated with international comparisons involving educational attainment levels.

Disparities within countries

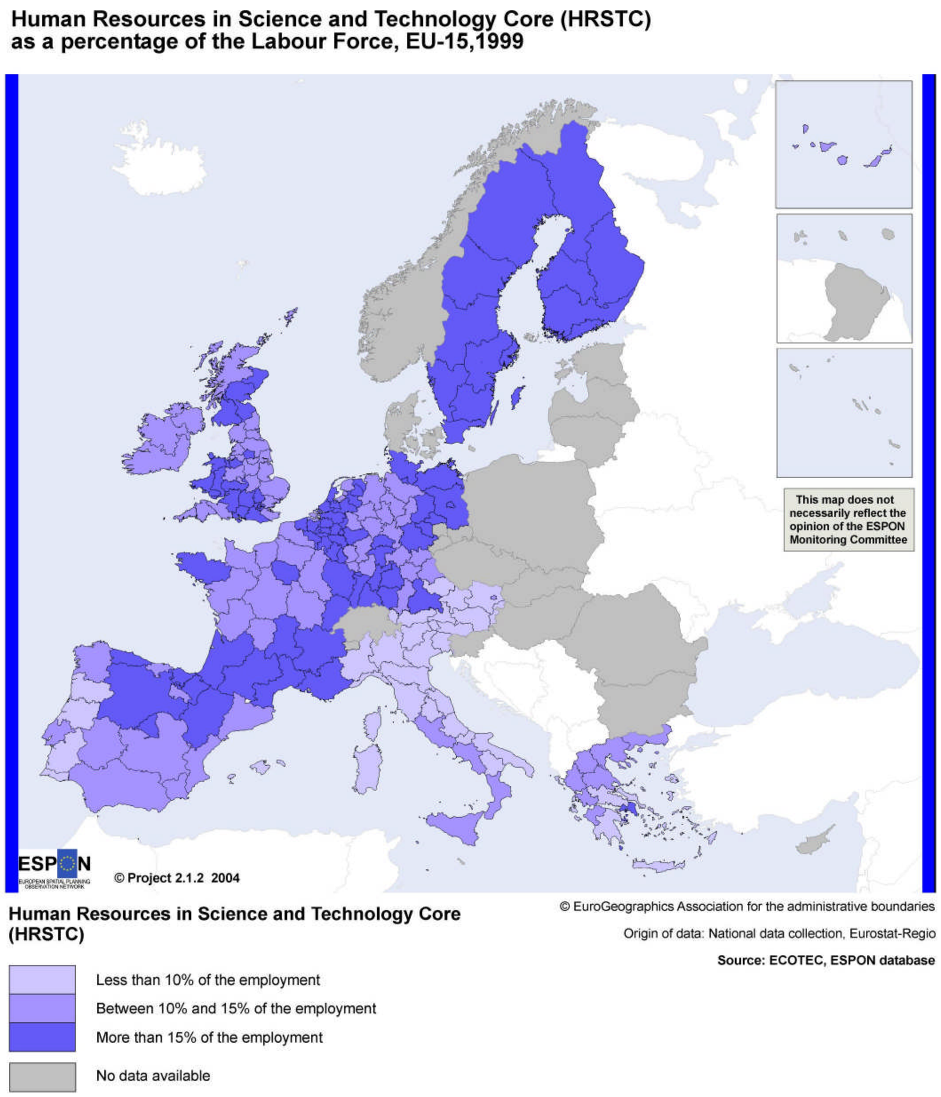
As noted above, some countries, such as Sweden or Belgium, Italy or Greece, perform consistently well or consistently poorly against this indicator, across nearly all regions. Nevertheless, some countries in the EU-15 do show marked regional disparities in terms of core human resources in science and technology. The UK and Spain emerge as the most unequal countries in this respect, ranging from London and Madrid in the top 25 regions in the EU-15 to Cornwall and the Isles of Scilly, Tees Valley and Durham and the Canaries, which are among the bottom 50 performing regions.

Trends

Growth in the proportion of the workforce in this area is higher than that recorded under R&D personnel. Whilst we cannot go deeply into the reasons for this here, it may signify an increasing focus on core R&D activities and a reduction in the proportion of administration and other ancillary posts. Stronger growth in this area is certainly a positive sign.

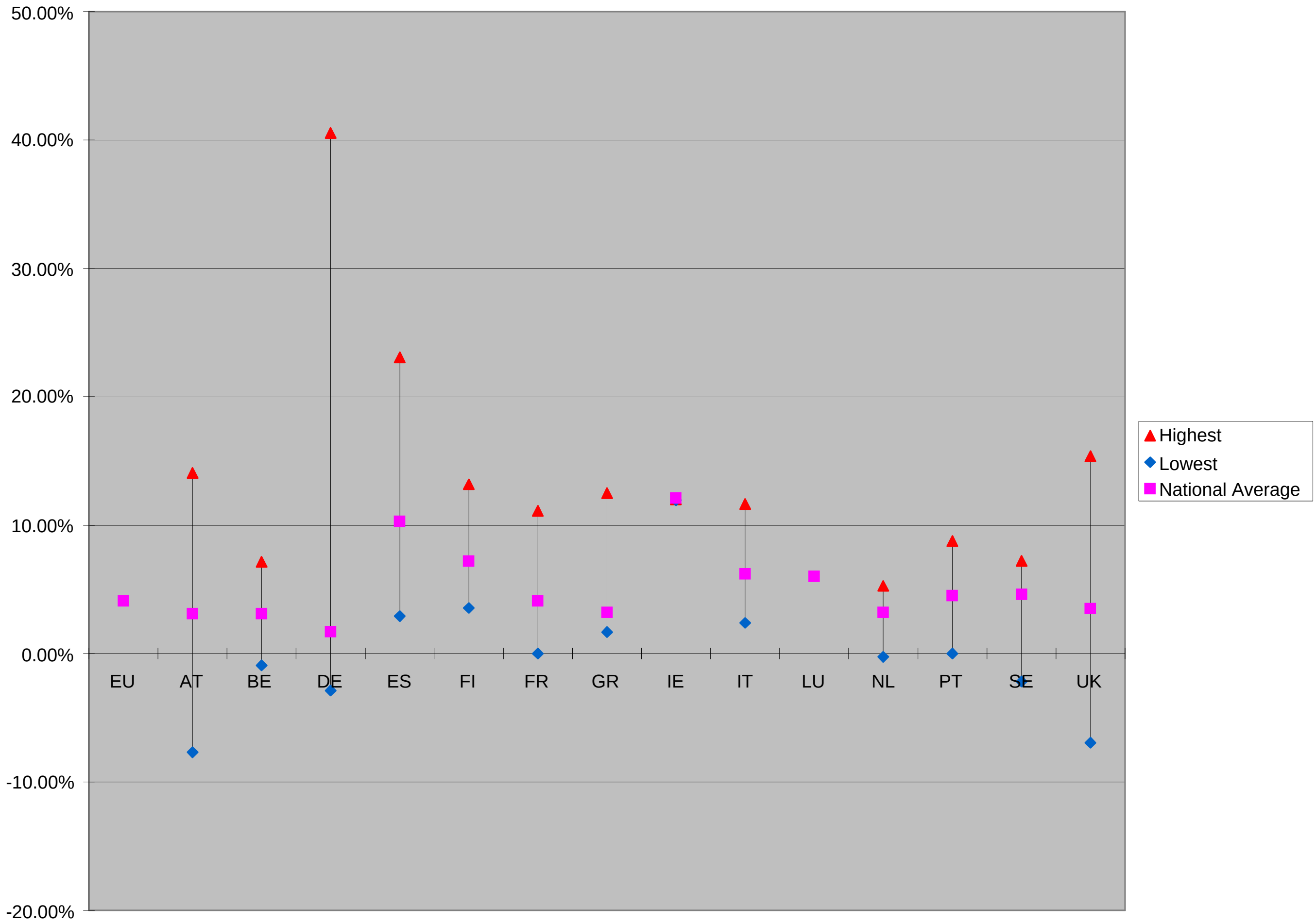
Unfortunately, comparable trend data is not available beyond the EU-15. The data that is available (Figure 5.4) demonstrates the disparities in growth rates both within and between countries.

Map 5.7 Human Resources in Science and Technology Core (HRSTC): EU-15 1999



Data: NUTS II except Ireland (NUTS I), Switzerland and Norway (NUTS 0)

Figure 5.4 Regional Disparities in Annual Change in HRSTC 1995-2001: EU-15



In this instance, the highest growth rates were recorded in Koblenz, Germany, whilst the greatest falls were in Austria (Kärnten) and the UK (East Riding and North Lincolnshire). Table 5.4 and Map 5.8 below illustrates the different geography of personnel gains using this indicator compared to that of R&D personnel. In this instance the greatest gains are to be found in Spain. Again though, the relatively strong performance of non-core regions is noteworthy.

Table 5.4 Top 20 regions with highest growth rates in HRSTC during the period 1995-2001

NUTS	Region
AT12	Niederösterreich
DEB1	Koblenz
ES21	Pais Vasco
ES24	Aragón
ES41	Castilla y León
ES42	Castilla-la Mancha
ES43	Extremadura
ES52	Comunidad Valenciana
ES53	Islas Baleares
ES62	Région de Murcia
FI14	Väli-Suomi
FR52	Bretagne
GR22	Ionia Nisia
IE01	Border, Midlands and Western
IE02	Southern and Eastern
IT32	Veneto
IT33	Friuli-Venezia Giulia
ITB	Sardegna
UKL2	East Wales
UKM4	Highlands and Islands

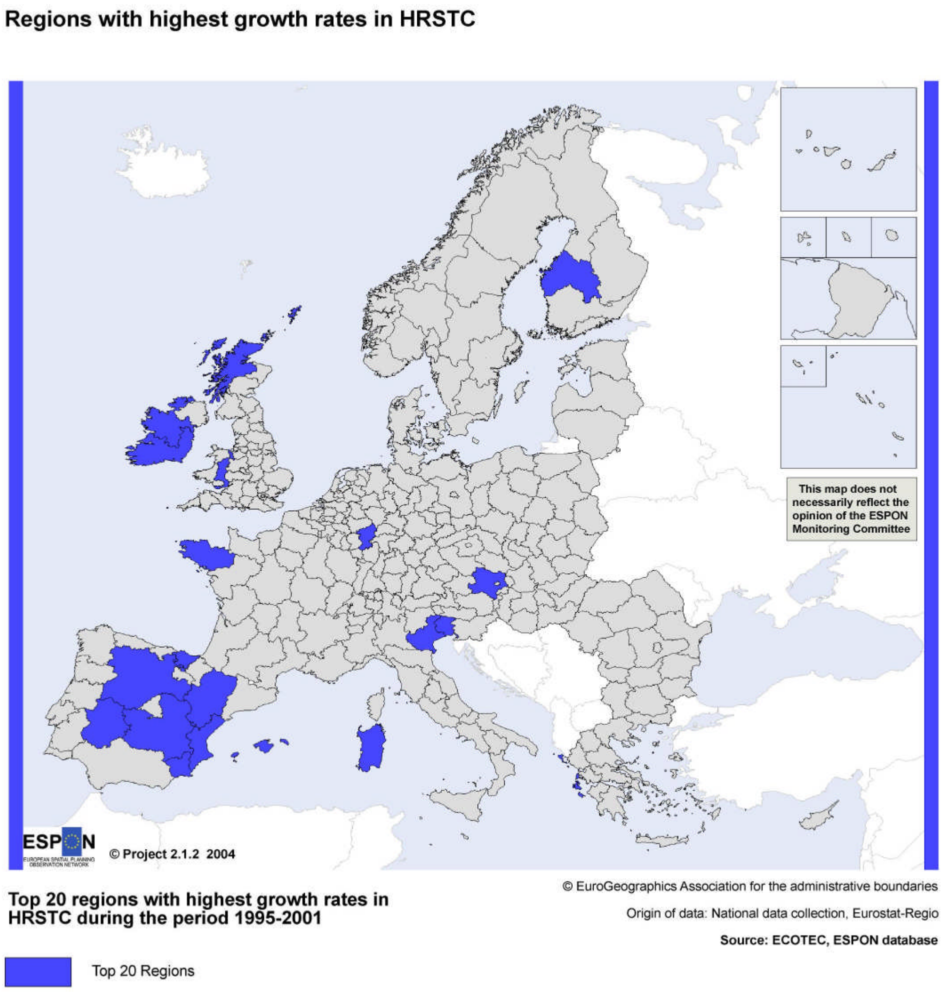
5.4 Distribution of Research and Innovation Infrastructures

One factor that can assist in the development of a strong and innovative economy is the strength of supporting infrastructure. At a European level, the strength of the local university base, presence of recognised science parks and Business Innovation Centres can all play a role. Map 5.9 illustrates the distribution of the University and Science Park research infrastructure across the European territory. Note that Universities in the New Member States or Accession Countries were not included in the assessment data available. Whilst strong university concentrations are evident in the north west of Europe, all of the EU's trans-national programme areas have some sources of strength on which to build.

Analysis of the location of this infrastructure across Europe demonstrates some strong patterns, highlighting the importance of a limited number of regions. 4% of EU regions account for 40% of the leading research universities and institutes; 46% of recognised Science Parks and 25% of Business Innovation Centres. In contrast, 76% of regions contain none of these.

All EU-15 Member States contain at least one region in this leading group, although the institutional mix varies (Table 5.5). In general, the leading regions have a very strong university base, or a balance between Science Parks, Business Innovation Centres and Universities. The presence of a university on its own is not sufficient though, it must be actively engaged in commercially-relevant research.

Map 5.8 Regions with the highest growth rates in HRSTC (1995-01)



Map 5.9 High level R&D infrastructure across Europe

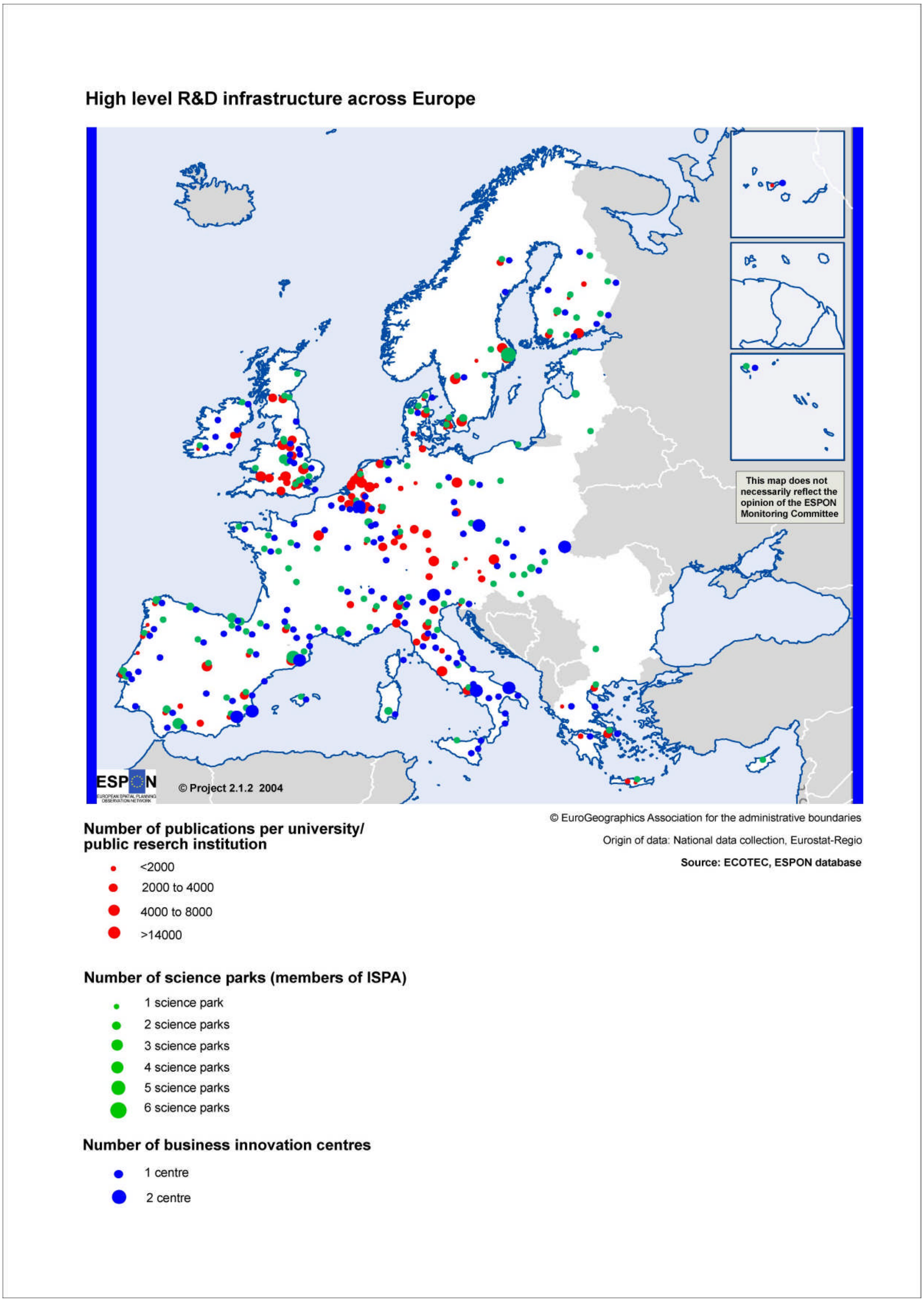


Table 5.5 Research Infrastructure in the EU-15

Member State	Number of leading regions	Strength
Austria	1	University base
Belgium	2	University base
Denmark	1	Balanced
Finland	4	University base
France	4	Balanced, although Paris all university-base
Germany	1	University base
Greece	1	Balanced
Ireland	2	Balanced
Italy	8	Balanced, although Roma all university-base
Luxembourg	1	No university
Netherlands	1	University base
Portugal	3	Balanced
Spain	12	Science Parks and BICs, universities concentrated in 3 of the 12 regions
Sweden	5	Balanced
UK	3	Balanced

In the 12 New Member States and Accession Countries the distribution of research infrastructure is spread more thinly, with just 18 recognised Science Parks and 10 Business Innovation Centres.

The concentration of research infrastructure is not just at a national level. More than half of the research infrastructure in the leading EU regions is located in just 8 regions, representing a significant endowment of knowledge and opportunity. These are distributed between different Member States with the common denominator being the fact that all are capital city regions. The regions are:

Stockholm Län
Paris
Barcelona
Dublin
Grande Lisbon
Communidad de Madrid
Attiki
Roma

5.5 Distribution of human resources for innovation

In addition to measures that are directly relevant to R&D activity within regions, the study has also examined measures that provide an insight into the potential of a region to adopt innovations. As set out previously, these include employment in high and medium technology manufacturing and service sectors and the proportion of the population with tertiary education. We examine each in turn.

5.5.1 Employment in High and Medium High Technology Manufacturing

The medium high and high technology manufacturing sectors include chemicals, machinery, office equipment, electrical equipment, telecom equipment, precision instruments, automobiles and aerospace and other transport (based on the NACE industrial classification). As these sectors are viewed as the most innovative within the manufacturing economy, the proportion of the workforce employed in these fields is an indicator of the capacity of the economy as a whole to exploit the results of R&D and innovation. This said, caution must be exercised in interpreting the figures, as they include employment in assembly plants that are often reliant on the outputs of R&D activity conducted elsewhere. However, as we are assessing innovation capacity here rather than R&D capacity this need not be a significant issue.

Current strengths, weaknesses and disparities

Map 5.10 shows the level of employment in High and Medium High Technology manufacturing sectors across the EU-27 for the most recent years for which data is available.

The average level of employment in High and Medium High Technology manufacturing sectors in the EU-15 in 2001 was 7.57%, compared with a figure of 6.63% across the candidate countries. The highest proportions of employment in these sectors in the EU-15 are found in Germany, where the top seven regions are all located. The region with the highest proportion of the labour force engaged in high technology manufacturing sectors is Stuttgart with 21.08%. Other top performing regions include Franche Comté, Piemonte and Comunidad Foral de Navarra.

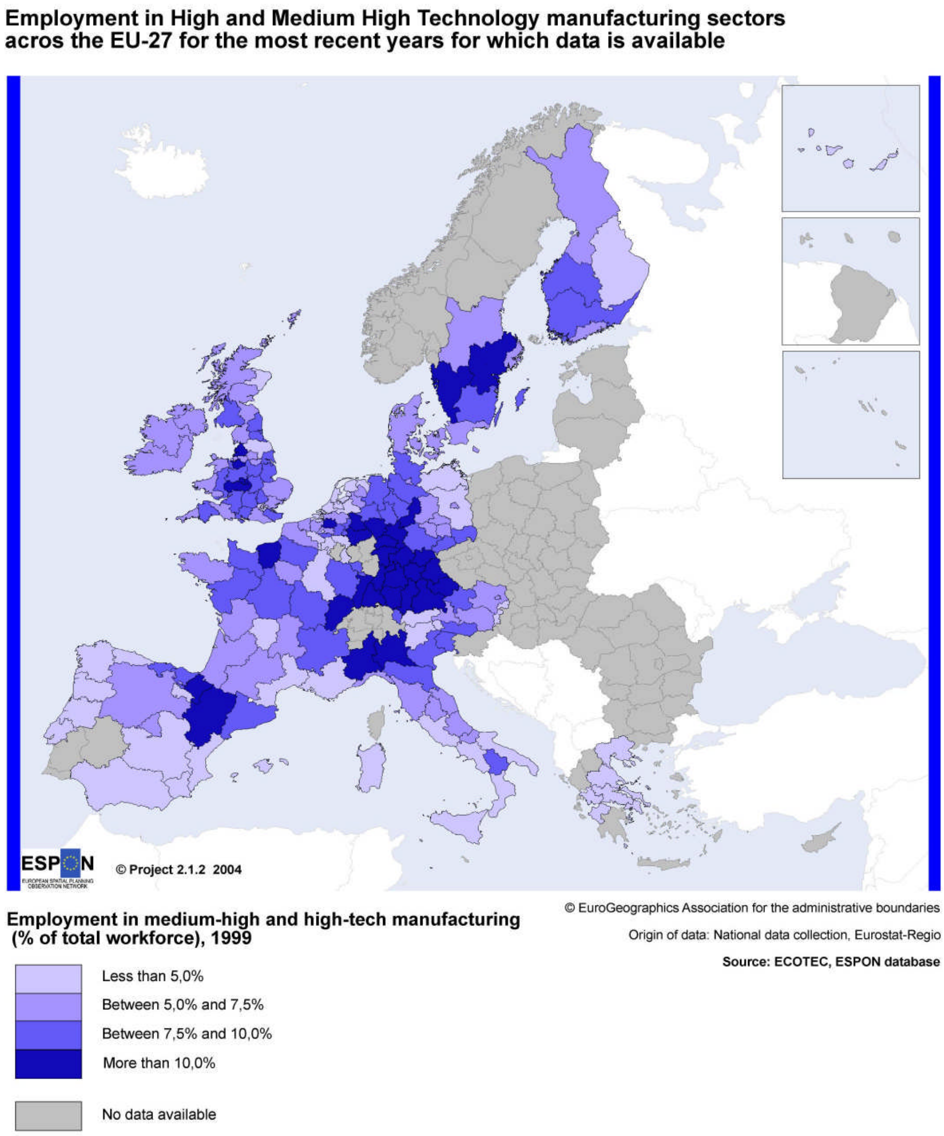
The bottom 50 regions include a high proportion of regions from cohesion areas of Southern Europe, along with a number of regions from core economic areas of the continent such as Outer London (1.96%), Utrecht (2.14%) and Noord Holland (2.56%). The figures for these latter regions reflect the proportionately dominant role of the service sector in these areas.

The highest rates in the New Member States are found in the Czech Republic, Hungary and Slovenia, all of which have levels of medium high and high tech manufacturing above the EU-15 average. Cyprus, the three Baltic States and Romania all have rates of employment in these sectors well below the EU-15 and N12 country average.

Disparities within countries

Particularly marked regional disparities in terms of the level of high technology manufacturing employment occur in Germany, Spain and Italy. These variations reflect profound differences in the economic structure of regions in these countries, between some of the manufacturing heartlands of Europe and the rural periphery.

Map 5.10 Employment in High and Medium High Technology manufacturing sectors across the EU-27 for the most recent years for which data is available



5.5.2 Employment in High Technology Services

This indicator focuses on three leading edge sectors that produce high technology services: post and telecommunications, information technology including software development and R&D services (NACE 64, 72 and 73). These sectors provide services directly to consumers and inputs to the innovative activities of other firms in all sectors of the economy. This indicator is considered to be a more accurate indication of innovative potential in the service sector than “knowledge intensive services”, which includes a far wider range of sectors.

Current strengths, weaknesses and disparities

In 2001, 3.61% of the EU-15 labour force was employed in High Technology Services. The highest levels of employment in these dynamic sectors of the economy are found in North Western Europe, in London and the South East in the UK, in Stockholm, Helsinki, Utrecht and the Paris region (Map 5.11). Berkshire, Buckinghamshire and Oxfordshire, all in the UK, registered the highest figure at 4.65% of the labour force.

In the New Member States and Accession countries, 2.34% of the labour force in 2001 was employed in high tech services. The highest proportion was found in Estonia (3.38%), with similarly high levels in the Czech Republic, Hungary, Malta and Slovakia (3.22%, 3.24%, 3.06% and 3.03% respectively). Romania, Cyprus and Latvia had the lowest rates of employment in these sectors (1.43%, 1.83% and 2.01%).

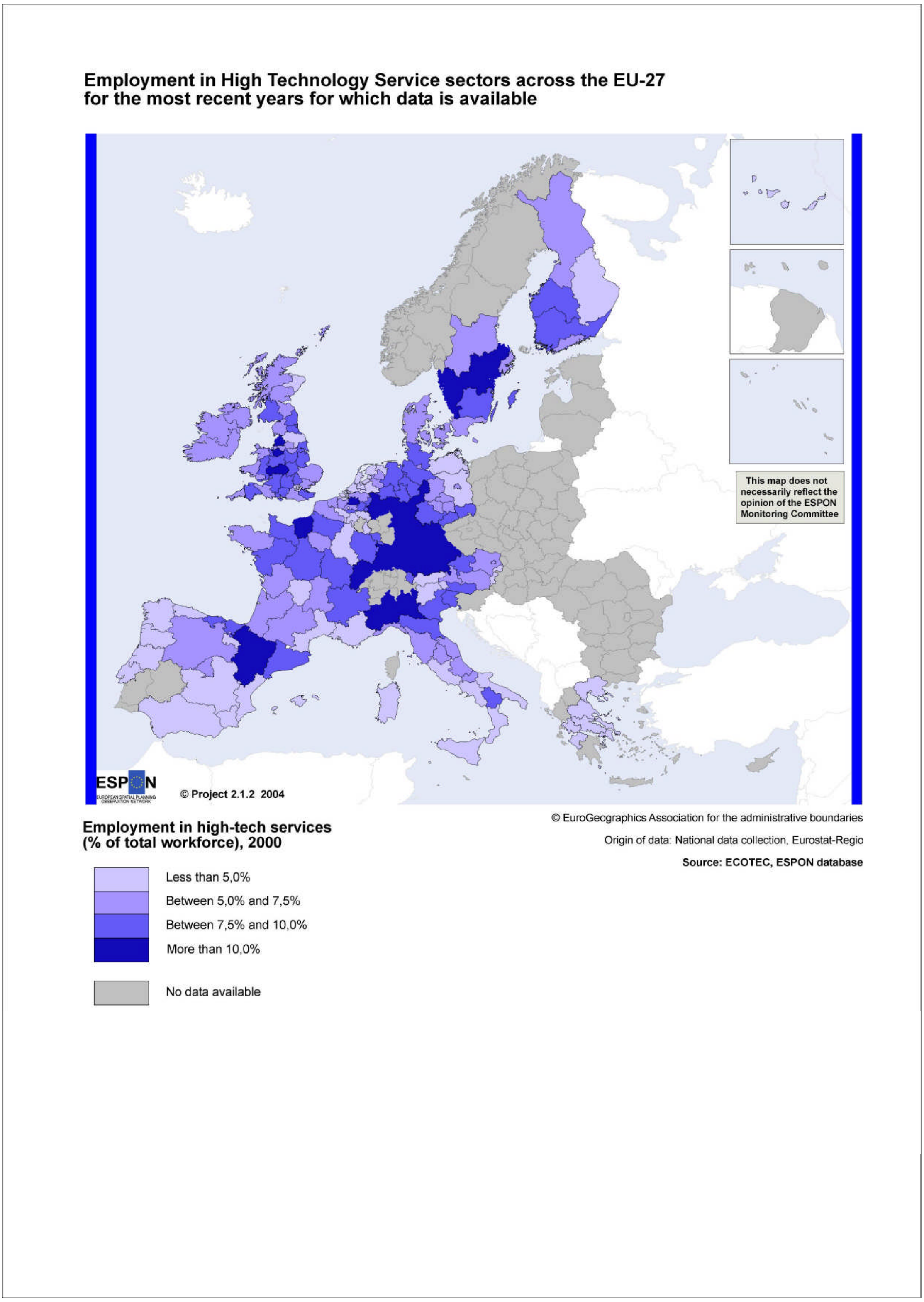
Disparities within countries

As with many of the other indicators examined in this report, strong concentrations of employment in High Technology services are found in capital regions, such as London, Paris, Madrid or Stockholm. For obvious reasons, the levels of employment in these parts of the economy are much lower in peripheral and rural areas of the continent. In the absence of reliable regional data for the N12 countries, it is not possible to comment on the national distribution of employment in these states.

5.5.3 Population with Tertiary Education

This indicator shows the percentage of the working age population (aged 25 to 64) with some form of post secondary education (ISCED 5 and 6). This is a general indicator of the supply of advanced skills in the economy. It is not limited to science and technical fields and, as such, is less useful as an indicator of the scientific knowledge base. However, the adoption of innovations in many areas, particularly in the service sectors, depends on a wide range of skills, which may not be captured by an overly narrow focus on scientific subject areas. Tertiary education is generally considered to act as a reasonable proxy for the capacity of a region to adopt new innovations.

Map 5.11 Employment in High Technology Service sectors across the EU-27 for the most recent years for which data is available



One of the major drawbacks of the indicator is relates to the comparability of national educational systems. Differences in national systems, in particular concerning the level of attainment required to enter third level education make it very difficult to make meaningful international comparisons. As such differences between countries should be interpreted with care.

Current strengths, weaknesses and disparities

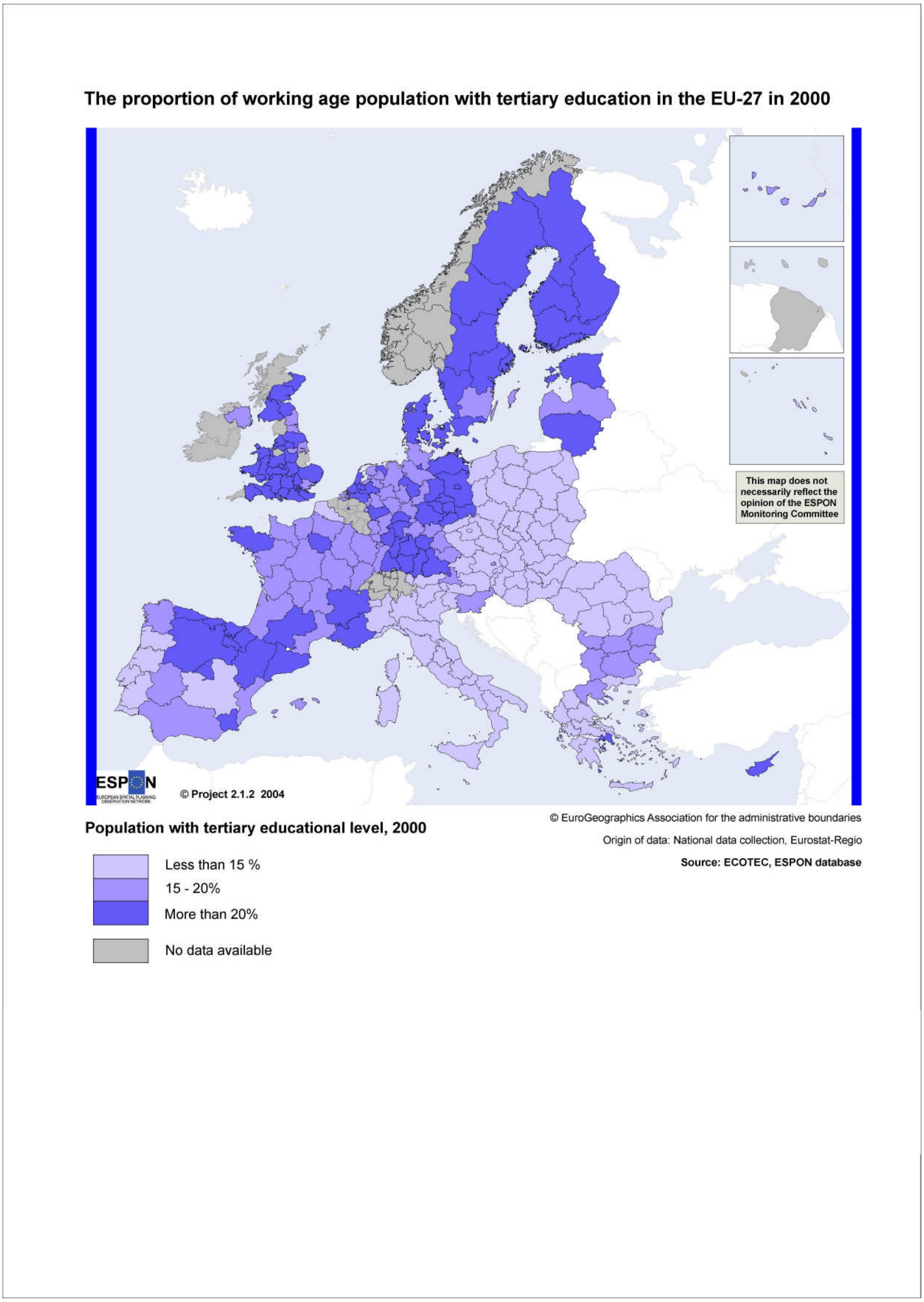
Map 5.12, based on data currently available to the project, shows the NUTS 2 regional picture for tertiary level educational attainment for 2000. The aggregate proportion of the working age population with tertiary education in the EU-15 for this year was 21.2%. As can be seen, the regions with the highest levels of highly qualified people in current members of the Union are concentrated in the Nordic Countries and parts of Germany, the Netherlands and the UK. The lowest levels are found in Northern Portugal, parts of Italy and Greece. The disparity between the Länder of the former GDR (characterized by high levels of tertiary education) and the rest of Germany reflect the legacy of different education systems and illustrate why international comparisons on the basis of this indicator need careful interpretation.

There are very large disparities between the tertiary education levels in the New Member States and Accession countries. While the overall proportion of the N12 country population of working age with tertiary education was 13% in 2001, Bulgaria, Cyprus, Estonia and Latvia all have rates above the EU-15 average (with rates of 21.3%, 26.8%, 29.4% and 45% respectively). The Latvian figure is particularly high, most probably reflecting differences in the definition of tertiary education in this country. Poland, Romania, Slovakia, Hungary and the Czech Republic all have similar proportions of the working population with tertiary education of between 10 and 15%.

5.6 Distribution of Innovative Firms

In an analysis of the regional dimension to innovation in the EU, STEP Economics (Richiardi, M (2000)) identified that the highest numbers of innovative firms were located in northern and central Italy, extending into the Rhone-Alps region and the German Länder of Baden-Württemberg and Bayern. Hot spots were also noted in Ile de France, Catalunya and Denmark. This, he argues, is largely a function of the high number of SMEs in these regions for when the data is analysed according to the share of innovative firms in a region the most 'innovative' regions are located in an area stretching from Austria, through the Netherlands to the UK and Ireland, reaching up to Denmark and extending across from Baden-Württemberg to the East German Länder. Hot spots can also be identified in Italy and Sweden. A similar picture emerges when examining the distribution of firms that had introduced product innovations (as opposed to process innovations), although the number of regions with a strong showing in this instance is much reduced.

Map 5.12 The proportion of working age population with tertiary education in the EU-27 in 2000



6.0 Typologies

6.1 Developing indicators typologies and concepts.

There is an increasing level of importance attached to the extent to which R&D is being undertaken in the EU and the degree to which this is being transformed into new products and more efficient production processes through innovation. The 3rd Report on Economic and Social Cohesion (EC 2004) for example makes much of the gap between the proportion of GDP spent on R&D in the EU compared to the USA and Japan. One of the reasons for this increasing interest is the perceived link between R&D activity, innovation and economic growth. Evolutionary theories of economic growth stress the role of R&D and innovation in securing sustained and lasting growth trajectories. The incorporation of 'technology' into economic models as an endogenous variable highlights the fact that the accumulation of knowledge generates increasing returns. Regions with strong R&D endowments are likely to attract more of these knowledge intensive activities establishing a virtuous circle. Conversely those regions that do not have existing endowments may continue to lag behind and may indeed see the gap between their levels of economic output compared to more advanced regions widen. However, it is not enough simply to undertake R&D, the outputs of the R&D exercise must be exploited by firms through innovation. This offers an opportunity for regions to exploit knowledge generated elsewhere.

In constructing a typology of regions for this study we have sought to identify indicators that reflect regional strengths in R&D, together with indicators of levels of innovation activity. In doing so we have focused on the following aspects:

Levels of R&D activity within a region. The best proxy for levels of R&D activity within a region is currently the level of R&D expenditure. This has the advantage of being commonly measured across the EU and is a key target of the Lisbon agenda31. In order to control for the effects of the different size of NUTS regions across the EU we have focused on R&D intensity, that is the level of R&D expenditure relative to GDP. In constructing the typology we have analysed gross expenditure on R&D. We distinguish elsewhere in this work between expenditure by government, business and the higher education sectors. Level of patent applications is another commonly used indicator of R&D activity and we consider this in one of our typology calculations. Whilst this indicator is an accepted measure of R&D strength it has recognised deficiencies for regional level analysis. Firstly it assumes that R&D activity results in patents and, secondly, that the

[31] Insert ref

address for which the patent is registered relates to the address at which the research took place. There is evidence that in the EU, at least, patents may be registered at the Head Office of an organisation, regardless of where the research took place.

Level of R&D capacity. The capacity of a region to undertake R&D is crucial to its ability to access research opportunities. The strongest indicator in this area is the proportion of the labour force engaged in R&D activities. There are two measures commonly applied here. Firstly the number of people employed in R&D occupations (R&D personnel) as a proportion of the labour force and secondly the number of employees with tertiary education who are working in a science and technology occupation (Human Resources in Science and Technology Core). In both cases the numbers are usually expressed as a percentage of the labour force. Different Member States choose to measure either one of these indicators, or both. There is no consistent indicator as yet for the whole of the EU. For this reason we have chosen to use both.

Firm profile. The profile of firms within a region will influence levels of R&D and innovation activity. Two indicators that are accepted proxy measures of innovation performance are the proportion of firms which are engaged in high technology, or medium technology, sectors in the economy and the proportion of firms engaged in high technology service. In both cases evidence suggests that these are the sectors that are most likely to be engaged in innovative behaviour, particularly the introduction of new products.

Skills of the resident population. The overall level of education within a population is judged to be a good guide to the potential for innovation to occur within an economy. The higher the level of education the more likely is innovation to occur. A commonly accepted measure of this is the proportion of the population of working age (aged 25-64) which has received tertiary education.

Other aspects that the study might have focused on include:

Actual innovation activity. In recent years attempts have been made to measure the actual level of innovation activity present in an economy through the use of company level surveys. The most wide-ranging of these is the CIS. Designed to provide robust statistics at the national and European Union level, sample sizes are generally too small to provide robust measures at a regional level. However, regional data has been calculated using the second CIS. This study has not made use of CIS data (see Box 6.1) but measures that have been used by others include: share of turnover due to products new-to-firm; sales of new-to-firm products; proportion of innovative manufacturing enterprises;

proportion of innovative service enterprises; innovation expenditure by manufacturing enterprises; innovation expenditure by service enterprises.

Levels of co-operation and collaboration. There is some evidence that economies that have higher level of co-operation and collaboration tend to have a higher level of innovation. This collaboration may be between firms and universities; firms and other research organisations, or between different firms. Again there are, as yet, no good measures of levels of co-operation consistently available across the EU. The partial exception to this is again the CIS which does contain an indicator based on the proportion of firms with co-operation agreements. However, this indicator also suffers from issues of robustness and availability.

Box 6.1 The Community Innovation Survey (CIS) and regional data analysis.

The CIS is carried out periodically across the EU to assess the scale of firm-level innovation within the EU. It is undertaken at a Member State level by Member States on behalf of EUROSTAT. In some Member States completion of the survey is compulsory, in others it is voluntary. In all cases it is based upon a sample of firms.

Results of the CIS survey have only been publicly released at the Member State level. Some data from the second CIS (appertaining to the period 1994-96) has been estimated at a regional level using national data by Step Economics. This data has in turn been recalculated by the European Innovation Scoreboard (in Nov. 2003) to provide some estimations of innovation activity at a regional level.

The Monitoring Committee for the ESPON programme requested that ECOTEC seek to acquire up to date regional level data for firm level innovation, using the third CIS. ECOTEC agreed to pursue this matter with EUROSTAT to explore potential data availability. EUROSTAT report that there is no regional level data available for the third CIS, because "countries carrying out the CIS 3 did not include the region when stratifying the sample with the effect that no production of regional data at acceptable data quality is possible". They acknowledge that some Member States may have included a regional variable but they have not pursued this and do not have this data. In our contacts with all Member States in pursuit of regional CIS data we have been able to track down relevant datasets for two Member States (Finland and the UK).

Looking to the future, EUROSTAT report that a regional identifier has been included in the fourth CIS and that the initial results of this survey will be available early in 2006. This will provide a valuable resource for regional analysis.

6.2 Analysing the data[32]

Two methods were used to construct the typologies for this study.

- Firstly, we used an approach based on z-score analysis. This provides a measure of the distribution from the European average (based upon the standard deviation from the mean) for each region.

- Secondly, a k-means cluster analysis was also undertaken. This is a form of nearest neighbour analysis which uses statistical techniques to identify clusters of regions with similar attributes based upon the data used.

We set out the method used for each in more detail below.

6.2.1 Z-score analysis

In the first approach the method adopted is based upon assigning Z scores for each indicator- relative to the European average. On the basis of this score, regions were graded into a high, medium or low category (top, middle and bottom third of scores) for R&D and for innovation. In each case (R&D and innovation) regions were only included in the final assessment if at least 2 indicators were available. The indicators (with dates) were as follows:

- R&D Scores – average of the Z scores for the indicators:

  - ► R&D expenditures (1999) as a percentage of regional GDP (1999)
  - ► R&D personnel as a percentage of the labour force (1999) or Employees with Tertiary level education working in a Science and Technology Occupation (HRSTC) (2001).

- Innovation scores – average of the Z scores for the indicators:

  - ► Employment in High Technology and Medium High Technology Manufacturing as a percentage of total employment (2000);
  - ► Employment in High Technology Services as a percentage of total employment (2000);
  - ► Percentage of the Working Age Population (aged 24-65) having successfully completed some form of tertiary education (2000).

[32] Methodological details are also contained in the Methodology Section

All regions could thus be located within a 3x3 matrix of the form:

	R&D Score			
Innovation score		High	Medium	Low
	High			
	Medium			
	Low			

A typology was then produced on the basis of the combined scores for the two categories of R&D and innovation. The typology is based upon 5 'types' of region.

Type 5 regions are those regions that score highly both in terms of R&D indicators and innovation indicators.

Type 4 regions are those that exhibit strengths in terms of R&D indicators but perform less strongly with respect to innovation indicators.

Type 3 regions are those that exhibit strengths against innovation indicators but are not so strong in terms of R&D indicators.

Type 2 regions are those achieve a medium score (ie around the EU average) against either the R&D indicators or the innovation indicators and a medium or low score in the other set of indicators

Type 1 regions are those that present a low score (ie significantly below the EU average) against both R&D indicators and innovation indicators.

This is summarised in Table 6.1.

Table 6.1 Typology of regions

Type	Description
Type 1 (Lacking capacity)	Low R&D capacity and low innovation capacity
Type 2 (Standard capacity)	Medium R&D capacity and medium innovation capacity
Type 3 (Innovation rich)	Low or medium R&D capacity but high innovation capacity
Type 4	High R&D capacity but low or medium innovation capacity

Type	Description
(R&D rich)	
Type 5 (Knowledge hubs)	High R&D capacity and high innovation capacity

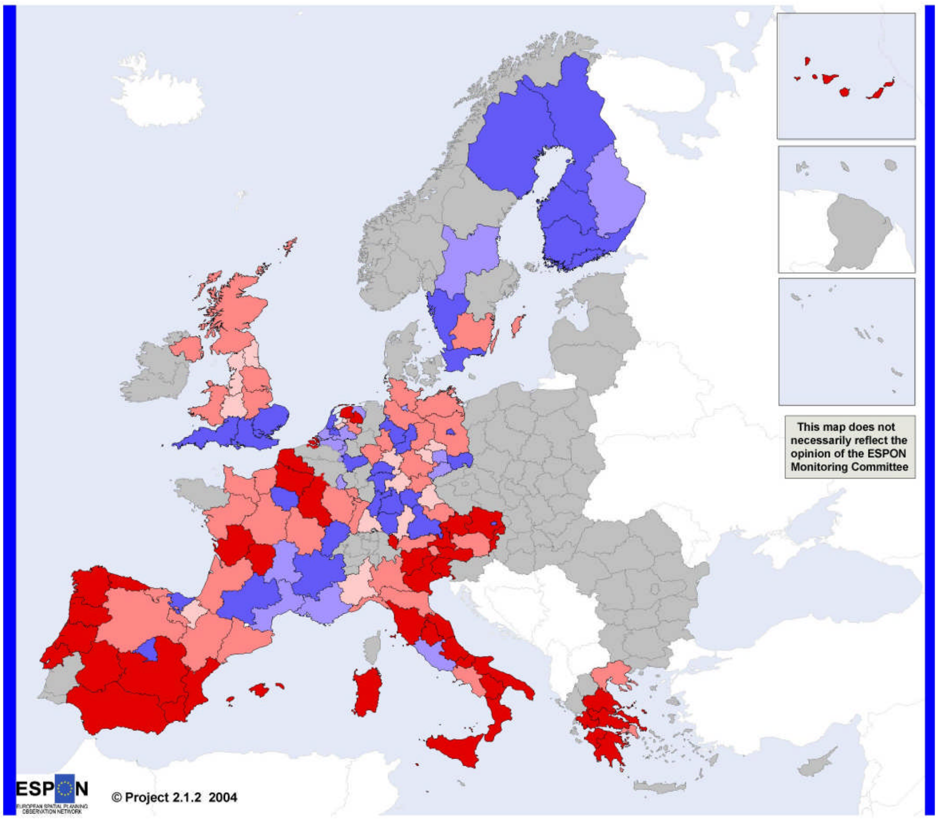
Essentially, Types 4 and 3 are special cases in the context of regions that perform well either as producers of R&D or as users of R&D that is produced elsewhere. They reflect the potential reality of the EU as an area of transnational and transregional knowledge flows but may also suggest asymmetries in the regional innovation systems in these places. Types 1 and 2 should not necessarily be seen as the 'worst cases' as not all regions will find a high R&D capacity a desirable objective.

The distribution of regions between the different categories is set out in Table 6.2 below. This includes those countries for which national data was available but not regional data. Excluding these cases does not substantially change the distribution, as illustrated in Table 6.3.

Table 6.2 Number of regions by Type

Type	Approach 1	
	No.	%
Type 5	33	21
Type 4	18	11
Type 3	16	10
Type 2	47	29
Type 1	46	29
Total count	160	

Typology of Regions based on Z-score Analysis



Typology of regions: Cluster analysis, NUTS2

Origin of data: National data collection, Eurostat-Regio

Source: ECOTEC, ESPON database

- Region type 1
- Region type 2
- Region type 3
- Region type 4
- Region type 5
- No data available

Examining the distribution by country it is clear that the majority of regions with strong R&D and innovation capacities are located in northern Europe, whilst in southern Europe there is a higher concentration of regions with lower capacities. Exceptions to this pattern are to be found in Spain and in the UK and France. The number of missing data points complicates building a more detailed spatial picture.

Table 6.3 Distribution by country

	Type 5		Type 4		Type 3		Type 2		Type 1	
Austria	11%	1	-	-	-	-	22%	2	67%	6
Germany	32%	12	11%	4	22%	8	35%	13	-	-
Spain	12%	2	-	-	6%	1	29%	5	53%	9
Finland	80%	4	20%	1	-	-	-	-	-	-
France	19%	4	14%	3	-	-	43%	9	24%	5
Greece	-	-	-	-	-	-	33%	2	67%	4
Italy	-	-	5%	1	5%	1	21%	4	68%	13
Netherlands	16%	2	42%	5	8%	1	8%	1	25%	3
Portugal	-	-	-	-	-	-	-	-	100%	3
Sweden	60%	3	20%	1	-	-	20%	1	-	-
UK	33%	4	-	-	25%	3	42%	5	-	-
TOTAL	22%	32	10%	15	10%	14	29%	42	30%	43

Regional data was not available at the time of the original data collection for Luxembourg, Denmark, Ireland, Belgium or the New Member States

6.2.2 Cluster analysis

The second approach is based upon cluster analysis. The analysis has been run twice combining the indicators in a different manner. The first quick cluster uses 4 indicators to determine the 5 clusters: business R&D, HRSTC, patents and high-tech employment. The second quick cluster combines these to create 2 composite indicators: research capacity and innovation capacity. We have included the methodological explanations in this section to aid interpretation. This repeats material presented in the separate methodology chapter.

Cluster analysis is widely used in research to determine clusters of similar objects33. Clustering objects means classifying a set of different objects into smaller groups of more

[33] For an introduction into cluster analysis, see e.g. H. Charles Romesburg, "Cluster Analysis for Researchers", Lulu Press, 2004.

similar objects. Cluster analysis uses mathematical techniques to sort objects with similar descriptions into the same cluster. For exploratory purposes only, we have used the K-means clustering technique as available in SPSS. The first cluster analysis determines 5 clusters using data on four widely available indicators[34]. The second cluster analysis determines 5 clusters using data on the two composite indicators on research and innovation capacity.

i) Cluster analysis 1

For the first cluster analysis, re-scaled data[35] for the following four indicators were used to determine 5 clusters:

- Business R&D expenditures (BERD) as a percentage of GDP[36];
- Core human resources (HRSTC) as a percentage of total employment;
- Patent applications per million population;
- High-tech employment as a percentage of total employment.

Table 6.4 gives the mean re-scaled values per cluster for each of these indicators. These clusters can be described as follows:

- Cluster 1: worst R&D performance, lowest share in high-tech employment;
- Cluster 2: mediocre R&D performance, strong HRSTC base;
- Cluster 3: mediocre R&D performance, average share of high-tech employment;
- Cluster 4: 2nd best R&D performance, average share of high-tech employment;

[34] The *assumption* of 5 clusters was taken based on the information contained in the dendrogram of a comparable hierarchical cluster analysis.
[35] Re-scaled data were used to make sure that data for all indicators were in the same range. By first subtracting the highest regional value and then dividing by the difference between the highest and lowest regional value, all regional scores are converted between 0 and 1, where the worst performing region will have a score of 0 and the best performing region a score of 1.
[36] Total R&D expenditures (or GERD) as a percentage of GDP was not used as this indicator could be "biased" by the fact that some governments plan their R&D expenditures in *backward* regions.

Table 6.4 Mean indicator values and regional distribution by cluster (Analysis 1)

	#1	#2	#3	#4	#5
Business R&D	.06	.21	.17	.41	.71
Core human resources	.23	.53	.27	.42	.52
Patent applications	.05	.14	.17	.37	.68
High-tech employment	.17	.30	.43	.53	.68
Number of regions (143 in total)	36	34	44	16	13
Austria	4	-	5	-	-
Belgium	-	3	-	-	-
Germany	1	9	13	7	8
Spain	10	2	2	-	-
Finland	1	2	-	2	1
France	4	6	8	3	-
Greece	3	-	-	-	-
Italy	10	-	7	-	-
Luxembourg	-	1	-	-	-
Netherlands	1	5	2	1	1
Portugal	2	-	-	-	-
Sweden	-	3	1	1	3
United Kingdom	1	3	6	2	-

- Cluster 5: top R&D performers, strong HRSTC base, highest share of high-tech employment.

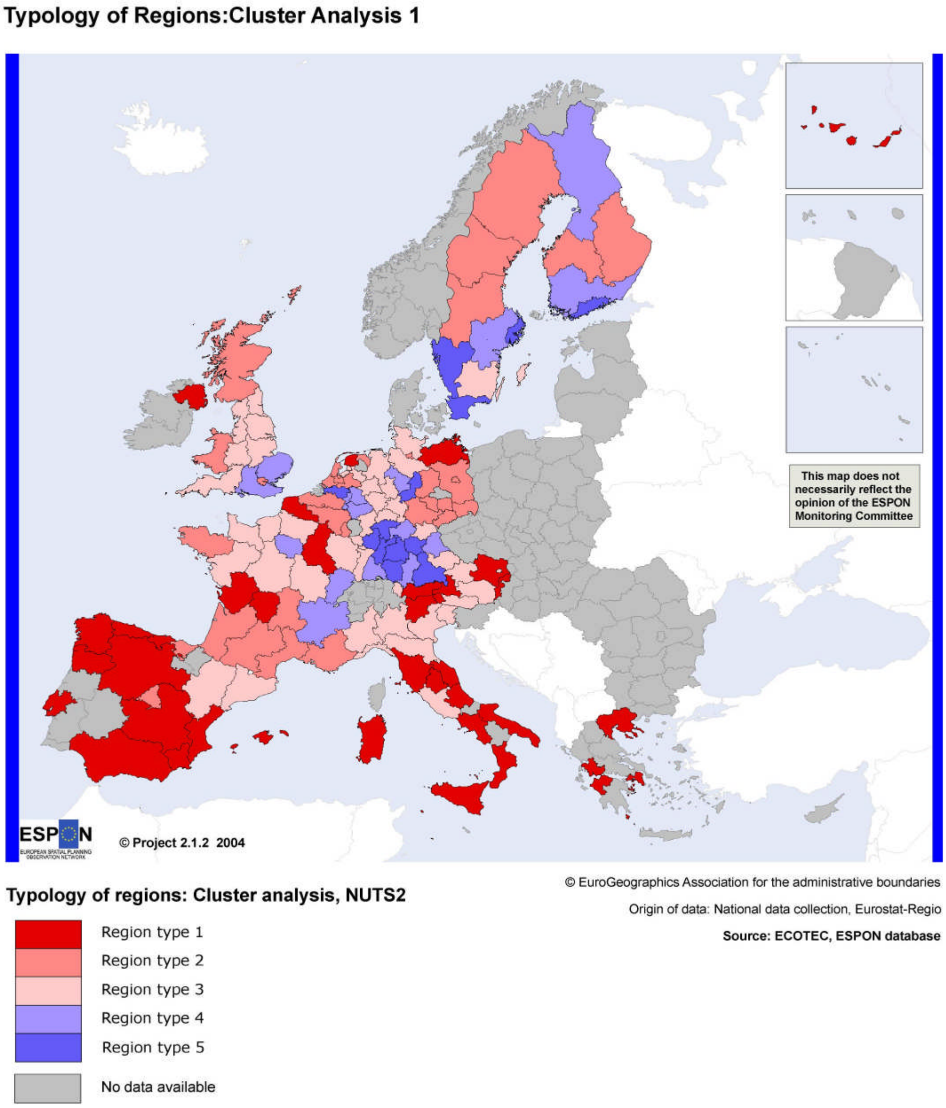
Cluster 5 regions are the regional innovation leaders. These leading regions are located in Germany, Sweden, Finland and the Netherlands. These regions have highest per capita GDP, business R&D expenditures, patent applications, high-tech patent applications and lowest unemployment (Table 6.5). It is perhaps interesting to note that it is note these regions that have the strongest level of lead partner participation in the Framework Programmes, that falls to regions lying in Cluster 4 (although these are also the most populous regions).

Table 6.5 Table 6.5 Mean cluster characteristics (Analysis 1)

	#1	#2	#3	#4	#5	Average
Per capita GDP (euros)	16541	23865	22662	25473	29607	22353
Population (000s)	2159	2323	2568	3386	2304	2474
Population density	148.9	703.1	319.8	306.2	266.5	361.6
GERD as a % of GDP	.69	1.90	1.26	2.49	3.95	1.58
BERD as a % of GDP	.26	.98	.78	1.88	3.24	1.04
GOVERD as a % of GDP	.11	.38	.17	.23	.33	.23
HERD as a % of GDP	.34	.51	.32	.42	.48	.39
Patent applications per mln population	36.2	111.1	132.9	285.9	519.4	155.6
Hi-tech patent applications per mln pop	3.2	19.2	13.4	56.0	127.3	27.5
FP4 primary	39.0	105.2	53.0	146.6	110.0	77.0
FP4 secondary	124.8	251.2	171.4	358.1	355.4	215.3
FP5 primary	35.6	93.3	50.0	117.2	102.9	68.6
FP5 secondary	146.9	283.0	197.2	384.6	412.2	244.7
Employment (000s)	808	1003	1116	1566	1117	1062
HRSTC (%)	11.3	19.8	12.4	16.5	19.4	15.0
% of workforce with tertiary education	14.8	27.0	16.5	22.3	26.4	19.8
Share of high-tech employment	8.4	9.7	11.2	12.2	14.7	10.7
Unemployment (%)	10.3	8.9	6.1	6.0	4.8	7.7

Map 6.1 depicts the distribution of regions by cluster. The strengths of parts of the core of the EU, particularly around southern Germany, Benelux and the greater South

Map 6.1 Typology of regions: cluster analysis 1



East of England and the northern periphery are clearly apparent. However, the strengths are not uniform and even in the core of the EU there are regions which fall into cluster groups 1 and 2.

ii) Cluster analysis 2

For the second cluster analysis, we used data from two composite indicators. The composite indicator on research capacity is calculated as the average score of the re-scaled data for the indicators on business R&D expenditures and core human resources. The composite indicator on innovation capacity is calculated as the average score of the re-scaled data on patents and high-tech employment (Table 6.6).

Table 6.6 gives the mean re-scaled values per cluster for each composite indicator. These clusters can be described as follows:

- Cluster 1: low R&D capacity, low innovative capacity;
- Cluster 2: medium R&D capacity, low innovative capacity;
- Cluster 3: medium R&D capacity, medium innovative capacity;
- Cluster 4: high R&D capacity, medium innovative capacity;
- Cluster 5: high R&D capacity, high innovative capacity.

Table 6.6 Mean indicator values and regional distribution by cluster (Analysis 2)

	#1	#2	#3	#4	#5
Research capacity	.14	.32	.29	.63	.57
Innovation capacity	.12	.20	.38	.35	.69
Number of regions (145 in total)	49	52	25	13	6
Austria	8	1	-	-	-
Belgium	-	1	-	2	-
Germany	4	12	14	3	5
Spain	10	4	-	-	-
Finland	-	2	-	3	-
France	4	13	3	-	1
Greece	4	1	-	-	-
Italy	14	-	3	-	-
Luxembourg	-	1	-	-	-

	#1	#2	#3	#4	#5
Netherlands	2	7	1	-	-
Portugal	2	-	-	-	-
Sweden	-	4	-	4	-
United Kingdom	1	6	4	1	-

The number of leading regions (cluster 5 regions) has decreased to 6. Leading regions are located in only two countries: Germany and France. These regions have highest per capita GDP, business R&D expenditures and patent applications. In this analysis Cluster 5 regions have the highest FP4 and FP5 participations – by a substantial margin - and lowest levels of unemployment (Table 6.7).

Table 6.7 Mean cluster characteristics (Analysis 2)

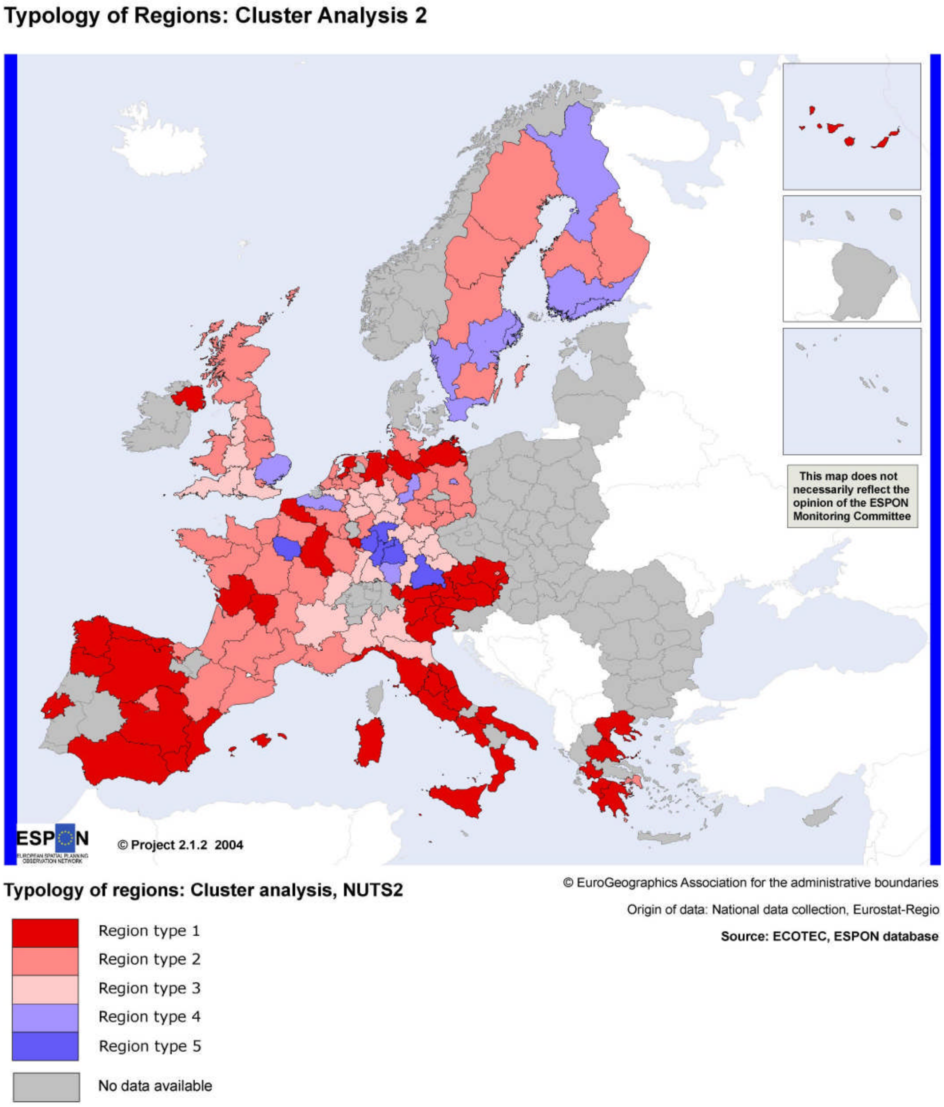
	#1	#2	#3	#4	#5	Average
Per capita GDP (euros)	17693	22677	24444	28294	32015	22187
Population (000s)	1983	2263	3358	2245	4545	2450
Population density	139.6	449.6	295.8	884.7	448.1	357.2
GERD as a % of GDP	.80	1.64	1.66	4.15	3.85	1.57
BERD as a % of GDP	.35	.92	1.18	2.87	3.00	1.03
GOVERD as a % of GDP	.16	.27	.14	.33	.44	.22
HERD as a % of GDP	.32	.43	.33	.66	.41	.39
Patent applications per mln population	63.2	106.2	252.7	336.2	512.9	155.6
Hi-tech patent applications per mln pop	5.3	15.9	39.5	100.6	90.2	27.5
FP4 primary	34.1	84.9	78.1	97.6	298.8	75.9
FP4 secondary	109.2	221.2	234.2	338.0	678.0	212.3
FP5 primary	32.1	77.5	62.4	88.0	260.2	67.6
FP5 secondary	131.8	250.1	246.1	383.0	790.5	241.3
Employment (000s)	754	984	1514	1033	2160	1051
HRSTC (%)	10.6	17.2	13.7	22.6	18.5	14.9
% of workforce with tertiary education	14.3	22.8	18.2	29.9	25.5	19.7
Share of high-tech employment	9.0	10.3	12.6	11.7	14.5	10.7
Unemployment (%)	9.0	8.1	5.3	6.9	5.0	7.7

Map 6.2 illustrates the distribution of regions by cluster. The strengths of parts of the EU core and the northern periphery are clearly visible.

iii) Cluster Analysis 3

Finally, we have run a third cluster analysis using our 6 indicators. This analysis recognises that many regions rely upon Government expenditure on R&D and on R&D carried out by the Higher Education Sector. There is a danger that focusing solely on business expenditure will underplay the potential of these regions. We have retained the measure of R&D output (in the form of patent applications) as a measure of the commercial-orientation of different regional innovation systems. In this cluster analysis we have also made use of additional measures of human capital available within regions, including the proportion of the population with tertiary education and differentiating between employment in high technology manufacturing and services.

Map 6.2 Typology of regions: cluster analysis 2



The clusters have been calculated on the basis of the mean for each variable, these calculations have been produced using a statistical software package called GenStat. We explored data availability for both R&D personnel and HRST(C), with the better coverage of HRST(C) in the EU-15 leading us to focus on this indicator of R&D capacity. For each region the distance from the EU mean has been calculated for each indicator. The results for each variable are presented in Table 6.8. In this instance the Cluster groups are not hierarchical. A hierarchical grouping could be as follows:

- Cluster 1 – Very high capacity for R&D and innovation
- Cluster 5 – High capacity for R&D and innovation
- Cluster 3 – Above average capacity for R&D and innovation
- Cluster 2 – Average capacity for R&D and innovation
- Cluster 4 - Below average capacity for R&D and innovation

Table 6.8 Overview of variables, including mean scores (Analysis 3).

	Minimum	EU average (mean)	Maximum
Gross Expenditure on R&D (% of GDP)	0.1	1.4	6.3
Proportion of Population with Tertiary Education	6.3	19.0	45.0
EPO Patent Applications (Per million - population)	0.1	22.3	301.2
Employment in Med & High Tech Manufauring	0.9	7.0	21.1
Human Resource in Science and Tech (core)	4.8	14.1	26.4
Employment in High Tech services (% of workforce)	0.7	2.8	7.1

	R&D intensity	Tertiary Education	EPO Patent	Empl in MH tech. Manufg.	HRSTC	Empl in High tech. services
Minimum						
Cluster 1	2.7	21.9	268.6	7.0	15.1	3.4
Cluster 2	0.4	13.8	0.2	2.0	8.7	1.5
Cluster 3	0.4	12.3	26.7	2.1	4.8	1.9
Cluster 4	0.1	6.3	0.1	0.9	5.2	0.7
Cluster 5	1.8	16.2	68.1	6.7	11.5	2.6
Maximum						
Cluster 1	4.8	40.7	301.2	12.9	26.4	7.1

	R&D intensity	Tertiary Education	EPO Patent	Empl in MH tech. Manufg.	HRSTC	Empl in High tech. services
Cluster 2	3.7	45.0	25.3	15.0	22.1	6.0
Cluster 3	6.3	33.9	59.1	18.1	26.1	6.5
Cluster 4	2.5	24.9	17.5	14.9	18.3	5.6
Cluster 5	4.8	33.0	153.7	21.1	24.1	6.5
Average						
Cluster 1	3.8	29.7	283.5	9.0	20.1	5.1
Cluster 2	1.4	23.6	13.7	7.0	16.2	3.2
Cluster 3	2.4	22.8	39.2	10.1	16.5	3.5
Cluster 4	0.8	13.9	3.8	5.5	11.3	2.1
Cluster 5	3.4	25.9	93.8	10.9	18.1	4.2

The class mean values for each cluster are provided in Table 6.9 below, also demonstrated is the variance from the EU Average (mean) to the cluster mean for each variable:

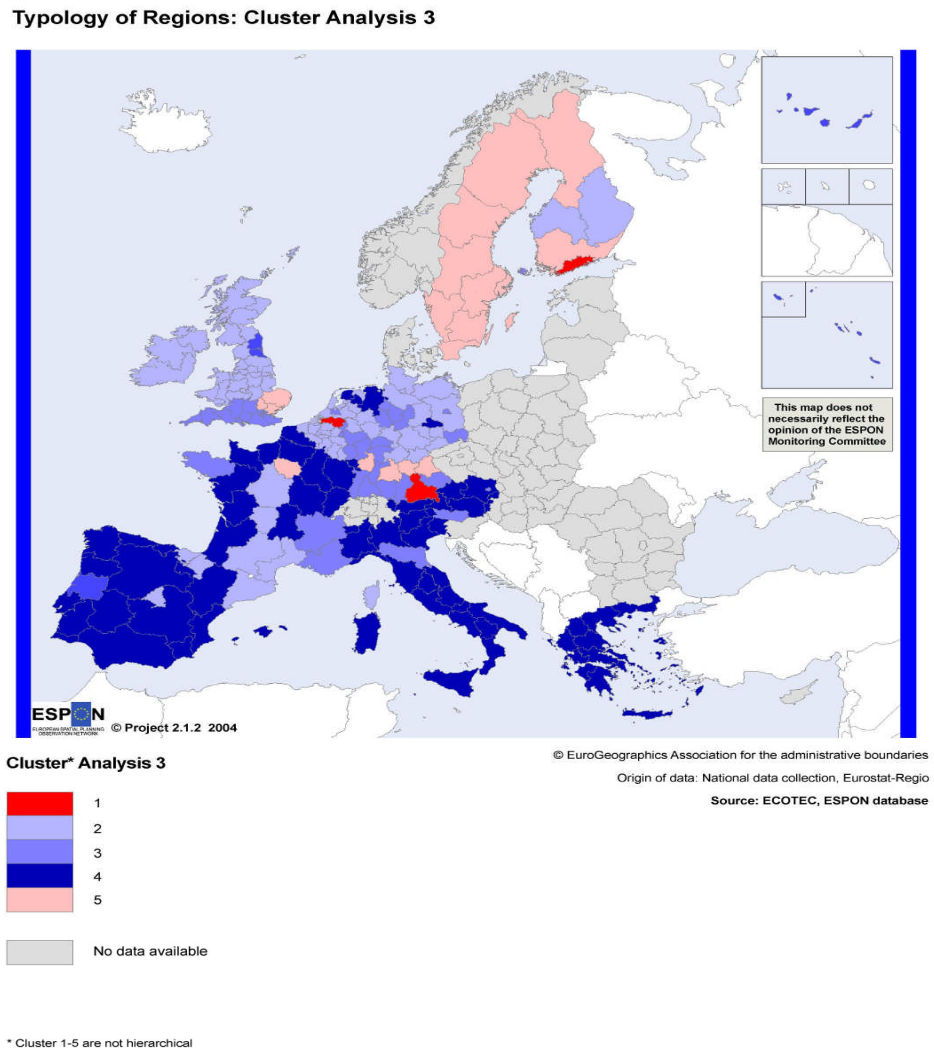
Table 6.9 Cluster Values (Analysis 3)

Mean value of each variable within the clusters

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	EU
Gross Expenditure on R&D (% of GDP)	3.9	1.5	2.4	0.8	3.4	1.4
Proportion of Population with Tertiary Education	29.7	23.6	22.8	13.9	25.9	17.3
EPO Patent Applications (Per million - population)	283.4	13.7	39.2	3.8	93.8	22.3
Employment in Med & High Tech Manufauring	9.0	7.0	10.1	5.5	10.9	7.0
Human Resource in Science and Tech (core)	20.2	16.2	16.5	11.3	18.2	14.1
Employment in High Tech services (% of workforce)	5.1	3.2	3.5	2.1	4.2	2.8
Variance from EU Average						
Gross Expenditure on R&D (% of GDP)	2.4	0.0	0.9	-0.6	2.0	
Proportion of Population with Tertiary Education	12.4	6.2	5.5	-3.4	8.5	
EPO Patent Applications (Per million - population)	261.1	-8.6	16.9	-18.6	71.5	
Employment in Med & High Tech Manufauring	2.0	0.0	3.1	-1.4	3.9	
Human Resource in Science and Tech (core)	6.1	2.2	2.4	-2.7	4.1	
Employment in High Tech services (% of workforce)	2.3	0.4	0.7	-0.7	1.4	
Number of regions in each cluster	**3**	**44**	**23**	**74**	**8**	

A description of the different cluster characteristics is set out below. Map 6.3 illustrates the location of different regions according to cluster type. From the map the strengths of the core of the EU and the northern periphery are apparent. Although strengths are not uniform across the EU core a clear 'corridor' can be seen stretching from southern Germany upwards to southern England. Outside of this corridor 'islands; of above average performance can be distinguished.

Map 6.3 Typology of regions: cluster analysis 3



Cluster 1

Regions located within cluster 1 demonstrate mean scores above the EU average in all indicators. This is especially the case in relation to the number of patent applications which are well above the EU average (per million of the population), % of GDP expenditure on Research and Development is also above the EU average, the proportion of the regional workforce employed within the High Technology sector is also above the EU average. There are 3 regions within this cluster these are Oberbayern (Germany), Uusimaa (Finland) and Noord-Brabant (the Netherlands).

Cluster 5

The regions located within cluster 5 demonstrate, on average, higher than the EU average mean levels across all our indicators; although not to the levels experienced in cluster 1. The particular strengths of this cluster lie in high and medium technology manufacturing, where performance is stronger even than Cluster 1. There are 8 regions demonstrating these characteristics, located in Germany, France and the UK.

Cluster 3

Regions located within cluster 3 are above the mean average for all indicators in comparison to the EU average (mean), though not to the levels experienced in cluster 1 or cluster 5. The mean for R&D intensity is slightly higher than the EU average as is the % of people employed within the High Technology Services sector. They also exhibit strengths in terms of the mean number of patents compared to the EU average and the percentage of people employed within medium or high technology manufacturing within the region. Regions within this cluster demonstrate the middle ground between all the clusters. There are 24 regions within this cluster; a little over half of these are located within Germany. The remaining regions are spread across the United Kingdom, France and the Netherlands.

Cluster 2

Regions located within cluster 2 on average demonstrate average performance in terms of R&D intensity and employment in high or medium technology manufacturing, but they have below average performance in terms of patent applications. For three indicators - Tertiary education, HRSTC and Employment in High Technology services – mean performance is slightly above the EU average. The mean level of R&D intensity is the same as the EU. There are 44 regions within this cluster, primarily located in Germany, Spain, France, the Netherlands and the United Kingdom.

Cluster 4

The regions located within cluster 4 are below the EU average mean for 6 of the 6 indicators, these regions demonstrated a slightly lower than average expenditure on Research and Development (% GDP), and the proportion of the workforce employed within the High Technology Services sector. The mean value in terms of the number of patent applications (per million of the population) was the lowest in terms of its position from the EU average.

Almost half of the regions considered in this analysis fall into this final cluster, indicating the long-tail of regions with weak levels of R&D and innovation across the Union. Whilst these regions are predominantly to be found in southern Europe, particularly Portugal, Spain, Italy and Greece, isolated islands can also be seen in northern Europe, with a substantive area of France exhibiting similar characteristics.

6.3 Comparing different typologies

Looking across the different approaches taken to developing regional typologies demonstrates that each approach gives a broadly similar picture. On the whole the same parts of the EU emerge as centres of R&D and innovation strengths. However, there are differences and it is worth identifying these as an illustration of the variable results that emerge from typologies depending upon the factors that are taken into consideration and the technique used to compile a typology.

Comparison of the results for the Z-score typology with those for Cluster 1 immediately demonstrates the stronger position that regions in the core of the EU – and the northern periphery - occupy in the latter. This is primarily due to the emphasis on the distribution of business related R&D activity in Cluster 1 – where business expenditure on R&D and EPO patent applications are 2 of the 4 variables adopted. This typology is thus a good reflection of the location of private sector R&D strengths. Looking at Cluster 2 illustrates that the picture has become further concentrated. This is most probably the result of the combination of the 4 indicators into 2 composite variables which tends to 'even out' overall performance. In contrast the z-score analysis highlights a small number of regions located in southern Europe which have strong levels of R&D personnel which tends to pull their overall score 'upwards'. A listing of different regional positions based upon the various typological approaches is included at Annex 4.

One of the challenges of developing typologies is that in a broad analysis the categorisation of individual regions can vary slightly between different approaches. Equally, it is not always the case that two regions in one typological category in one analysis will also be in a similar category when a second approach is used. This point is emphasised to illustrate that whilst typologies serve a useful analytical purpose interpretation of the analysis must be tempered by a recognition of which variables are being measured as well as the method used.

To illustrate this point further we have undertaken a short comparison of our summary cluster analysis and compared it with the Regional Summary Innovation Index of the European Innovation Survey. It was agreed that in the light of innovation data not being available from the third CIS ECOTEC would seek to compare the typology developed by the EIS with those developed in the course of this work. It was felt that this offered a more meaningful analysis than simply incorporating the 1994-1996 CIS 2 data into our own typology. In part this is because of the similarities between the EIS indicators and our own (see Table 6.10).

Table 6.10 A comparison of indicators selected for regional innovation typologies

ESPON 2.1.2 (2002)	EIS RSII (2003)
Gross expenditure on R&D (% GDP)	Public sector expenditure on R&D (% GDP)
	Private sector expenditure on R&D (% GDP)
HRSTC (% Labour Force)	
EPO patent applications (per million population)	EPO patent applications (per ml pop)
	High tech EPO patents (per ml pop)
Employment in high and medium tech manufacturing (% workforce)	Employment in high and medium tech manufacturing (% workforce)
Employment in high tech services (% workforce)	Employment in high tech services (% workforce)
Proportion of population aged 25-64 with tertiary education	Proportion of population aged 25-64 with tertiary education
	Proportion of population aged 25-64 engaged in lifelong learning
	Sales of new-to-firm products*
	Innovative manufacturing enterprises*
	Innovative services enterprises*
	Innovation expenditure by manufacturing sector*
	Innovation expenditure by service sector*

* estimated using CIS 2 estimates (1994-96)

We are also aware of additional work undertaken for DG Regional Policy setting out the innovation characteristics of regions eligible for support under the future 'competitiveness and employment objective' of the Structural Funds 2007-2012. The similarity of the indicators used in this study would enhance the comparative element of this part of the study. Unfortunately the results of the DG Regional Policy study will not be available until January 2006 and so we are unable to draw on it here. It would be useful for subsequent work to take this into account.

Both the EIS and the ESPON work use a similar statistical technique (clustering) to establish their respective typology. The principal differences between the two approaches are in terms of the use of CIS 2 data by the EIS study and the inclusion of Human Resources employed in Science and Technology by TPG 2.1.2. A further difference emerges in the number of clusters identified. The EIS study identifies six clusters, the characteristics of which – and broad distribution - are summarised below (Box 6.1). For the relevant categories for the ESPON typologies please refer to the explanation earlier.

Box 6.1 EIS regional typology37 (incl. number of regions included)

Cluster 6 regions (56 regions) have the lowest share of people working in high-tech sectors, lowest business R&D-intensity, almost no patent activity, lowest educational performances and lowest per capita GDP. Most of the cluster 6 regions are found in the Southern EU countries and France. Most cluster 6 regions have either low- or medium-low-income levels. Notable exceptions are Trentino-Alto Adige (IT) having medium-high-income and Salzburg (AT) having high-income.

Cluster 5 regions (65 regions) have a per capita GDP close to the EU average, but below EU average R&D and patent performance. These regions are also weak in education, especially in life-long learning. Most of the cluster 5 regions are located in Germany, France and Austria. Most regions have mediumlow- or medium-income levels. Five regions have a high-income level: Bremen, Hamburg and Darmstadt (all DE), Åland (FI) and Southern and Eastern (UK).

Cluster 4 regions (28 regions) have an above EU average per capita GDP, have a strong educational performance, but a less than average R&D and patent performance. Most cluster 4 regions are located in the UK and the Netherlands. All regions have medium-low- or above income levels. Six regions have a high-income level: Brussels (BE), Groningen, Utrecht and Noord-Holland (all NL), and London and South East (both UK).

[37] The following is quoted from *European Innovation Scoreboard 2003 – Technical Paper No 3: Regional innovation performances* pp17-18

Cluster 3 regions (16 regions) have an above EU average per capita GDP, strong R&D and patent performance, strong educational performance and a high employment share in medium-high and high-tech manufacturing. Ten cluster 5 regions are located in Germany, the other regions in Finland (1), France (2), the Netherlands (1) and Sweden (2). Most regions have medium- or above income levels. Only Dresden (DE) – low-income – and Flevoland (NL) – medium-low-income – have not (yet) been able to convert their above average innovative performance into above average per capita GDP.

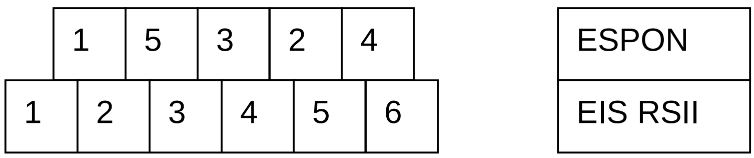
High-tech cluster 1 regions (3 regions) have highest per capita GDP, the best-educated workforce and seem more service oriented with a relative employment share in high-tech services more than twice than in medium-high and high-tech manufacturing. High-tech cluster 1 regions are only found in Finland (1) and Sweden (2). Of these, Uusimaa (FI) and Stockholm (SE) have high-income levels, Sydsverige (SE) has medium-high-income.

High-tech cluster 2 regions (3 regions) have a high per capita GDP, the best patent performance, a strong focus on manufacturing and a strong educational performance. High-tech cluster 2 regions are found in Germany (2) and the Netherlands (1). Of these Oberbayern and Stuttgart (both DE) have high income levels, Noord-Brabant (NL) has medium-high-income.

Source: European Trend Chart on Innovation. Technical Working Paper 3, Nov. 2003.

In comparing the typologies used by the EIS and ESPON 2.1.2 we have sought to identify where regions fall in broadly similar categories. A like-for-like comparison is complicated owing to the different number of cluster categories used. However, if one accepts a certain level of overlap between similar categories we can capture the relationships between different categories as illustrated in Figure 6.1. Regions that fall into cluster 1 of the ESPON typology should fall into cluster 1 or 2 of the EIS typology. Similarly regions that fall into cluster 4 of the EIS typology should fall into either cluster 3 or 2 of the ESPON typology, and so on.

Figure 6.1 Equating the EIS and ESPON cluster groups



Using this format we calculate where regions fall into comparable categories using the following matrix (Figure 6.2). A region that is categorised as cluster 2 by the EIS approach and as cluster 5 of the ESPON approach will be located in the cell corresponding to EIS 2 and ESPON 5. The anticipated location of regions (where cluster types overlap) are illustrated by the shaded cells. We have included results for the 150 regions across the EU 15 for which we have results for both the EIS and the ESPON work.

Figure 6.2 Locating regions in the EIS and ESPON clusters

	ESPON 2.1.2 categories					
EIS RSII categories		1	5	3	2	4
	1	1				
	2	2	1			
	3		3	8	2	
	4		2	5	15	1
	5		1	11	22	24
	6				2	50

Figure 6.2 demonstrates that around 90% of all regions are categorised in a similar manner by each typology. This is a very strong level of comparability. In the circumstances of the current study it demonstrates that the typology developed by ESPON 2.1.2 appears to be robust even without the inclusion of the CIS 2 data. Of the exceptions, almost two-thirds are to be found in one cell: categorised as cluster 5 by the EIS and as cluster 3 by ESPON 2.1.2. As can be seen in Table 6.11, these are all located in Austria, Germany and France.

Map 6.4 European Innovation Scoreboard: RSII typology

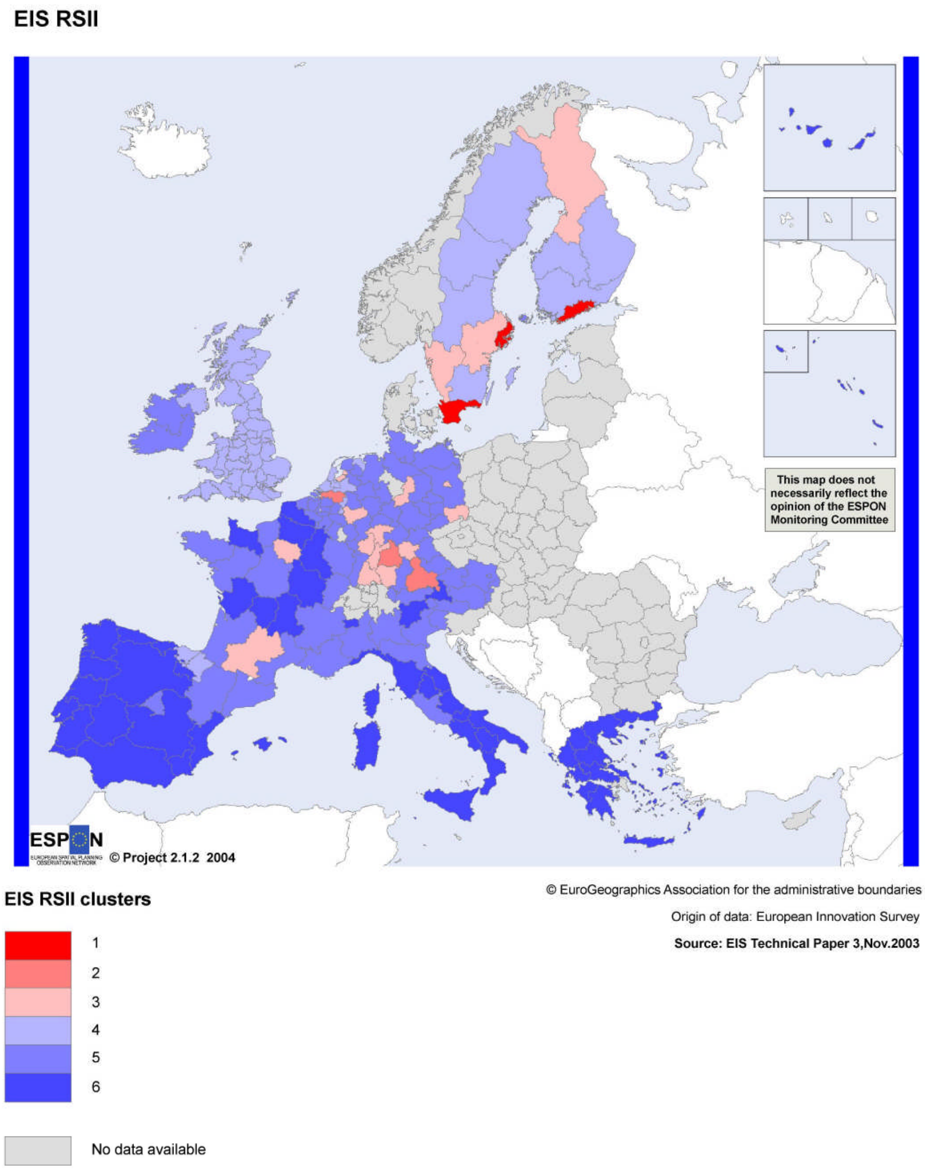


Table 6.11 Outlying regions (EIS cluster 5: ESPON cluster 3)

NUTS 2	Region
AT13	Wien
AT21	Kärnten
DE22	Niederbayern
DE27	Schwaben
DE30	Berlin
DE72	Gießen
DE92	Hannover
DEA4	Detmold
FR42	Alsace
FR52	Bretagne
FR71	Rhône-Alpes

In seeking an explanation for this we examine where differences might lie. Both the EIS and ESPON identify that these regions are largely characterised by below EU average R&D intensity (with the exception of Berlin, Vienna and Rhone-Alpes). Tertiary education levels are about EU average (although the EIS highlights the below average performance in lifelong learning – a variable that the ESPON typology does not use). The ESPON typology notes the better than average performance in terms of employment in high and medium technology manufacturing and in employment in high technology services, however as these variables are also included in the EIS approach this is likely to have been taken into consideration. The ESPON study considers the human resources working in R&D activities in the regions – a variable that the EIS does not consider. In each of these regions the figure for employment in HRST(C) is strongly above the EU average. It is likely that this is the reason for the better performance of these regions in the ESPON cluster analysis in comparison to that of the EIS.

Of the remaining exceptions (6 regions) only one significantly outlies it's expected location - based upon our assessment. This is the region of Oberpfalz in Germany which is classified as strong in research and innovation by the ESPON approach (cluster group 5) and weak according to the EIS approach (cluster group 5). The variance is due to very high performance of the region in terms of patent applications and employment in high technology manufacturing. Owing to the fewer indicators used this tends to 'pull' the overall performance of the region up accounting for its stronger position within the ESPON typology.

Whilst both the EIS and the ESPON typology show differences in the classification of a small number of individual regions perhaps the most apparent difference is in the picture for the UK (Maps 6.3 and 6.4). Whereas the ESPON typology identifies regions in the UK as relating to 4 different cluster categories (clusters 5, 3, 2 and 4) the EIS typology regards regions in the UK as homogenous with all belonging to cluster group 4. The ESPON typology was not able to differentiate between regions in Sweden owing to issues of data disaggregation. This accounts for the apparent difference here.

7.0 Analysis of EU R&D policy

EU R&D policy is undertaken through two principle instruments: The Structural Funds and the Framework Programmes. The following section examines the spatial distribution of activity for each of these instruments.

7.1 Broad spatial distribution

7.1.1 Structural Fund programmes

Of the 243 programmes across the EU for which we have details, some €10 billion is planned to be spent on activities designed to stimulate R&D activity in the current programming period (Table 7.1). The bulk of this expenditure (95%) is planned in the EU 15. This constitutes around 7% of all planned Structural Fund expenditure in these programmes, with programmes in the EU 15 allocating slightly higher proportions of their funds to R&D activities.

Table 7.1 Structural Fund spending on R&D

	Planned spend on FOI 18	% of total planned SF spend	Actual spend on FOI 18 as % of total planned	Actual spend on all activities as % of total Structural Funds
EU 15	€9.5bn	7.7	44	47
NMS	€0.4bn*	6.5	0**	1**
Inter-regional programmes	€0.1bn	5.5	24	29

* NMS allocation spread over 3 years (2004-06) rather than 7 years as for EU15
**NMS records for actual expenditure very sparse. This is probably a significant underestimate of actual position.

By June 2005 programmes in the EU 15 had spent some 44% of all their planned expenditure on R&D activities for the period 2000-2006. This is only slightly behind the overall profile of expenditure in these programmes, which is currently standing at 47% (Table 7.1). Spending on R&D activities in the inter-regional programmes, whilst significantly lower than in the EU15, is also broadly keeping pace with the pattern of overall spend. The situation in the NMS is more difficult to assess. The records provided by DG Regional Policy suggest that actual expenditure on R&D was just 0.05% of planned expenditure by June 2005. However, there are very significant gaps in the data record suggesting that this may be a product of limited returns.

Planned expenditure levels in the EU15 have risen since the programmes were first approved by some 7.6%38. This is likely to be due to indexation, allocation of the performance reserve and, potentially, to virement of funds between measures within programmes. The increase in funds allocated to R&D activities is proportionately greater than the increase in the total value of structural funds allocated to the programmes themselves (the corresponding increase is 5.2%), suggesting an increase in the importance attached to R&D activities in the Structural Funds.

In terms of the broad spatial distribution of planned expenditure across the EU there are no significant patterns apparent (Map 7.1). The weakest levels of expenditure are planned in Greece, the Netherlands, northern France and central Italy. It seems that outside of the south-eastern Mediterranean area peripheral regions attach a stronger importance to R&D expenditure, with strong levels of expenditure planned in the Iberian peninsular. There are also strong plans present across Germany.

When looked at as a proportion of overall programme values (Map 7.2) the picture weakens slightly, although the overall picture remains much the same. Regions in Spain and Germany both dedicate a higher proportion of programme funds to R&D activities, whilst regions in Greece are in general providing lower proportions of programme funds for these actions. The picture in southern Italy is mixed.

7.1.2 Framework Programme

In assessing the spatial distribution of Framework Programme activity we have chosen to control for a number of potential variables. Simply identifying those regions that have high or low numbers of project partners located within their borders is misleading owing to the great differences in the physical size of regions. It also fails to take into account the influence of variables such as GDP (as a proxy for economic strength) and overall levels of R&D expenditure (as a proxy for existing R&D strengths), which might also be expected to influence levels of participation. In the following analysis we focus on the spatial distribution weighted by population. We turn to the other variables in the following section.

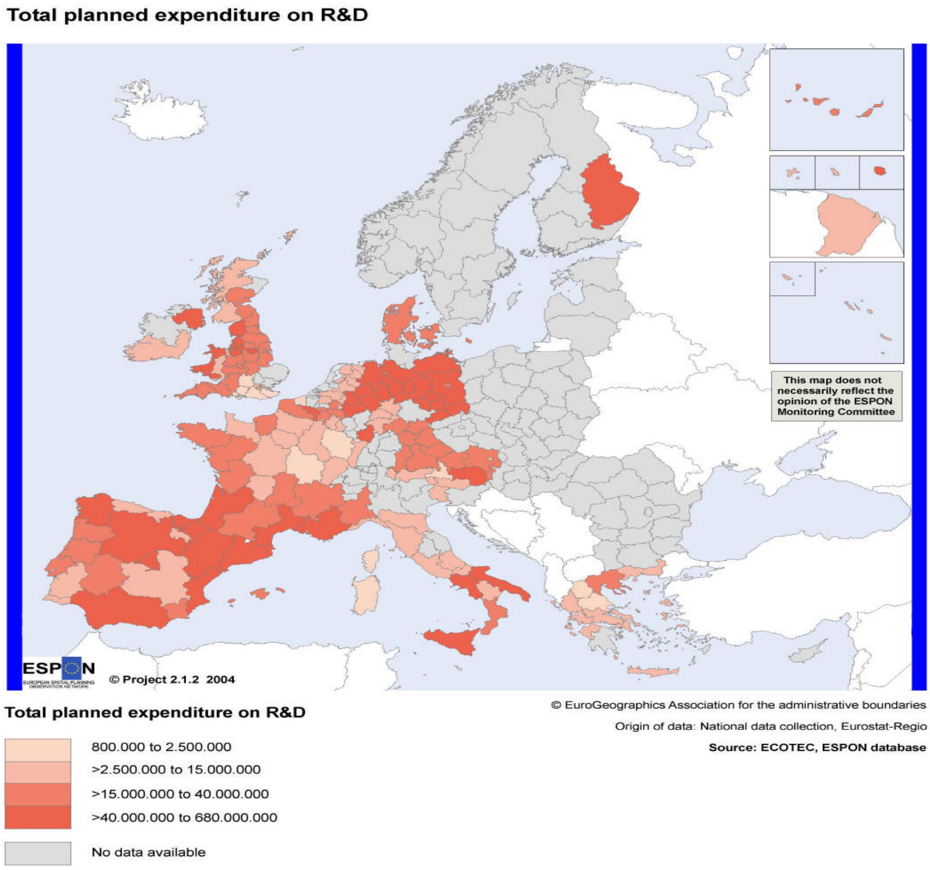
Maps 7.3 and 7.4 show the total number of project participants in the Fourth and Fifth Framework Programmes respectively (both Primary and Subsidiary contractors) across the EU-27, Norway and Switzerland, weighted by population (total project participations

[38] Calculated as the difference between planned expenditure recorded in 2002 and planned expenditure recorded in 2005. Based on data for 150 programmes where consistent data available on both occasions.

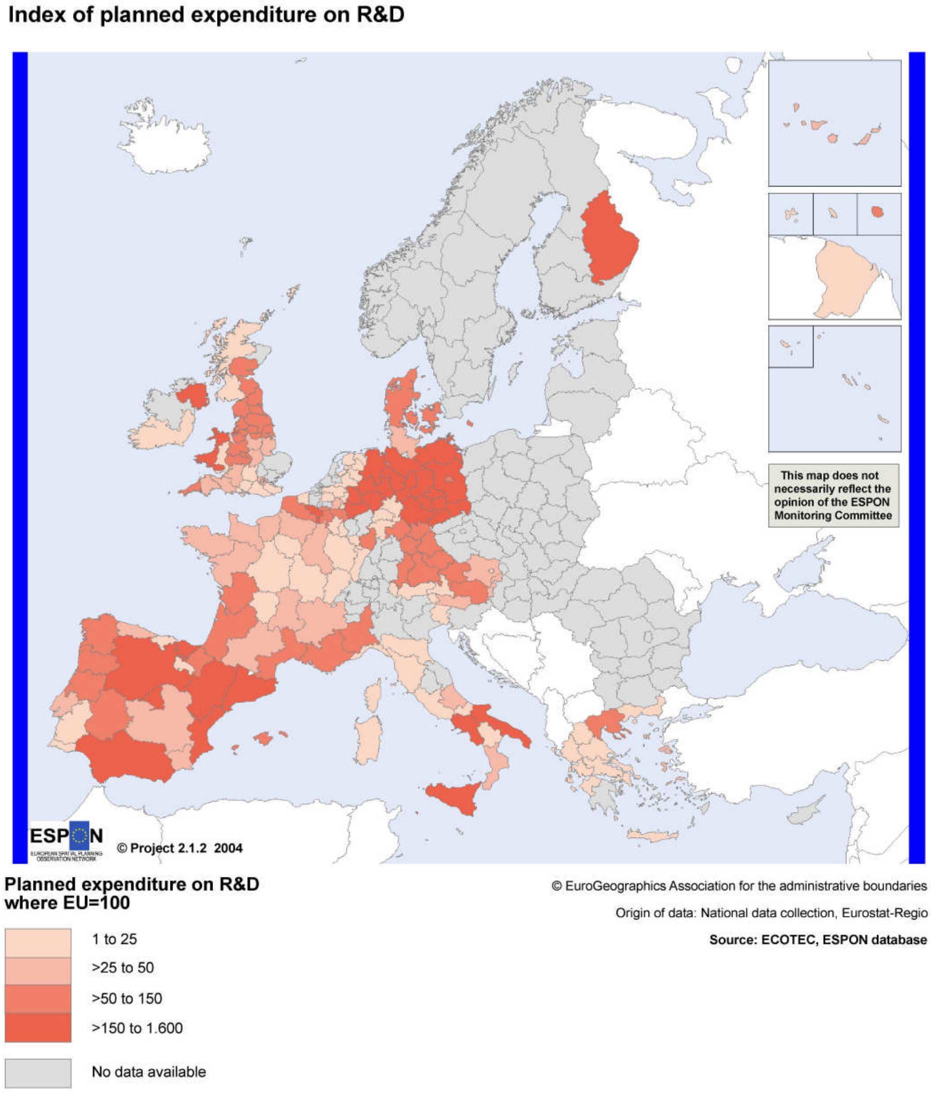
per million population). Participation levels in the New Member States and Accession Countries are lower and a number of other clear patterns are visible:

Strong ‘islands’ of activity are visible in the Iberian peninsular; north west France and central Europe.

Map 7.1 Planned spending on R&D by Objective 1 and 2 programmes



Map 7.2 Planned spending on R&D as a proportion of Structural Fund programme values



- There is a relatively strong ‘cross’ of regions focused on the north of Italy extending north south from the Benelux countries to Rome and east west from Slovenia through to north east Spain.
- Ireland, the UK, Sweden and Finland demonstrate general strengths but in the case of the UK and Sweden pockets of weak participation can be identified
- Eastern Europe has generally low rates of participation.
- There is a generally increasing 'spread' of participation from the 4th the 5th Framework Programme.

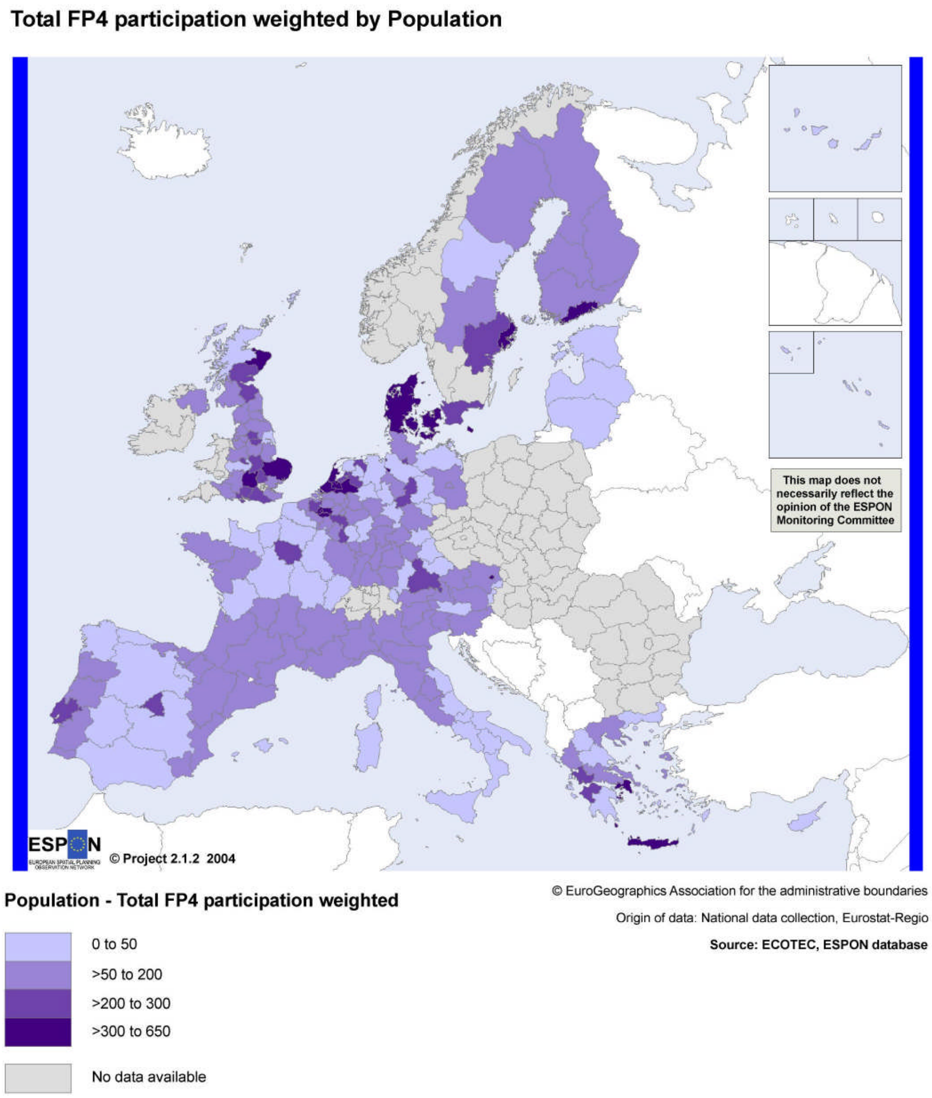
Examining the data in terms of those regions with the highest and lowest levels of participation in FP 4 and FP 5 (Table 7.2 below) a number of patterns are visible.

Overall there is a strong consistency in the number of partners from regions in each Member State participating in FP4 and FP5.

The level of participation across the regions of Europe is gradually becoming more even. This is both within Member States and between Member States, the exception to this is there appears to be an increase in levels of concentration in Germany and Sweden.
The number of prime contractors follows a similar pattern to total participation, although regions in Belgium, the UK and the Netherlands are more likely to be home to prime contractors. Regions in Sweden and Germany are slightly less likely to contain prime contractors than expected.

Overall, the gains have been made outside of the pentagon of the EU, although the more significant losses in the UK have been in the peripheral area. This may suggest a shift in the balance of Framework Programme participations in the EU southwards, or, more likely, when Sweden is taken into account, increasing levels of polarisation within some Member States that are not simple to categorise in terms of core-periphery relationships.
The overall strength of northern European regions remains evident both in FP 4 and FP 5. The improvement in the relative position of regions in those Member States that have not traditionally been significant participants in the Framework Programmes is reflected in the distribution of the 20% of regions that performed least strongly in terms of number of project participations. German and UK positions have worsened slightly relative to others, and partners in Greece and, to a lesser extent, Spain are less likely to be leading projects. It should also be noted that within Germany there appears to be an increasing level of disparity between rates of regional participation between FP4 and FP 5.

Map 7.3 Number of FP 4 projects per million population



Map 7.4 Number of FP 5 projects per million population

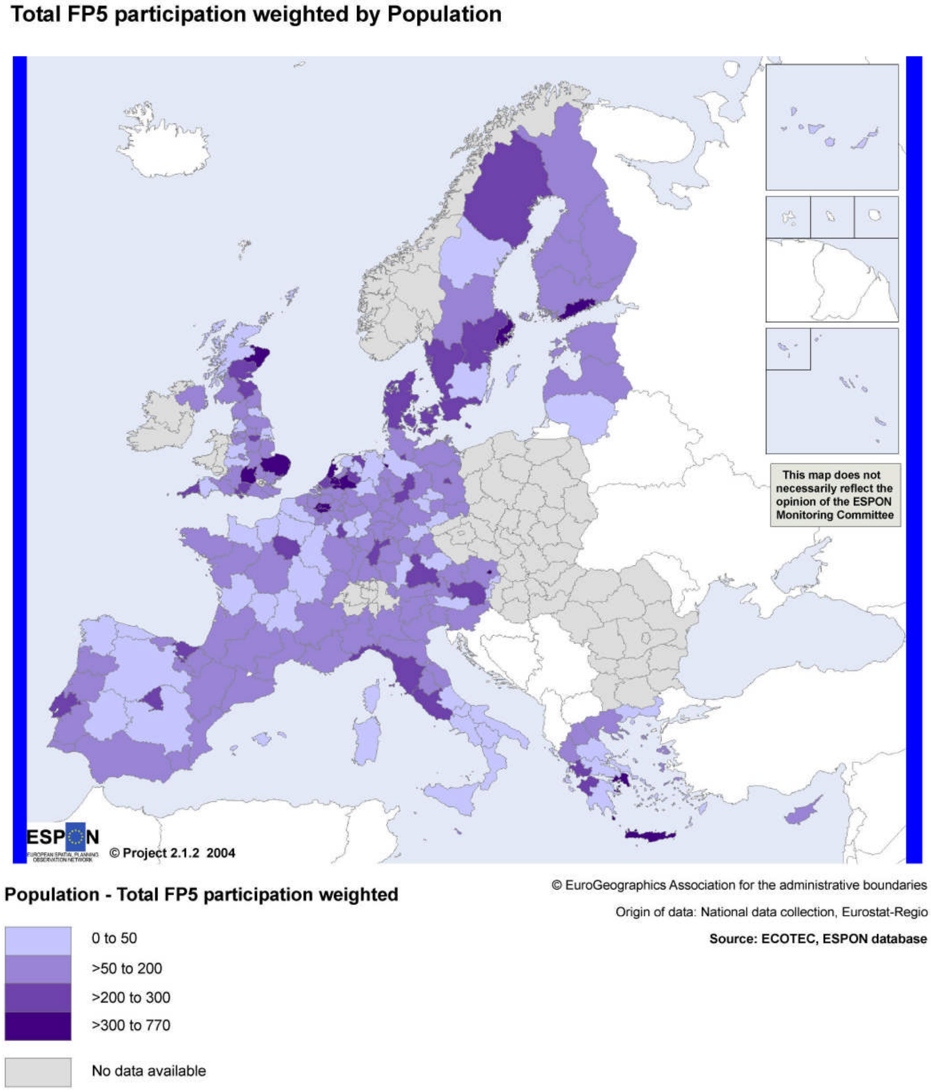


Table 7.2 FP Participation by population: Number of regions in top and bottom quintile by member state

	Top quintile				Bottom quintile			
	FP 4		FP 5		FP 4		FP 5	
	Total	Prime	Total	Prime	Total	Prime	Total	Prime
AT	1	1	2	2	1	1	1	2
BE	5	4	3	5	-	-	1	1
CY	-	-	-	-	1	1	-	-
DE	4	3	6	4	8	7	10	9
DK	1	1	1	1	-	-	-	-
EE	-	-	-	-	1	-	-	-
ES	1	2	2	2	6	4	5	3
FI	1	1	1	1	1	1	-	-
FR	1	2	1	1	7	4	7	7
GR	3	4	3	3	4	5	2	6
IT	-	-	2	1	5	8	4	5
LT	-	-	-	-	1	1	1	-
LV	-	-	-	-	1	1	-	-
LU	1	1	1	1	-	-	-	-
NL	7	7	6	8	1	-	2	-
PT	1	-	1	-	2	2	2	2
SE	1	2	5	2	1	1	2	3
SL	-	-	-	-	1	1	-	-
UK	11	12	7	9	1	2	4	3

Source: CORDIS and ECOTEC Analysis

7.2 The pattern of EU R&D policy with respect to cohesion objectives

EU R&D policy can be assessed in terms of its fit with the cohesion objectives of the Union. In this respect it is worth considering the distribution of the EU's R&D policy activities according to GDP. In the case of the Structural Funds we have broken this down according to programmes funded under Objective 1 of the Structural Funds and those funded under Objective 2. In the case of the Framework Programmes we also examine the pattern of expenditure according to existing levels of R&D expenditure.

7.2.1 Structural Funds

The bulk of R&D activity is planned to take place in regions which are eligible for support under Objective 1 of the Structural Funds. A total of €7.12bn[39] is intended to be invested in R&D activities by the Structural Funds through Objective 1 programmes, this constitutes around 7.04% of allocated programme funds. The proportion of Structural Funds allocated to R&D activities in Objective 2 programmes is higher, at 10.72%, although the overall amounts are naturally less, at €2.38bn[40].

The importance of funding for R&D activity has been increasing in Objective 1 areas over the programming period, in contrast with Objective 2 programmes (Table 7.3). Overall, Objective 1 programmes have increased the amounts allocated to R&D activities by almost 10% since the programmes were agreed, nearly double the 5.5% increase in total programme allocations. Objective 2 programmes on the other hand have only increased their allocations by around 2.5%, somewhat lower than the total programme increase of 3.7%.

Table 7.3 Levels of R&D activity by Objective

	Objective 1	Objective 2	EU average
% allocated to FOI 18	7.0	10.7	7.7
% change 2002 to 2005	9.4	2.5	7.6
% planned spend actually spent	43	46	44

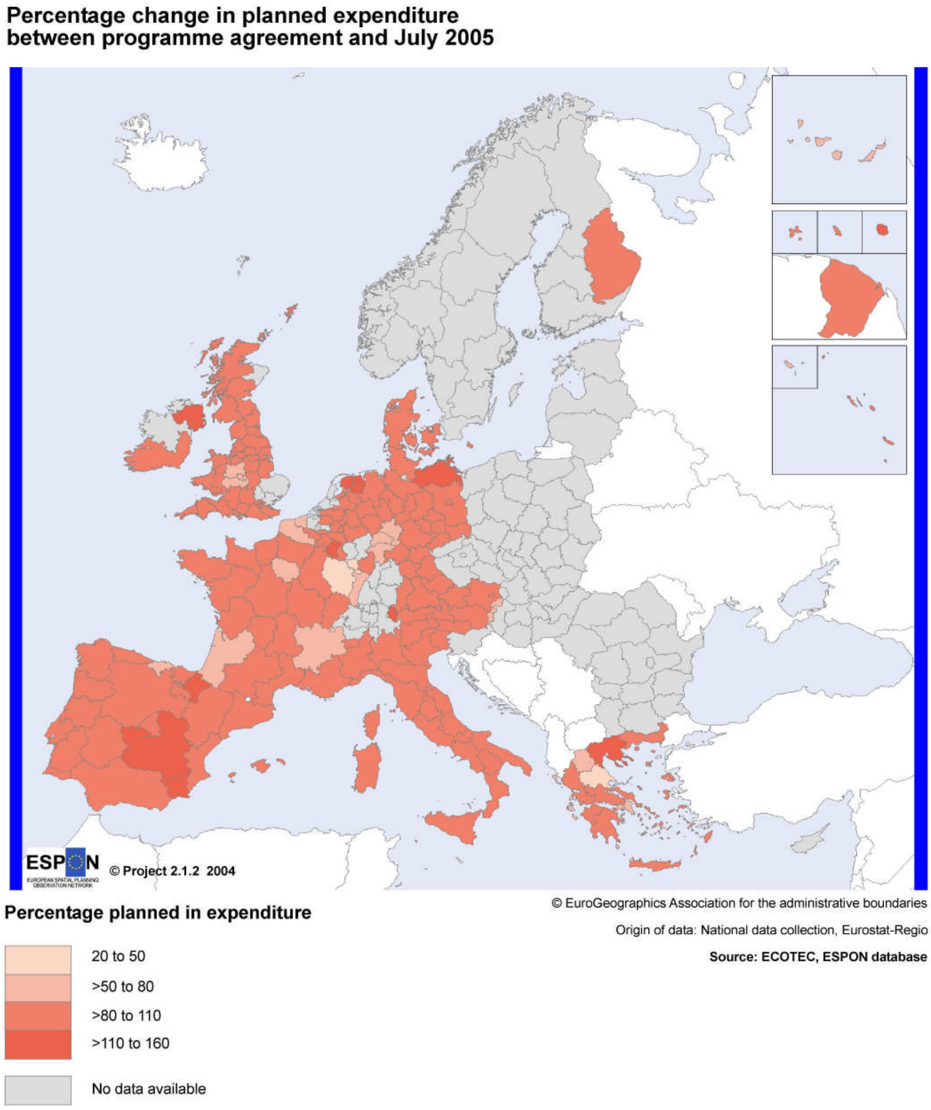
Programmes where reductions have occurred in the amounts planned to be spent on R&D activities are scattered widely across the EU territory (Map 7.5). The same can be said for significant increases in planned levels of activity. It is not dependent upon location or programme type.

Both Objective 1 and Objective 2 programmes are recording similar levels of actual expenditure, at 43% and 46% of planned expenditure on R&D activities. The rate of spending in Objective 2 programme areas is exactly the same as actual expenditure across all Structural Fund activities. In Objective 1 areas the rate is slightly below the 47% being realised for all Structural Fund activities.

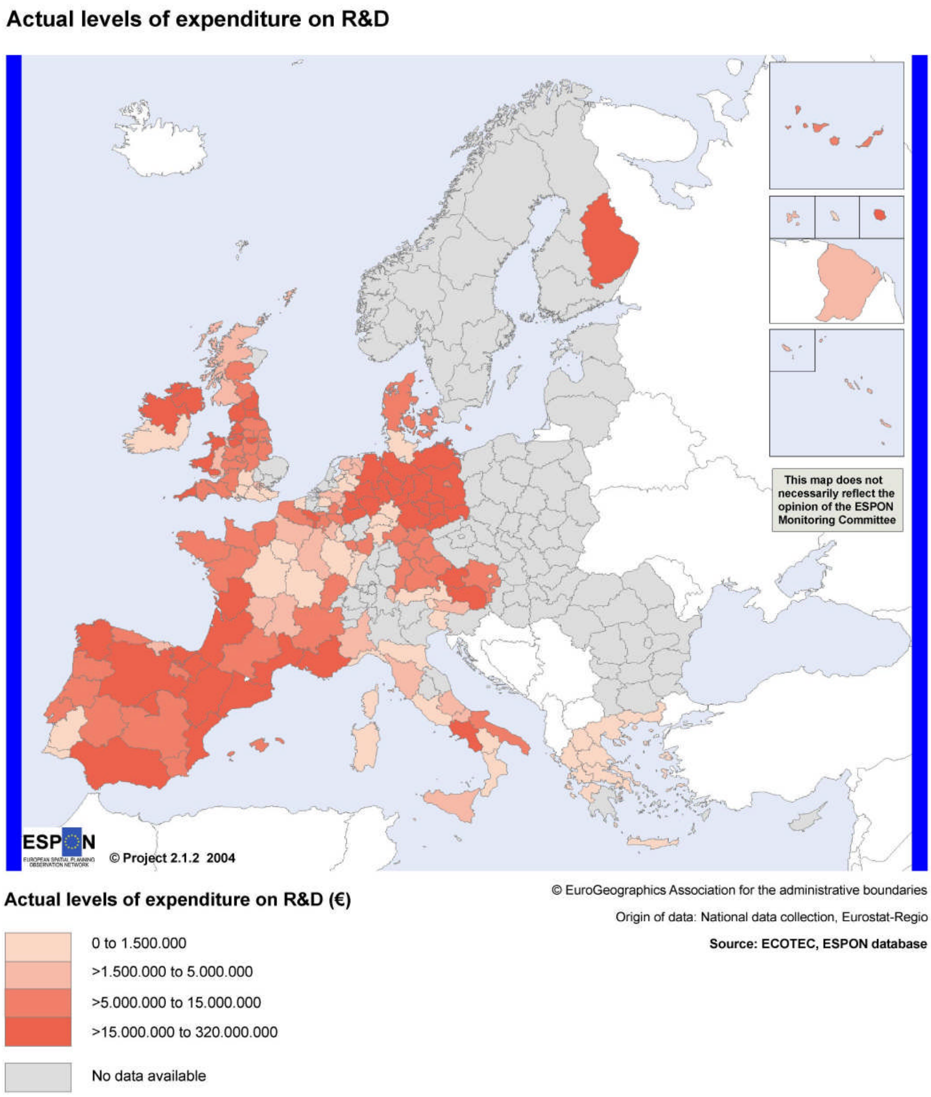
[39] Based on 69 programmes
[40] Based on 81 programmes

In examining the spatial pattern of activity (Map 7.6) the strongest levels of actual expenditure are visible across Spain and northern Portugal; south west France, the UK, Ireland and Germany. In contrast, the weaker position of Italy and Greece is clearly apparent from the figures available. When looked at in terms of actual expenditure as a proportion of planned expenditure (Map 7.7) a similar picture emerges, although parts of the UK and Germany appear to be committing a smaller proportion of funds than the absolute analysis suggested.

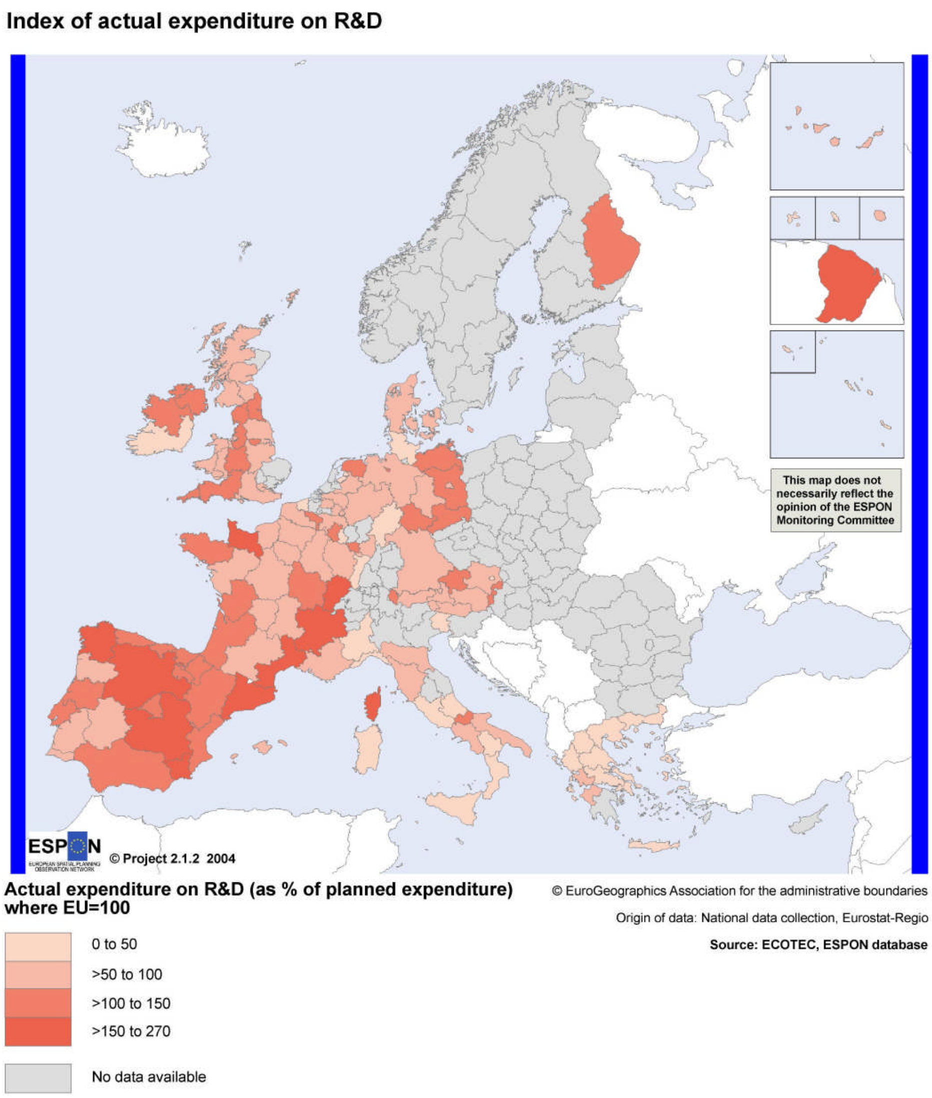
Map 7.5 Changes in planned levels of expenditure by the Structural Funds on R&D



Map 7.6 Actual levels of spend on R&D in Structural Fund programmes



Map 7.7 Actual levels of spend on R&D as a proportion of programme values



7.2.2 Framework programmes

7.2.2.1 *Patterns allowing for GDP*

Examining the spatial distribution of Framework Programme participation, once GDP is taken into consideration (Map 7.8 and 7.9 for the 4th and 5th Framework programmes respectively) illustrates that many regions that were previously not seen to be strong beneficiaries under the Framework Programmes (based on the number of participations relative to population) now appear more strongly. In particular, as well as strong points in the UK and the Benelux, it is worth noting the strong 'islands' apparent in Spain and Greece as well as some of the New Member States. Although substantial swathes of the European territory do not have high levels of participation in the Framework Programmes, even in these areas strong patterns are evident. In particular, the areas of stronger performance in Portugal and the crescent stretching around southern France and into central Italy are worth mentioning.

Further examination of the data demonstrates that participation in the Framework Programmes is significantly related to levels of GDP. Regions in the lowest quartile of regions based on the level of GDP per capita tend to have the lowest levels of participation in the Framework Programmes. Those regions in the highest quartile have the highest levels of participation (Tables 7.4 and 7.5).

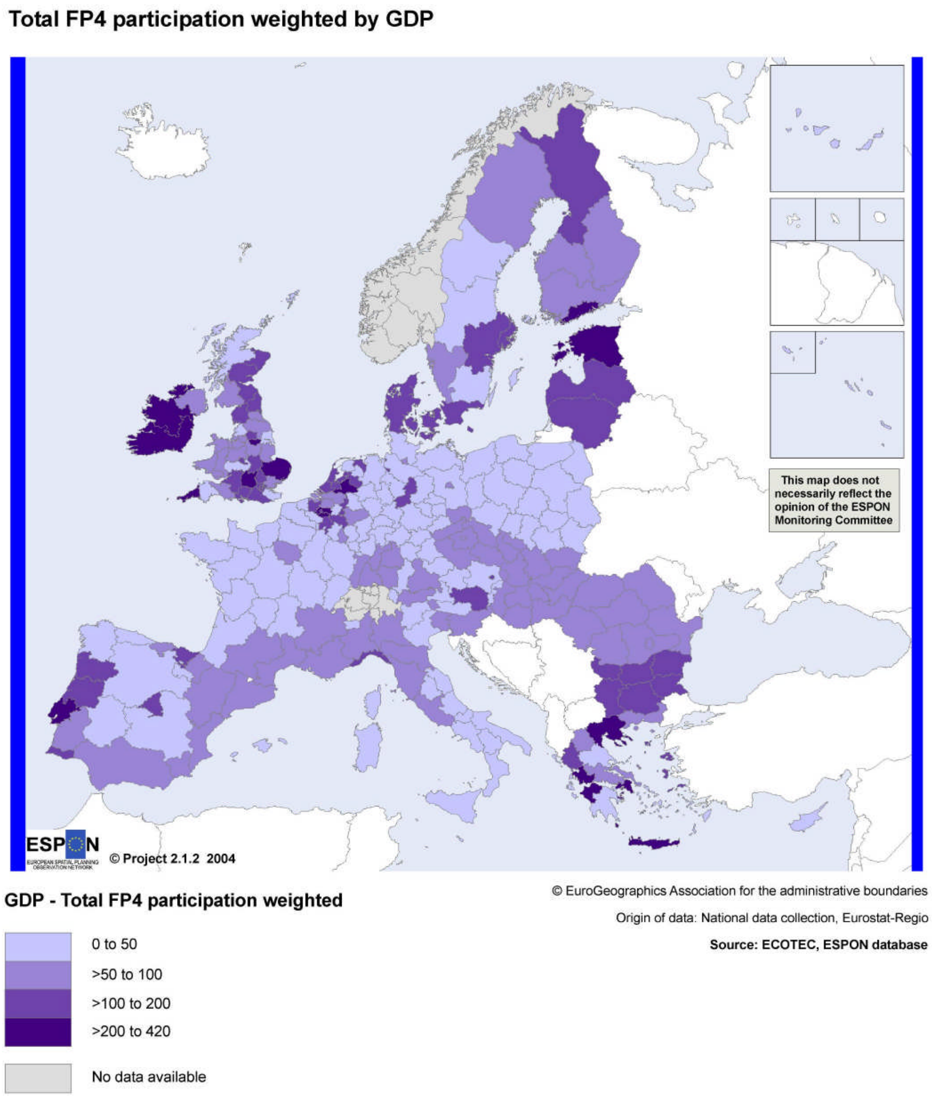
Whilst the picture between Framework Programme 4 and Framework programme 5 remains broadly similar there are signs that participation levels by less favoured regions are increasing. However, not withstanding this, the highest levels of participation remain the preserve of those regions with the highest levels of GDP per capita.

Table 7.4 FP4 Participation against GDP

	FP4 Participation Quartiles				Total
Quartile GDP/Capita	1	2	3	4	
1.0	68.4	18.4	5.3	7.9	100.0
2.0	19.5	48.8	22.0	9.8	100.0
3.0	7.3	17.1	48.8	26.8	100.0
4.0	5.1	15.4	23.1	56.4	100.0
Total	24.5	25.2	25.2	25.2	100.0

157 Valid Cases
Pearson’s Chi-Square: 0.000 (Significant relationship)

Map 7.8 FP 4 participation allowing for GDP



Map 7.9 FP 5 participation allowing for GDP

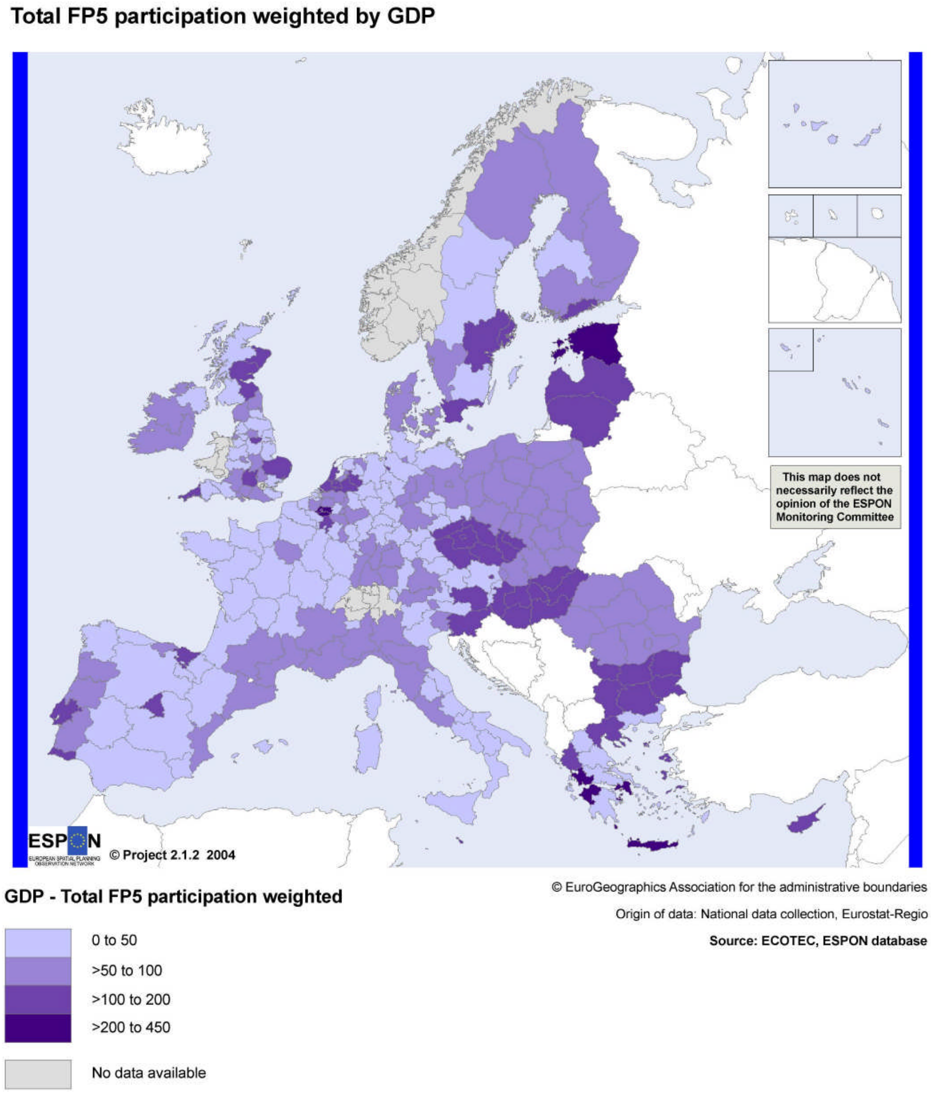


Table 7.5 FP5 Participation against GDP

	FP5 Participation Quartiles				Total
Quartile GDP/Capita	1	2	3	4	
1	50.0	34.2	10.5	5.3	100.0
2	22.0	41.5	29.3	7.3	100.0
3	19.5	7.3	43.9	29.3	100.0
4	7.7	17.9	15.4	59.0	100.0
Total	24.5	25.2	25.2	25.2	100.0

157 Valid Cases
Pearson's Chi-Square: 0.000 (Significant relationship)

Looking at this on a spatial basis presents a more complex picture. In this case we have examined the spread of regions based upon the number of FP projects per €10 billion GDP (Table 7.6 below).

- On the whole we find that the distribution of Framework Programme partners is spread much more evenly across the European territory when overall levels of economic activity are taken into account. This is particularly the case in FP 5 compared to FP 4.
- The greatest shift occurs within the UK, with the number of regions in the top quintile halving. This is partially balanced by an increase in the number of regions in the bottom quintile
- Traditionally strong participant regions fall out of the top quintile, whilst those which traditionally are less strong increase their visibility. This is particularly the case for regions in Germany.
- On this basis regions that have lower levels of GDP do appear to benefit from the Framework Programmes.
- Organisations in the new Member States have significantly improved their propensity to lead projects between FP 4 and FP 5.

Table 7.6 FP Participation by GDP: Number of regions in top and bottom quintile by member state1

	Top quintile				Bottom quintile			
	FP 4		FP 5		FP 4		FP 5	
	Total	Prime	Total	Prime	Total	Prime	Total	Prime
AT	-	-	2	2	4	1	1	2
BE	6	4	4	4	-	-	1	1
BG	-	-	1	1	1	-	-	-
CY	-	-	1	-	1	-	-	-
CZ	-	-	1	-	1	-	-	-
DE	-	-	1	1	14	10	13	12
DK	1	1	-	-	-	-	-	-
EE	1	-	1	1	-	-	-	-
ES	2	2	2	3	3	3	3	2
FI	1	1	1	1	1	1	1	-
FR	-	2	-	3	9	6	8	8
GR	6	5	6	5	2	2	2	6
HU	-	-	1	-	1	-	-	-
IE	1	1	-	1	-	-	-	-
IT	-	1	1	1	4	4	4	4
LT	-	-	1	1	1	-	-	-
LV	1	-	-	1	1	-	-	-
LU	-	-	-	-	-	-	-	-
MT	-	-	1	-	1	-	-	-
NL	7	7	6	8	1	-	2	-
PT	3	1	2	-	1	1	-	2
RO	-	-	-	-	1	-	-	-
SE	3	2	3	2	2	2	3	3
SK	-	-	1	-	1	-	-	-
SL	-	-	1	1	1	-	-	-
UK	12	16	6	7	2	3	6	4

[1]For new Member States and Candidate Countries data is only available at the national level. In many cases this is equivalent to NUTS 2 but in several cases it is not. In the latter cases we cannot assume even or uneven distributions within the country, therefore overall positions could change if NUTS 2 data was available.

7.2.2.2 *patterns allowing for R&D expenditure*

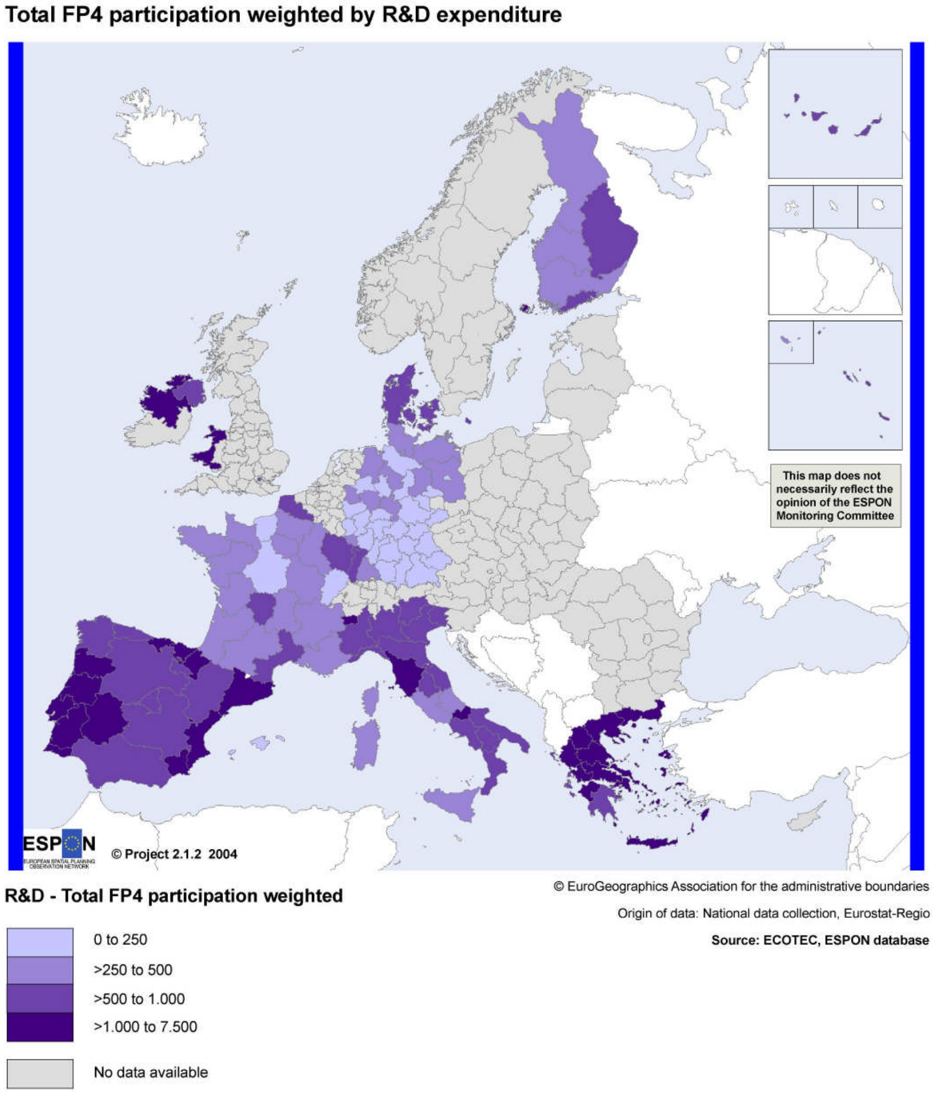
Intuitively it might be anticipated that Framework Programme participation would be related to overall levels of expenditure on R&D within a region. Those regions that spend the most on R&D could potentially gain the most. If so then this would support the suggestion that EU R&D policy reinforces existing divides.

Analysis of the data illustrates a slightly different picture. Analysis was not possible for all regions owing to previously cited difficulties of accessing R&D expenditure for NUTS 2 areas in some Member States, such as the UK, and the absences of regional Framework Programme participation figures for the New Member States and Accession countries. Consequently, the analysis has been undertaken for 10 Member States[41] (Maps 7.10 and 7.11).

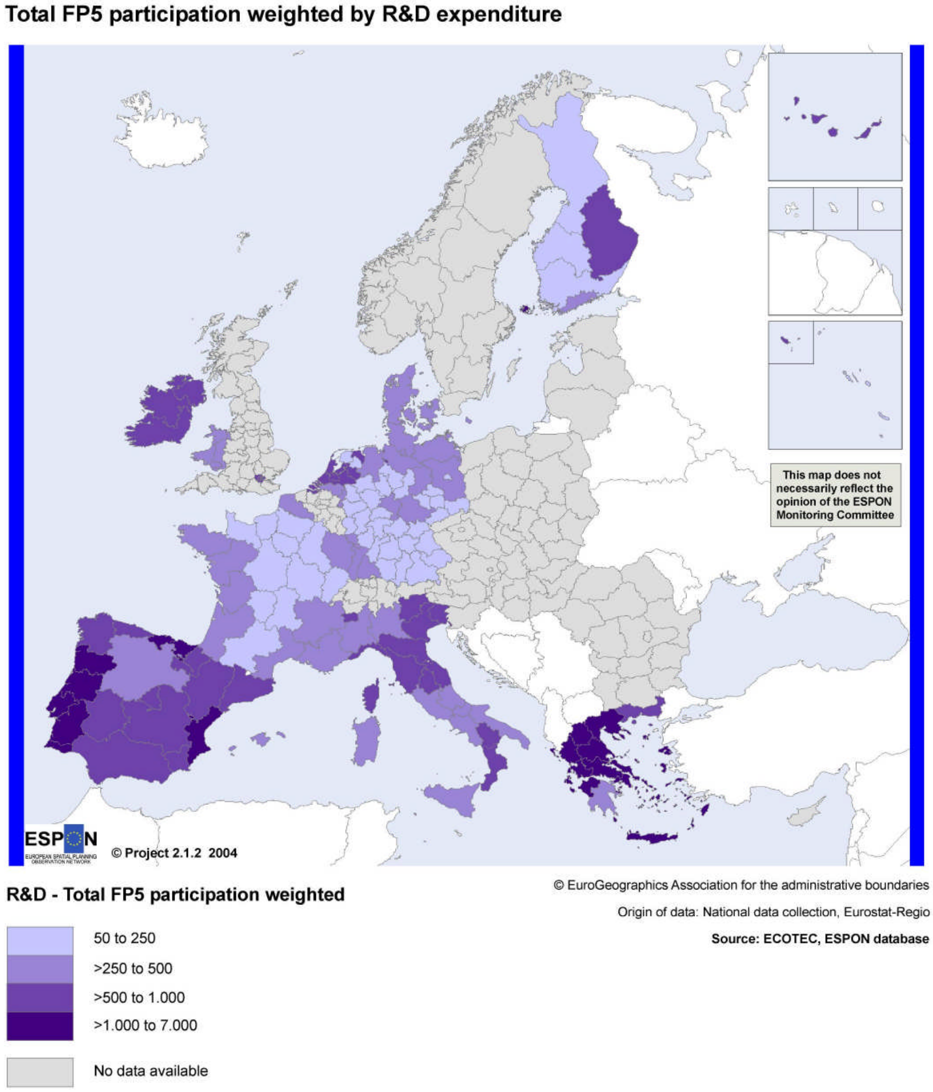
The resulting picture is illustrated in the following table (Table 7.7). This demonstrates that the regions with the greatest number of projects per million euros of total expenditure on R&D (GERD) are predominantly located in the Member States on the periphery of the EU. In contrast, regions in the bottom quintile are predominantly located in Germany and France.

[41] DE, DK, ES, FI, FR, GR, IE, IT, NL, PT

Map 7.10 FP 4 participation allowing for R&D expenditure



Map 7.11 FP5 participation allowing for R&D expenditure



On this basis the Framework Programmes do seem to be supporting project partners located outside of the 'core' of the EU and in regions with lower levels of R&D capacity (as traditionally measured). This lends weight to the suggestion that the Framework Programmes are, at least in principle, acting to support knowledge transfer and capacity building in Member States with lower levels of existing R&D inputs.

Table 7.7 Number of regions in the top and bottom quintiles of Framework Programme project participations per million euros of total expenditure on R&D (GERD) (10 Member States)

	Top quintile		Bottom quintile	
	FP 4	FP 5	FP 4	FP 5
DE	-	-	22	18
ES	7	5	1	-
FI	1	1	-	1
FR	-	-	3	7
GR	11	11	-	-
IE	1	-	-	-
IT	1	3	-	-
NL	-	1	-	1
PT	5	7	-	1

Looking at this through a map based illustration (Maps 7.10 and 7.11) the substantially stronger performance of regions in Spain, Greece, Portugal and Ireland becomes very evident. Alongside the Netherlands it is regions in these countries that have the highest levels of participation in the Framework Programmes, allowing for R&D expenditure.

7.3 EU R&D policies in the regions

The nature of the activities supported by EU R&D policies will influence their potential territorial impact. We analyse this through two principal sources: firstly an assessment of the types of actions being funded by the Structural Funds as indicated by monitoring data, and secondly through information gleaned from our regional case studies. In analysing Structural Fund monitoring data we make use of data relating to expenditure under Field of Intervention code 18.

7.3.1 R&D activity in the Structural Funds

Quantitative data on different types activity in the Structural Funds is recorded through the use of Field of Intervention codes. In the case of R&D the broad FOI code is number 18, with four sub-categories (181, 182, 183 and 184). These relate to:

181 Research projects based in universities and research institutes
182 Innovation and technology transfers, establishment of networks and partnerships between businesses and/or research institutes
183 RTDI Infrastructure
184 Training for researchers

Of the 150 programmes in the EU 15 for which we have details (Table 7.8), nearly all are supportive of the development of networks (FOI 182). Support for the provision of infrastructure (FOI 183) is also common. At least half are intending to promote research projects (FOI 181). Around a fifth of programmes are also retaining flexibility in how they allocate funds by including the overall R&D code FOI 18 as part of their programming. The least common intervention envisaged is support for the training of researchers (FOI 184). All regional programmes containing this intervention are to be found in France.

Table 7.8 Incidence of types of R&D activity

	18	181	182	183	184
No. of programmes	29	75	130	93	9
% of programmes	19	50	87	62	6

Planned expenditure levels are set out in Table 7.9 below. Across the EU-15 support for the development of networks (FOI 182) has the most planned expenditure dedicated to it. This is a feature of the number of programmes planning activity in this area. Looking at the average spend per programme shows that, relatively, support for the promotion of research funds receives more attention. Note that as more than one FOI can be undertaken in each programme, the totals will not sum.

Table 7.9 Levels of planned expenditure by R&D Field of Intervention

FOI	Planned expenditure 2005 (€)	No. of programmes	Average planned spend per programme (€)
18	783,753,082	29	27,025,968
181	2,519,308,471	75	33,590,780
182	3,421,138,271	130	26,316,448
183	2,447,717,374	93	26,319,542
184	330,580,467	9	36,731,163
total	9,502,497,665	150	63,349,984

The pattern is reinforced when we turn to actual expenditure levels. As Table 7.10 illustrates, on average, expenditure has been strongest under FOI 181. Overall, FOI 182 has the highest levels of expenditure, although by only a small margin in this instance. Again totals do not sum.

Table 7.10 Levels of actual expenditure by R&D Field of Intervention

FOI	Actual expenditure to June 2005	number of programmes	Average actual spend per programme
18	372,552,994	29	12,846,655
181	1,219,622,057	75	16,261,627
182	1,342,877,475	130	10,329,827
183	1,044,030,035	93	11,226,129
184	185,582,060	9	20,620,229
total	4,164,664,621	150	27,764,431

If we turn to the pattern of expenditure between different FOIs we can see that actual expenditure is currently running at around 40% to 50% of planned levels (Table 7.11). FOI 182 (technology transfer and the development of networks) is currently the least advanced, with spending running some 10% points behind that of FOI 181.

Table 7.11 Actual spend on R&D compared to that planned

FOI	average planned	average actual	%
18	27,025,968	12,846,654.97	0.48
181	33,590,780	16,261,627.43	0.48
182	26,316,448	103,298,26.73	0.39
183	26,319,542	11,226,129.41	0.43
184	36,731,163	20,620,228.89	0.56
total	63,349,984	27,764,430.81	0.44

Analysis of the change in planned expenditure between the agreement of the programmes and July 2005 demonstrates that although FOI 182 is responsible for the largest single share, followed by 181 and 183, its relative importance has fallen slightly since the start of the programmes (Table 7.12). The increase in funds to FOI 182 is, at 2.5%, significantly below that of the other FOI codes and lower than the average of 7.7% recorded for all R&D activities combined.

Table 7.12 Comparison of planned spend in 2002 and 2005

	18	181	182	183	184
% Planned '05	8.2	26.5	36.0	25.8	3.5
% planned '02	8.5	25.6	37.9	25.0	3.0
% Change '02-05	5.1	11.3	2.3	11.1	23.6

Examining the distribution of activity between programme types demonstrates that the division of activity between different FOI codes is similar in both Objective 1 and Objective 2 programmes. There is a slightly higher emphasis on supporting R&D infrastructure (FOI 183) in Objective 2 programmes compared to Objective 1 regions (Table 7.13). In contrast there is a higher emphasis on researcher training in Objective 1 programmes, although this is based on a very limited number of programmes.

Table 7.13 Planned R&D expenditure by Objective (%) 2005

	18	181	182	183	184
Objective 1	7.7	26.7	36.0	25.2	4.4
Objective 2	9.9	25.9	35.9	27.5	0.8

The stronger emphasis on promoting networks in Objective 1 regions is apparent in Table 7.14. On average, Objective 1 programmes plan to spend more than 4 times more than

Objective 2 regions on FOI 182. This is a significantly higher difference than for other FOI categories. Interestingly, Objective 1 regions are also attaching relatively more importance to directly supporting research projects (FOI 181).

Table 7.14 average planned spend per programme (2005)

FOI	18	181	182	183	184
Objective 1	36,558,532	47,533,523	44,237,726	34,478,219	104,159,511
Objective 2	16,812,507	17,656,216	11,879,864	15,971,951	3,016,989
difference	2	3	4	2	35

Although the overall amount planned to be invested in stimulating R&D activities has increased between the programme approval and July 2005, this is not true for all planned activities. In particular there has been a decrease in the level of resources allocated to the support of networks (FOI 18) in Objective 2 regions (Table 7.15).

Table 7.15 average change in planned expenditure to July 2005.

	18	181	182	183	184	Average
Objective 1	8%	12%	4%	13%	25%	9%
Objective 2	-5%	9%	-2%	6%	3%	2%

In terms of actual spend to date, the patterns between Objective 1 and Objective 2 regions in terms of different FOI codes are fairly consistent (Table 7.16). Where details are available, it appears that programmes are most advanced in terms of their expenditure on research projects (FOI 181), and are least advanced in terms of expenditure on networks (FOI 182). There is a greater variation around the average in Objective 2 programmes than in Objective 1 programmes.

Table 7.16 Levels of actual spend (%)

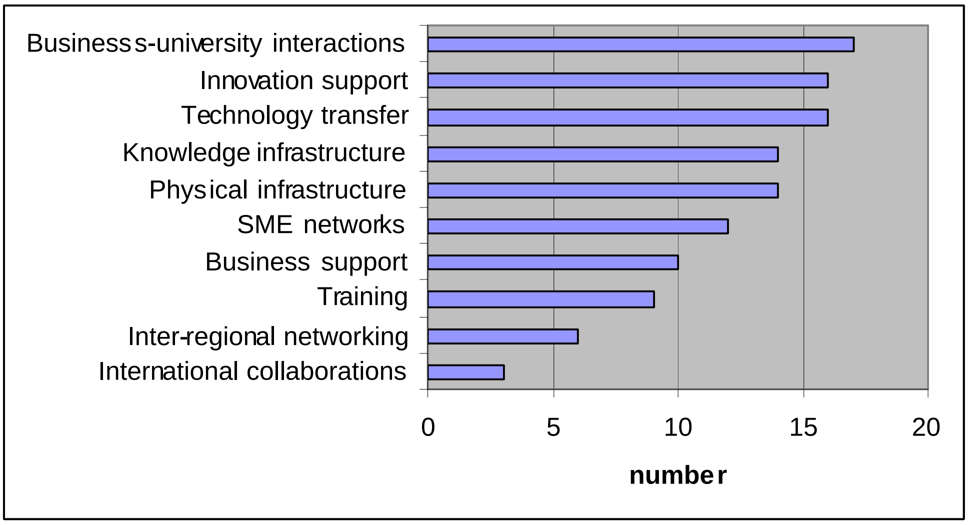
	18	181	182	183	184	Average
Objective 1	46	46	39	43	57	43
Objective 2	51	56	41	42	38	46

7.3.2 R&D activities in the regions

Through our case study analysis we have examined the manner in which EU R&D policies (Structural Funds and Framework Programmes) are being utilised within specific regions of the EU. This analysis provides a broad assessment of the types of actions that are being supported as well as some of the identified effects.

Within the types of actions being supported by the Structural Funds there is a very strong focus on a range of actions within each of the case study regions (for selection criteria please see Methodology section). Most regions include actions supporting innovation support, business-university interactions and technology transfer (see Table 7.17 below). In contrast training schemes were less visible as were inter-regional collaborations and international networking. From what we know of the Framework Programmes, with their emphasis on intra-regional and international collaborations; interactions between enterprises, research centres and universities, and researcher mobility schemes we can intuitively see that there is scope for complementary actions at a regional level. The following analysis seeks to explore this in some additional detail drawing on examples from our case study material.

Table 7.17 Structural Funded actions in each case study regions



The focus identified in Table 7.17 above reflects the changing focus of Structural Fund activities since 1994 highlighted through our case study work. In the 1994-99 programming period there was a strong focus on the provision of physical infrastructure and the development of knowledge infrastructures, such as Science Parks and Research Centres. In the current programming period, whilst still important, such actions have been eclipsed by actions focusing on softer dimensions of R&D support, particularly the development of networks and support for technology transfer and innovation.

The strong intra-regional focus of the Structural Fund programmes is also evident from Table 7.17 (above). Neither inter-regional networking nor international collaborations feature strongly. Rather the focus is on building the infrastructure base of the region, promoting business-university linkages to maximise the potential of the regional research base and on supporting technology transfer and innovation in companies more generally.

Synthesising the types of R&D-related actions into six groups allows us to highlight the principle areas where EU R&D policy is having an impact.

Knowledge Infrastructure and Equipment. The case study research highlighted the importance attached to strengthening the infrastructural capacity of regions. This reinforces the findings of our earlier aggregate analysis. Investments in infrastructure and equipment were important features in both Objective 1 and Objective 2 regions across the Union. Examples of this from the 2000-2006 period include direct support for centres of scientific excellence (such as a grant to a Max Planck Insitut in Greifswald in Mecklenburg-Vorpommern) and the provision of sites for developing production-related research (West Wales). In some instances, such as Calabria, the National Operational Programme is the primary source for funding such activities. Objective 2 programmes are contributing to physical infrastructure development, although the overall amounts are less. Examples include support for expanding business parks and educational establishments (for example in East Netherlands, Lorraine and Cologne) or for the acquisition of equipment, such as computer software (Liguria). We found little evidence of the Framework Programmes providing significant resources for investment in these areas, although some isolated examples were identified.

Direct support for the knowledge base. Naturally this is the area where the effects of the Framework Programmes are most clearly identifiable, with the bulk of investments targeted on supporting research actions in universities, enterprises and other research organisations. The case study analysis also confirms the high level of activity that can also be identified in this area funded through the Structural Funds. The types of actions that were identified within the case studies included support for stimulating links between businesses and universities; direct support for public or private research, such as direct grants for R&D projects, and R&D-related productive investment in businesses; contributions to the cost of recruiting R&D personnel, and subsidies for the registration of patents (the latter action noted in Mecklenburg-Vorpommern, for example)

Business support services. Support is in some cases directed at the provision of advice and consultancy to business, in particular to SMEs. This includes assistance with Business plans and training and advice about innovation management for existing businesses, as well as support for start-ups. An example of this latter type of intervention is the “Gründungsoffensive” in Cologne, a start-up initiative supported by the Objective 2

Programme, which has provided a range of services to fledgling businesses. Funding in this area is often channelled through existing innovation support structures and does not always have an explicit R&D focus, in these cases it is important that R&D actions are not simply marginalised into some specialised niche. The Structural Funds can play an important role in widening the scope of existing actions for example, in both Vienna and Lorraine the possibility of directing venture capital towards R&D-based projects was developed to fill acknowledged gaps in regional provision.

Technology Transfer and Networking. This is an area where EU R&D policy is strongly focused with both the Framework Programmes and the Structural Funds placing an emphasis. Structural Fund actions in this area encompass a wide range of projects aimed at developing links between different actors in the regional innovation system, whether on the supply or demand side. In contrast Framework Programme activities are less orientated towards intra-regional activity but take a much more 'macro' perspective, arguably seeing the European Research Area as the appropriate scale for action.

Technology transfer and networking is commonly promoted through support for intermediary organisations tasked with bringing actors together. Initiatives co-financed by Objective 1 Programmes include the expansion of the Business Innovation Centre and creation of a network of business incubator support infrastructure in Wales, the development of a “one-stop shop” at a university in Calabria and promotion of R&D co-operation among business in Mecklenburg-Vorpommern. Actions in this area are just as strong within Objective 2 areas and again our case study work reinforces the evidence from our wider aggregate analysis. In Vienna for example, networking activities designed to promote clustering effects among firms are being promoted through the Structural Funds.

On the whole activities supported by the Structural Funds in this area are restricted to within a particular region, owing to eligibility restrictions. In contrast, partners in Framework Programme projects are less likely to have partners within their own region but have stronger external networks. Although INTERREG programmes might be a vehicle for trans-regional working in through the Structural Funds we have identified few examples of this through our case studies outside of those within some specific cross-border programmes (such as around Cologne). Where they are present, National Operational Programmes can also offer a mechanism for stimulating trans-regional working. Our case study analysis identified that this had provided an important opportunity for one of our regions: Castilla y Leon.

Development of human capital. This category of action includes training initiatives with a specific focus on R&D or innovation (as opposed to more general skills development actions, aimed at the wider population). Examples of this are evident in many current Objective 1 Programmes and can involve direct support of science and technology training or training for innovation support personnel (such as Innovation Centre staff). Outside of Objective 1 regions similar actions can be observed which promote the development of skills and experience within a region. Particular examples include graduate or researcher placement schemes for which examples can be found in East Netherlands and Liguria. These have the benefit of assisting individuals gain experience whilst also stimulating the quality of the human capital available to local companies. Courses and seminars on the management and implementation of new technologies, aimed at small businesses are a further example of activities in this area. Although this does not represent a large proportion of the Structural Funds expenditure, the value of such activities for innovation and knowledge transfer should not be underestimated. The strong emphasis on promoting the mobility of researchers through the Framework Programmes also serves to build up strong and lasting networks of researchers across the EU.

Direct support for research and innovation projects. The most significant direct support for research and innovation projects by the EU comes from the Framework Programmes. Clearly EU R&D Policy has a significant effect in terms of the number of projects supported although the differences in participation rates between regions has already been identified at the aggregate level. Despite this, the importance of such direct support should not be underrated even in regions which have a limited overall involvement in the Framework Programmes. For example, it is estimated that in Calabria almost a fifth of the University of Calabria's research funding was related to projects undertaken in the context of Framework Programme 4. For other places the impact is even stronger.

In Ireland our case study respondents have suggested that the impact of Framework Programmes on the academic research base has been particularly marked. The Irish HEI sector has been quite reliant on the Framework Programmes for research funding. It argues that the current strengths of the university research community in Ireland can partly be attributed to its involvement in successive Framework Programmes. The fact that the economic interests of Ireland coincided with a many of the broad aims of the Framework Programmes particularly in sectors such as agriculture, the environment, information technologies has enhanced Ireland’s participation in the FP’s. The report also notes the importance of Ireland's enthusiasm for participating in European trans-national projects as an important component in the level of activity sustained.

There are fewer examples of direct Structural Fund support for research projects from our case study material. A very few examples of this type of intervention were highlighted by the case studies in Objective 2 regions. In Liguria, for example, funding under the 2000-2006 programme has been set aside for the development of industrial and pre-competitive research activities. No evidence has been found for the Structural Funds being used to support Framework Programme projects in Objective 1 areas. Given the importance of the FOI 181 in the overall Structural Fund programme for 2000-06 this is an area which would merit further investigation.

Governance

Governance and regional innovation systems have been gaining in emphasis both in academic thinking, policy thinking and actions on the ground over the past 10 to 20 years. As the notion of a linear path from R&D through innovation to market has lost credibility, aside from in a few specialised circumstances, so the interactive model with which it has been replaced stresses the institutional and regulatory context in which R&D and innovation takes place.

Whilst the Framework Programmes and the mainstream Structural Funds (Objective 1 and Objective 2 programmes) do not – on the whole - directly target R&D governance arrangements themselves, their 'fit' with wider policy objectives within individual regions is an important part of the context in which actions take place. The Structural Funds themselves have also played an important role in influencing the workings of regional innovations systems in areas where the RIS-RITTS Innovative Actions have occurred.

The case study analysis for this project makes clear that regional governance arrangements for R&D are strengthening in the regions examined. This accords with the findings of other specialised studies that have specifically examined this matter42. Our case study analysis demonstrates a range of different governance arrangements for R&D policy. In some cases there was a very strong centralised element to policy. For example in the case of Finland and Ireland national policies were predominant. In a very small number of cases the regional level was much more dominant, with Flanders providing the strongest example of this. Most regions came somewhere in between these two cases and exhibited a mix of national policy frameworks being mediated through regional actions, with a variable balance between the two. These might be described as 'integrative' approaches in that the role of the regional government is to act as an integrating and facilitating force (See Box 7.1).

[42] See for example CEC 2002 *Benchmarking National RTD policies*

Box 7.1 'Integrative' R&D governance

The broad framework for R&D policy within a country tends to be established at the national level, through legal and financial actions. The EU plays a role in influencing this framework where it sets a common European perspective. The role of regional governance arrangements tend to be focused on co-ordinating actions and facilitating access to nationally-sponsored programmes and activities. To a greater or lesser degree regional authorities have the power to shape these national programmes to their own strategic objectives. This can play an important role in promoting closer policy co-ordination within a region. They can also choose the extent to which they wish to participate in and promote initiatives that have been established by other actors. In Meklenburg-Vorpommeren, to take one example, the region has chosen to focus on:

- Universities and research institutes
- Biotechnology, and
- ICT and renewable energy.

The role of the Länder in pursuing these three areas is described within the case study as 'integrative'. It is seeking to engage the relevant (and sometimes reluctant) actors across the region in appropriate programmes and activities. These programmes and actions are generally funded by the national authorities, or by the European Union, rather than by the Länder itself. A similar integrative approach is apparent in other regions, where regional strategies have been established as a mechanism for drawing together different policy areas.

Despite the variety of governance approaches there does not appear to be a strong correlation between different types of governance arrangements and the distribution of EU R&D policies. The quality of arrangements arguably has a stronger influence. In this respect, two attributes stand out. Firstly the extent to which there is a common objective towards which different bodies are working, separately or in partnership, and secondly, the extent to which there is a strategic approach being undertaken within the region. We draw out two examples of this in Box 7.2. In the first example the development of an integrated legal base has helped promote co-ordination and in the second a similar effect has been achieved through establishing an integrated institutional framework.

Box 7.2 Improving the quality of governance arrangements

Developing the legal base

In Madrid for example Law 5/1998 on the Promotion of Scientific Research and Technology Innovation was enacted in 1998. As the case study notes, this "regulates for the first time, from a global and systematic perspective, the actions carried out by the regional public administration concerning scientific research and technology innovation". It is based on the presumption that scientific research and technological innovation are complementary, a major advance on previous thinking. Law 5/1998 sets up three lines of action:

- To support quality research
- To promote interaction between the research base, public administrations and socio-economic stakeholders with innovation capacity
- To promote a more active participation at European scale

Significantly Law 5/1998 also established a multi-annual regional plan for scientific and technological research. The current plan (PRICT III) recognises that it "integrates national and European plans on RTDI" with clear links between the National Plan on RTDI and explicit reference and linked actions to the Structural Funds and the Framework Programmes.

Developing an institutional framework

In Castille y Leon there have been a strong institutional efforts to improve levels of co-ordination on R&D and innovation within the region and between regional, national and EU policies. Part of this process was the publication of an agreed Regional Technology Plan and the establishment of an institutional framework for the regional innovation system. This consists of a regional Advisory Committee on Science and Technology; a regional Co-ordination Committee for Science and Technology and a regional Management Body (which is made up of the Directorate General of Universities and Research in the region and the Economic Development Agency (ADE) for Castille y Leon).

The Structural Funds have recognised the importance of the governance dimension. Through the Innovative Actions they have supported regional strategies in areas such as Luxembourg, Limburg and Cologne. They have also strengthened regional governance capabilities in many regions, such as in Aragon, through the RIS-RITTS Innovative Actions. Here, RIS, RIS+ and INNOVARAGÓN have "forged" co-operation between different stakeholders. This is consolidating a model of joint working method between the different regional departments involved in R&D (such as Economy, Industry, Environment, Spatial Development and Education). In this respect, the creation of a new regional directorate on Science, Technology and University - to coordinate the efforts regarding R&D - has been considered a positive effect of RIS, RIS+ and InnovAragón.

Under the new Innovative Action (2000-06), we can also see evidence of increasing co-operation at the regional governance level, offering interesting possibilities for future trans-national working. For example, STRINNOP: Strengthening the Regional Innovation Profile, a network of which the Vienna region is a member, focuses on creating synergies between the member regions and the identification of potential areas for inter-regional co-operation; best practice methodology and support of regional SMEs for their innovation activities.

In a number of regions intermediary organisations have been established to improve governance arrangements in the field of R&D. In the best cases these can work very successfully. Although they need not have been initiated by the EU funding, often they come to rely on such funds heavily for their continuing operation. We present two examples of this approach in Box 7.3.

Box 7.3 Intermediary structures

titan e.V. Neubrandenburg:An important focus of federal R&D policy in the early 1990s was the creation of intermediate institutions which should enhance technology transfer and raise innovative capacity of regional SME´s. One institution established in this phase was titan e.V. Neubrandenburg, engaged in consultancy of SME´s in the field of innovation and technology with a special focus on patent consultancy. For building up and financing this institution in the first years Mecklenburg-Western Pommerania utilised a programme started by national R&D policy. After the financial support by the national level expired, titan e.V. was successfully applying for the RITTS programme which helped to ensure follow-up financing.

Madri+d: Madri+d[43] is a network, co-ordinated by the Regional Government, of public research centres and non-profit making entities (11 universities, 10 research bodies, 11 enterpreneurial and technological organisations and 14 specialised in innovation). Madri+d aims to promote technological innovation by stimulating co-operation between research centres and enterprises and between enterprises and other enterprises. Its actions are aimed at: stimulating the knowledge and dissemination of information regarding regional scientific and technological offer; creating and co-ordinating capacities in the regional innovation system, and providing information and assessment on technological innovation demands.

In contrast, where EU R&D policies are not appropriately integrated into the regional vision of local development the case study analysis suggests that there is a high likelihood that the actions will fail to achieve their objectives. For example in the Auvergne case study it is argued that there has been a relative absence of visible bodies representing EU initiatives on the ground and that this, coupled with limited publicity in the region regarding EU opportunities such as the Framework programmes, has led to EU R&D policies having little effect. The problem, the case study argues, is one of governance rather than any intrinsic gap in research capabilities or innovation propensity. In this case, the development of networking and knowledge flows (within the region and beyond) which should have been the major contribution of the RIS Auvergne have failed to materialise.

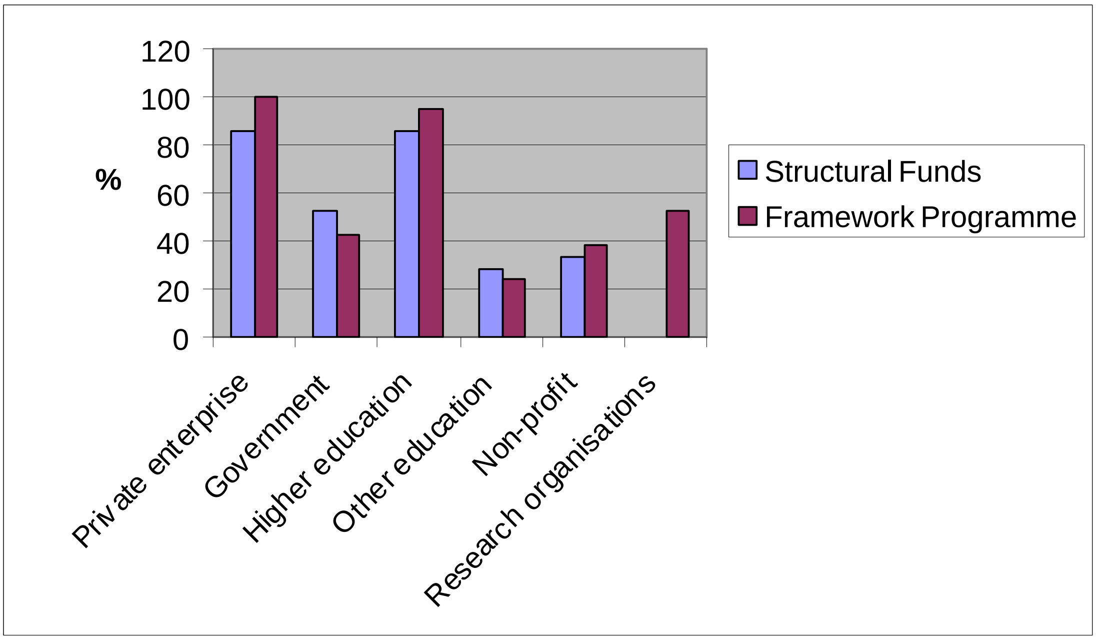
Outside of the Innovative Actions of the Structural Funds our case studies show less evidence of the proactive role of the Structural Funds in promoting governance arrangements. In the case of the mainstream Objective 1 and 2 programmes it seems that programmes follow existing priorities rather than leading them. In some cases, such as Limburg, this provides a strong reinforcing emphasis. In others, as the strategy changes so too may the focus of Structural Fund actions. For example in Luxembourg, one respondent reported that "In terms of regions benefiting the focus used to be on the industrialised south of the Grand-Duchy, whereas today one is focusing on the rural areas in the north." Here, it was argued, there were fewer opportunities for focusing upon building the R&D base of the NUTS 2 area than had been the case in the industrialised areas.

[43] Website: http://www.madridmasd.org

7.3.3 Beneficiaries of EU R&D policy

Examining the evidence from the case studies it appears that the Framework Programmes and the Structural Funds are accessed by similar groups. Figure 7.1 below illustrates the proportion of case study regions in which different sectors are known to benefit. The main difference arises because some case study regions do not have any Structural Fund measures in support of R&D and so record a zero support rating.

Figure 7.1 Proportion of regions with beneficiaries from identified sectors



Note: Research Organisations not separately identified in the Structural Fund analysis but are included within the Government category or private enterprise.

It proved difficult to gain a definitive picture of the scale to which different sectors benefit from Structural Fund actions within the regions. The message emerging from the case study analysis stressed the fact that, at a programme level, the SME sector is the focus of Structural Fund actions, with important levels of support being targeted on the HE and Government sector. The focus on SMEs has strengthened in the 2000-06 programme in comparison to that of 1994-99, although this is not universally the case and in some programmes the HE sector remains a significant actor, such as the University of Twente in Overijssel.

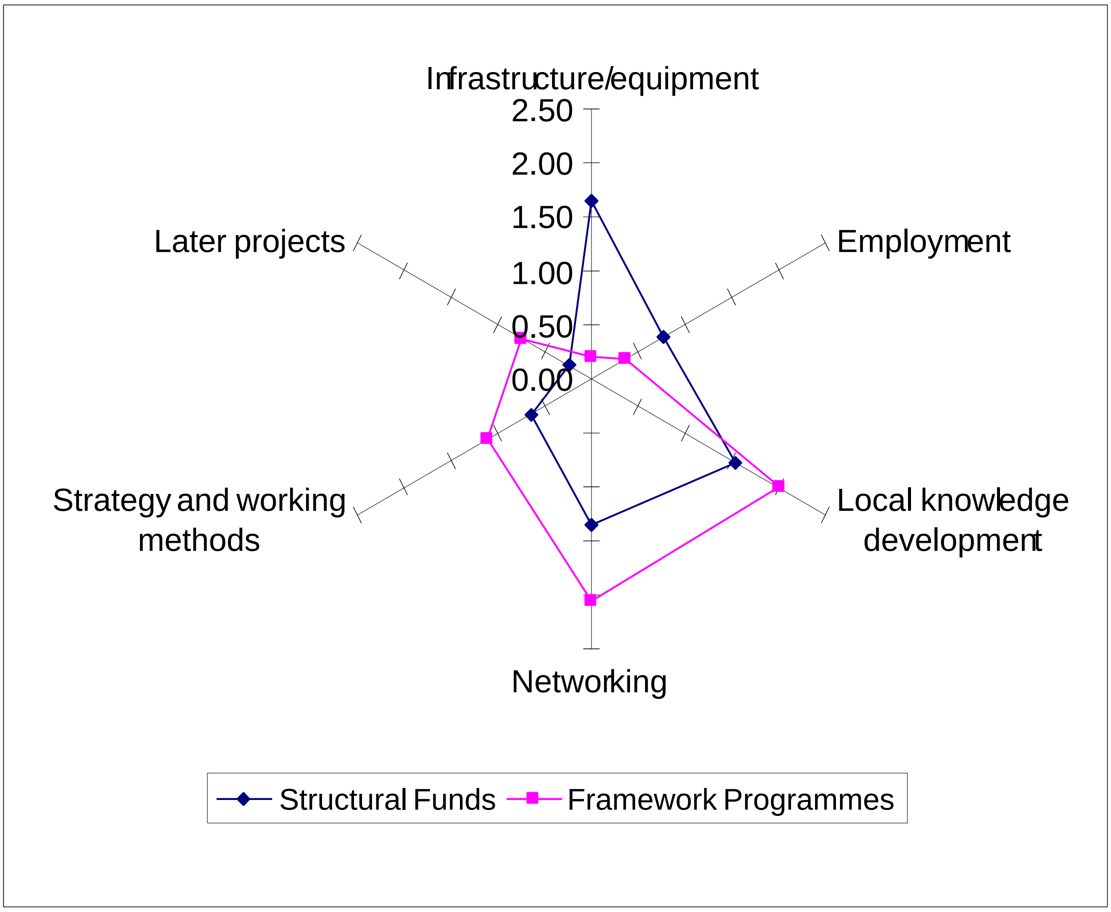
In contrast we have more detail on the split between sectors across the Framework Programmes. Here there remains a strong focus on the private sector in our case study regions but with the emphasis more strongly, but not exclusively, on larger enterprises.

There has, though, been a shift in a small number of regions to greater inclusion of SMEs in FP5 in comparison to FP4. The other principal beneficiary of the Framework Programme is the Higher Education sector. This is consistently responsible for between 40% to 60% of project participations in the case study regions. It is only in a minority of programmes where other sectors displace this pattern, examples including Madrid, Liguria, Aragon, Cologne and Luxembourg, where the private sector takes a greater share, and Uusimaa, where other research organisations are strong beneficiaries. Whilst research organisations are strong beneficiaries in around half of all the case study regions, the other education sector, non-profit sector and government sector generally account for a very small minority of project participations (typically in the single percentage figures each).

7.3.4 The territorial impacts of EU R&D policy

From the case study analysis an assessment has been made of the broad territorial impact of EU R&D policies within each region. Although it was not possible to quantify these impacts, the case study work enabled a qualitative assessment of where impacts were being felt and the level of significance of each of these. Assessed on a scale of 0 to 3 (where 0= limited or no impact, 1= modest impact, 2= important impact and 3= substantial impact) the aggregate results are represented in Figure 7.2 below. This demonstrates clearly where different components of EU R&D policy reinforce each other and where respective strengths lie. Low scores do not equate with failure - or necessarily have a negative connotation - as the impact is closely related to the aims and objectives of the different policy instruments, as well as how they have been used in different regions. For example, a low score under infrastructure/equipment is to be expected in the case of the Framework Programmes (as this is not a significant area of activity in practice) as is a high score under networking (as this is a requirement of the programmes).

Figure 7.2 Territorial effects of EU R&D policies



As Figure 7.2 (above) demonstrates, the strongest impacts are to be found around networking and local knowledge development, where the effects of the Framework Programmes and the Structural Funds overlap. The Structural Funds are also having an important impact in terms of the development of regional infrastructure. Immediate, direct employment effects are less significant in the regions examined as part of the case study work. We explore each of these different components in more detail below and also introduce some further spatial analysis based upon the findings of the case study material.

Networking The networking benefits of the Framework Programmes are well-reported. This has been reinforced by our own case study work. Correspondents universally regarded this as the strongest wider benefit for the region. Equally, the stimulation and promotion of networks has been seen as a strong success of the Structural Funds. In many respects the Framework Programmes and the Structural Funds can be seen as complementary in this regard. Whilst the Framework Programmes have been very successful at establishing extra-regional linkages so the Structural Funds have focused more strongly on intra-regional networks. In many respects the benefits of the networking activities are that they facilitate the exchange of knowledge and information so supporting the development of knowledge and technical ability within the region and that they encourage the development of more extensive spillover effects (as outlined below).

One of the indirect benefits, and sustaining, benefits of the Framework Programmes has been the high levels of mobility that they have engendered amongst young scientists. This has created an EU-wide network which, despite members moving to new posts in new locations, continues to operate to the benefit of knowledge generation in the EU.

Local knowledge development Both the Structural Funds and the Framework Programmes were reported to have positive effects on the development of local knowledge. This can range from technical know-how through to knowledge of new market opportunities. Such effects were highlighted by correspondents in Calabria, Liguria and Limburg, demonstrating that these benefits can be felt in any part of the EU.

Training courses and internships are an important aspect in building the knowledge base of different regions. In Castilla y Leon, for example, some 1354 workers, from 68 enterprises, benefited from around 146 training actions in 2002, with a further 450 workers from public research centres also benefiting. The training courses were funded through the Structural Funds and were closely linked to the Regional Technology Plan. In the same year the Structural Funds were also supporting around 2011 internships in Higher Education Institutes in the region. Similarly in Lisbon, some 2410 scholarships were supported between 1995 and 1999 by the PRAXIS XXI programme.

Equally important is the opportunity to engage companies in research and innovation activities. In Castilla y Leon 208 enterprises benefited from their involvement in projects supported by the Structural Funds promoting technological development and innovation. Between 2000 and 2002 a further 333 enterprises had benefited from similar programmes in the region. The types of activity typically supported included hiring consultancy services, investment in new equipment and the introduction of new production techniques.

Infrastructure Infrastructural impacts were present in all the case study regions which have earmarked Structural Fund resources in support of R&D. In more than half of these the impacts were judged to be important or substantial. Substantial impacts tended to be found in the Objective 1 regions, such as Vorpommern, but important impacts were identified in both core and peripheral regions, including Flanders, Wales, Overijssel, Algarve, Aragon and Castilla y Leon. In contrast there is very little evidence of significant impacts by the Framework Programmes in this area. Clear examples of where EU R&D policy is having an influence in this regard is in the construction of Science Parks and either the development of new research centres or the raising of the profile of existing centres.

One example of the value of EU R&D policies to such organisations and the development if soft 'knowledge' infrastructure is to be found in Flanders where the development of IMEC is held to be an important success story for the region. IMEC was founded as a inter university co-operation in micro-electronics. It has since spun off from its original university base and can now be regarded more as a large (R&D) firm. It still benefits from public support linked to objectives concerning spin-off, spillover and technology transfer to regional companies. IMEC has participated in a number of Framework Programme projects which suits its core activity of pre-competitive research projects for international networks of companies. Crucially IMEC is argued to be stimulating wider indirect benefits for the region with many of the researchers who have been attracted to the centre remaining in the region but employed with other companies or establishing their own businesses.

Employment effects There is limited evidence of strong employment results from EU R&D policy in the short term. In some regions evidence was provided of immediate job gains in intermediate support organisations and also in firms assisted through the Structural Funds. These included jobs in spin-out companies formed as the consequence of the commercialisation of research results. Under the Framework Programmes immediate employment effects were even less common. Again some examples were provided of employment gains in spin-out companies, for example in Luxembourg and Cologne, but most jobs were reported to be temporary research posts related to supported projects. Significantly, stronger employment gains are anticipated in the future, once the results of completed research projects had been commercialised. This will be dependent upon the uptake of processes and products, developed through supported projects, by industry more widely. However, these jobs cannot be picked up by traditional monitoring arrangements.

Strategy In terms of strategy effects there is some evidence from the case study work that the Framework Programmes – through trans-national project partnerships - are having an effect on the working practices of firms involved in different projects and on the development of new methodologies and scientific approaches. Together these are judged by our case study respondents to be helping to have an effect on levels of regional competitiveness. There was less evidence of mainstream Structural Fund actions having strong strategy effects, although in the case of the Innovative Actions (particularly RIS and RITTS) the strategy effects were much more marked and significant. Indeed, it was in the field of strategy development that these projects tended to have their strongest visible effects. In Aragon this link between the regional strategy and previous Structural Fund actions is clearly visible with two of the Measures contained in the 2000-2006 regional programme having a genesis in the previous RIS and RIS+ initiatives. Whilst it would be wrong to overplay the claims for the effectiveness of strategies developed as part of Structural Fund activities the overall effects can be important. In Castille y Leon for example the region's economic development agency, ADE, identifies that public investment in innovation increased threefold following the publication of the Region's Technology Plan and that it also had very strong qualitative effects by influencing the types of activities being promoted. The RTP was, itself, influenced by the EU's R&D supporting actions.

Spillover effects. One means by which EU R&D policy can have a wider territorial effect is though the existence of spillovers. The message emerging in this area from our case study work is mixed. At the one level there was a very clear belief that the benefits of the Framework Programme projects did not extend beyond the participating organisations, as one correspondent in Vienna forcibly put it: "Spillover effects on local, regional level or going beyond the region? None!". This limited experience of 'knowledge spread' effects was also reported in the Algarve and Lisbon.

However, other correspondents were more positive. In particular they highlighted the strong spillover effects that were present at the macro-scale identifying the flow of knowledge between regions in Europe facilitated by the Framework Programmes. As they argued, the Framework programmes result in high frequency knowledge networks with strong ties. The various projects foster ties between research institutions and firms, stimulating active innovation networks. These are, it is argued, leading to new working practices, greater communication and enhanced levels of trust – all fundamental attributes for enhancing levels of innovation.

Most correspondents agreed that the spillover benefits were weakest at an intra-regional (micro) level, owing to the limited number of intra-regional partnerships in the Framework Programmes. It appears that the knowledge generated is most likely to be spread around the consortia rather than being disseminated out into the regions in which partners are based. As one case study respondent put it – the closed circle of (Framework Programme) beneficiaries does not facilitate spillover effects.

In these circumstances intra-regional spillovers rely upon the efficacy of external mechanisms such as labour mobility and knowledge transfer routes. In one case study (Castilla y Leon) examples of efforts to improve intra-regional networking in the context of the Framework Programmes were explicitly identified. In other regions strong initiatives to improve intra-regional knowledge transfer are being promoted through the Structural Funds, with the potential to improve the level of spillovers from Framework Programme projects. The importance of building such mechanisms was highlighted in a number of our case studies. The fact is that in regions with a limited knowledge infrastructure it is the Higher Education sector that is in the strongest position to participate in Framework Programme projects. Yet it is these institutions that have the weakest record in terms of the commercialisation of ideas, employment generation and the stimulation of intra-regional spillovers. Observers in Puglia, amongst others, argued strongly that networks were required that were able to build out from the opportunities offered by the HE sector.

The distance over which spillovers can spread is an interesting consideration for the purposes of territorial impact assessments. It proved difficult to reach a strong conclusion through the case study work and this is an areas that would merit further research. In the case of Cologne, respondents reported that the reach was around 200km, however this is an anecdotal and untested proposition.

7.3.5 Linking the Framework Programmes and the Structural Funds

The case study evidence has repeatedly demonstrated the complementary nature of the actions supported by the Structural Funds and the Framework Programmes. In regions with a less developed research and innovation capacity the Structural Funds are seen as a first step in preparing the region to take advantage of the opportunities offered by the Framework Programmes. This was highlighted in regions such as Puglia, Vienna and Aragon. Within regions with a stronger research and innovation capacity the Structural Funds were still regarded as an important component in ensuring that the benefits of the Framework Programmes were diffused more widely across the region through the stimulation of networks and additional capacity. As case study respondents in Cologne put it: the difference between the Structural Funds and the Framework Programmes can best be described as FP participation is helping to achieve the linkage to worldwide knowledge flows and sustained competitiveness whereas Structural Fund initiatives are aiming to bring these effects to the region's hinterlands.

It seems that the Structural Funds play an important potential role in building the absorptive capacity of a region to a sufficient extent to assist in its participation in Framework Programme projects and in stimulating important intra-regional linkages to concentrations of R&D and innovation infrastructure. The Framework Programmes in turn help to connect regions to the European Research Area and, do themselves assist in stimulating the absorptive capacity of the region through the introduction of new knowledge and ideas. Together, the two dimensions of EU R&D policy have the potential to build the European Research Area. Despite this apparent complementarity there is, though, little evidence within the case study analysis of direct interconnections between the Structural Funds and the Framework Programmes being made in practice. On the whole the evidence consists of a series of complementary, but essentially separate, actions.

One area where there is potential for direct linkages to be made is in the mechanism for using Structural Funds in Objective 1 areas to co-finance Framework Programme projects. This mechanism was first introduced at the outset of FP 6 in 2002. However, no evidence for any such activity was found during the case study work for this project.

The project team were subsequently asked to undertake further work in this area. Five Member States responded to the team's request for information. In each case no evidence could be provided for any such actions occurring on the ground. Officials from both Spain and Germany also reported that in their opinion it was very rare for Objective 1 funds to be used to co-finance Framework Programme projects (for a full summary of responses please see Annex 5).

From the evidence available it appears that there has been very limited use made of the available co-financing mechanism. Valuable further research could be undertaken to ascertain the reasons for this. This should be seen as priority before the mechanism is continued further or discarded. One reason that may account for this is a lack of awareness of this opportunity. Whist we do not have strong evidence for this, there is certainly anecdotal evidence in support of this conclusion.

7.4 EU R&D policy and the ESDP

To assess the territorial impacts of EU actions in the field of R&D it is important to set them in the context of broad territorial objectives. The policy objectives of the ESDP, coupled with those which can be discerned in the Communication “The Regional Dimension of the European Research Area44” provide a guide in this respect. It must be stressed that these are identified spatial objectives, these are not necessarily the primary goals of either the Structural Funds or the Framework Programmes.

The goals set out in the ESDP can be divided into two main types:

- EU-wide spatial objectives (the macro scale)

[44] COM (2001) 549 Final

- Trans-regional spatial objectives (arguably a meso scale)

Using this sub-division we have identified the following spatial goals relevant to EU R&D policy.

EU-wide Spatial Objectives

- Wide-ranging integration of knowledge-relevant policies, such as the promotion of innovation and research and technology development into spatial development policies, especially in remote or densely populated areas
- Fostering networking among companies and the rapid diffusion of innovations, particularly through regional institutions that can promote innovations
- Supporting the establishment of innovation centres as well as co-operation between higher education and applied R&D bodies and the private sector, especially in economically weak areas.
- Expansion of the strategic role of metropolitan regions and 'gateway' cities, giving particular attention to the development of peripheral regions of the EU
- Facilitating Objective 1 regions to take part effectively in collaborative research projects to develop their human S&T resources.
- To broaden the technological absorption and creative capacity of Objective 1 regions.

Indirectly EU R&D policy might also support the following objectives of the ESDP:

- Strengthening a polycentric and more balanced system of metropolitan regions, city clusters and city networks
- Improvement of the economic basis, environment and service infrastructure of cities, particularly in economically less-favoured regions, in order to increase their attractiveness for mobile investment
- Support for the economic development of towns and cities in less favoured regions
- Strengthening small and medium-sized towns in rural areas as focal points for regional development and promotion of their networking

Trans-regional Spatial Objectives

- Strengthening of several larger zones of global economic integration in the EU, equipped with high-quality, global functions and services, including the peripheral areas, through trans-national spatial development strategies
- Strengthening co-operation on particular topics in the field of spatial development through cross-border and trans-national networks

- Promoting co-operation at regional, cross-border and trans-national level; with towns and cities in the countries of Northern, Central and Eastern Europe and the Mediterranean region; strengthening North-South Links in Central and Eastern Europe and West-East Links in Northern Europe

Looking over our analysis of EU R&D policy in the light of the principle spatial objectives of the ESDP we draw the following broad conclusions.

EU R&D policies are supportive of the first EU-wide spatial objective. There is good evidence emerging from our case study work that programmes such as the RIS and RITTS innovative actions have stimulated the development of R&D orientations in spatial development policies. These are often in the form of Regional Technology Plans. There is also evidence of EU R&D policies being integrated into spatial plans that have not been instigated by EU R&D policies, such as in Madrid for example. The breadth of our case study work suggests that this is occurring across the EU, including – but not especially – in remote and densely populated areas.

One of the most significant successes of EU R&D policies has been to stimulate networking amongst companies and other regional institutions engaged in promoting innovation. Our case study work has reinforced the strength of this activity. Both the Structural Funds and the Framework Programmes, in their own ways, are proving adept at encouraging the development of and facilitating the operation of networks and technology transfer arrangements. This is a growing area of EU R&D policy focus. EU R&D policies are thus highly supportive of this second objective.

Our evidence from the case study analysis is that Structural Funds have been used on many occasions to establish research and innovation centres as well as to promote co-operation between higher education and applied research bodies and the private sector. The Framework Programmes have also been instrumental in promoting such co-operative arrangements. Such actions are taking place in both economically strong and weak areas, although there is evidence that the relative impact is greater in economically weak areas.

We are unable to come to a firm conclusion as to the effect of EU R&D policy on the expansion of the strategic role of major metropolitan regions and 'gateway' cities, especially in the peripheral regions of the EU. There is certainly anecdotal evidence that this is occurring in some parts of the EU. However, there is also evidence that EU R&D policies are being used to seek to counteract the expanding role of some major metropolitan areas. This provides something of a conundrum for policy makers and is an area where additional research would be valuable.

EU R&D policies have had substantial success in facilitating many Objective 1 regions to take part effectively in collaborative research projects and to develop their S&T resources. There is evidence for these positive longer-term effects from both actions undertaken through the Structural Funds and for those undertaken through the Framework Programmes. The same finding applies to the final EU-wide spatial objective of the ESDP. EU R&D policies are helping to broaden the technological absorption and creative capacity of many Objective 1 regions. It is through the successes of these policies that Objective 1 regions are more able to effectively participate in collaborative research projects.

Turning to the trans-regional objectives the effects of EUR&D policy are, as yet, less clear. Whilst EU R&D policies are, without doubt, supporting R&D development in areas outside of the traditional core of the EU they cannot yet be said to be addressing the detailed objectives as set out in the ESDP. In particular there does not appear to be any substantive approach towards the strengthening of 'several larger zones of global economic integration', partly perhaps due to the lack of any explicit mechanisms for this. There has been more success in promoting co-operation at the regional, cross-border and trans-national level, with strong individual examples – as evidenced through the Cologne case study - providing a solid basis on which to build. This is an area where additional targeted research could be valuable.

7.5 Furthering the spatial analysis

Our analysis of EU R&D policies has provided an insight into the distribution and use of these policy instruments across the EU. In the following section we seek to assess the spatial dimension of these policies through the medium of the three-level typology applied by the ESPON research programme.

In the three-level typology applied by the ESPON[45] research programme a macro-, a meso- and a micro-scale were identified where:

- The macro-scale refers to "the dichotomy between the pentagon and the rest".
- The meso-scale refers to the extent to which "the dominance of the strongest functional urban area in a country has been reduced by other (inter-) national functional urban areas becoming stronger."
- The micro-scale refers to "the relations between different parts of a region."

[45] The definition of the different scales are taken from the ESPON Matera Guidance Paper 2004 (page 11)

Considering our results through the filter of these three lenses provides a useful summary of the spatial effects of EU R&D policy. On the whole the twin tracks of EU R&D policy (the Structural Funds and the Framework Programmes) appear to be complementary with their respective strengths reinforcing the combined effects.

7.5.1 Macro-scale

At the macro-scale there is evidence that EU R&D policy is supporting the development of regions outside of the traditional core of the EU (the so-called 'Pentagon'). The largest levels of Structural Fund expenditure on R&D activity are to be found in regions surrounding the core, particularly in the south west of Europe and the Eastern Lander of Germany: a picture that is reinforced by patterns of actual expenditure. Relatively strong levels of planned, and actual, expenditure are also visible in the western periphery of the EU. In contrast, levels of planned and actual expenditure on R&D through the Structural Funds in the south eastern periphery of the EU appear relatively low.

A number of regions in the core of the EU are planning to spend significant levels of Structural Funds on R&D, particularly within Germany. However, when actual levels of expenditure are examined as a proportion of planned spend the balance is redressed slightly, presumably due to lower levels of spend to date in some of the German programmes.

The distribution of Framework Programme activity across the EU highlights the principal role of a scattering of regions. Some of these leading regions are located in the core of the EU and others are to be found in the northern periphery. Below this small number of leading regions is a large number of regions which record significant levels of participation in the Framework Programmes. These are broadly distributed across the EU with localised strengths apparent in most Member States, particularly (but not exclusively) around capital cities – where concentrations of research infrastructure are to be found.

The strength of the support by the Framework Programmes to capital city regions and Ireland is more apparent when levels of GDP and – in a limited analysis – R&D expenditures are taken into consideration. In taking these variables into account the relative strength of Framework Programme support to regions in the northern periphery and the south eastern periphery of the EU is also apparent.

In the case of Greece there appears to be something of a paradox. Whilst overall R&D strengths are limited, when measured against EU averages, there is a high propensity of participation in the Framework Programmes suggesting a strong emphasis on EU R&D

policy activity. Yet, overall levels of expenditure (planned and actual) on R&D activities through the Structural Funds are not significant, suggesting that a stronger linkage may be possible.

Looking at the evidence available from the perspective of building a European Research Area the important role being played by the Structural Funds in building R&D capacities in less favoured regions is clear. Equally the Framework Programmes are also proving strongly supportive through their recognised role in developing networks of firms, research organisations and individuals at the European level. Arguably, and as the case study evidence suggests, this is assisting researchers in less favoured regions to increase their access to knowledge and expertise and so to build regional capacity for research and innovation.

It is also providing strong reputational benefits. For example a correspondent from Mecklenburg-Vorpommern reported that: "The Biotech sector has increased its reputation tremendously, resulting in multi-nationals and even non-German companies inquiring for business locations in Mecklenburg-Western Pomerania." Similarly, the same correspondent also argued that "The region is nowadays better known on national and international level as a location for maritime research". Returning to the case of Cologne, a correspondent similarly commented: "Furthermore the economic attractiveness of the whole region has increased due to the effects of R&D funding". These reputational effects were reported by both industrial partners and academic partners, suggesting that this is an important step in the macro-spatial effects of the Framework Programmes.

The relative strength of Framework Programme participation for many less favoured regions suggests that these regions may be gaining a 'helping hand' from firms and research bodies located in economically stronger regions. The evidence from the case study work is very suggestive of the importance of the introduction of new working methods in regions such as Liguria and Puglia. However, the fact that more significant effects in this area were recorded in Cologne and Uusimaa, two advanced regions, suggests that opposing forces are at work here which may result in stronger regions reinforcing their position, even as less favoured regions are helped in their development.

7.5.2 Meso-scale

The meso-scale appears to be a much over-looked dimension to EU R&D policy. It has been described by the EPSON programme as representing disparities within Member States, however, it can equally be viewed as applying to trans-national regions in the EU. In our opinion this is closer to the ethos of the ESDP. The closest administrative representation of such areas are those of the INTERREG IIIB Community Initiative programme areas. In the following assessment we briefly address both configurations.

There is some evidence that the strongest research orientated regions in Member States are the strongest participants in the Framework Programmes. To the extent that this serves to increase the advantages that are already present within these regions this can act to strengthen disparities within Member States rather than overcoming them. For example, in Portugal, around 72% of all national funding for R&D was reportedly focused on the Lisbon region between 1996-1999. In the same period the 2410 PRAXIS XXI scholarships reported in the case study for the Lisbon region constituted around 40% of the national total. In this guise the Framework Programmes can be argued to be reinforcing disparities at the meso-level, at least in the short-term. However, the picture is not universal and in some Member States, such as Greece and the UK for example, less-favoured regions feature amongst the strong participants in the Framework Programmes. What does seem clear is that it is those regions that have an existing active research base that are most likely to benefit from the Framework Programmes, as they have more generally from the increasing policy emphasis on supporting R&D activities.

There is also some, albeit limited, evidence from Ireland of Framework Programmes and the Structural Funds being used in complementary ways to support a more balanced distribution of R&D activities within a Member State. In this instance, whilst Framework Programme projects were largely to be found in Dublin and the university-towns of Cork and Galway, the Structural Funds were focused elsewhere in the country, targeted on enhancing R&D capacity across Ireland and particularly in its more peripheral areas.

The case of the Structural Funds is no clearer. The evidence suggests that national and regional policy perspectives are a more important influence on the levels of support for R&D through the Structural Funds between regions than levels of identified disparities. For example, the Structural Funds in the Algarve region in Portugal are not strongly focused on stimulating R&D activities. The focus in other Portuguese regions – including Lisbon - with greater R&D strengths and a stronger tradition of research and innovation is, in contrast, relatively stronger. In contrast, Structural Fund programmes in the UK Objective 1 regions of West Wales and the Valleys, Cornwall and the Scilly Isles and South Yorkshire all have a strong R&D element. However, these regions all have a relatively strong pre-existing R&D infrastructure or, in the case of Cornwall, aspirations to develop a Higher Education infrastructure.

One area where EU R&D policies might be anticipated to influence meso-scale patterns of activity is through the establishment of spatially-focused networks. There is no evidence from our case study analysis that this is occurring in the networks being established with the context of the Framework Programmes nor is there significant evidence of it occurring in the context of the Structural Funds.

Taking the alternative view of the meso-scale - whereby transnational working (such as through INTERREG IIIB programmes) is the measure - there is less evidence of significant policy actions supporting agreed spatial strategies for these areas. Whilst some 5% of INTERREG programme funds are available for R&D investments we have not found strong evidence of regions working closely together in this context within a common spatial strategy.

From the experience gained in the case study analysis it appears that national and regional policy perspectives have a strong bearing on the effectiveness of EU R&D policies at the meso-scale. In a number of regions EU R&D policies can be sent o be contributing to balancing the pattern of national R&D capacity, either because of a positive national policy effort in this direction – such as in the Algarve, Liguria and Puglia – or because of an increasing decentralisation of national policy making – as in Flanders and the Auvergne.

In considering the role of domestic policies in mediating the influence of EU R&D policies at the meso-scale it is useful, perhaps, to reflect on the difference between a regional policy and regional policies. The former is a positive instrument to differentially support identified regions and seek to overcome identified disparities. The latter refers to the 'integrative' role that regional authorities can play in facilitating the use of European and national policy instruments. As we identified in Section 2, national policies are increasingly focusing on increasing regional involvement in science and technology policies. Examples of this can be seen in our West Midlands, Cologne and Meklenburg-Vorpommern case studies. In this approach there is a great responsibility on the regional actors to engage with the opportunities provided by higher-level policy instruments. In some cases, such as in the Madrid and Castilla y Leon case studies, these opportunities are grasped, in other cases, such as the Auvergne case study, less use is made of them. In the absence of higher strategies, the emphasis falls on individual regions - and other regionally-based actors - to shape the wider meso-scale effects.

7.5.3 Micro-scale

The effects of EU R&D policies are most strongly visible at the micro-scale. Within individual regions the Structural Funds are having important effects on supporting the development of research and innovation capacity. The Framework Programmes are also making a valuable contribution to the development of the knowledge and capacity of individual organisations within regions and, in some cases, this is also leading to wider spillover effects. Taken together these policy instruments are making an important contribution to the pursuit of territorial cohesion in the area of R&D and are supporting the practical development of a widely-spread European Research Area in practice.

In the best cases the EU's R&D policies are:

- Strengthening regional knowledge infrastructures - through supporting the development of research facilities, science parks or other investments.
- Strengthening human resources for research and innovation in regions. This is a particular strength of the Framework Programmes and is more than just about the provision of training. It is also about 'learning-by-doing' and the Framework Programmes are raising the skills and experience of researchers, employees and managers through facilitating their involvement with advanced knowledge networks.
- Strengthening the access to knowledge of companies and research bodies within regions. They are doing so through supporting the development of collaborative working arrangements as well as through dissemination and knowledge exchange networks. The case study analysis has emphasised the role of the Framework Programmes in stimulating European-wide collaborations whilst the Structural Funds can promoted greater connectivity within regions. The value of an outward-looking culture – as emphasised in the case of Ireland – is an important factor here.
- Promoting new ways of working – the Framework Programmes were particularly identified as assisting in the introduction of new organisational strategies as a consequence of connections made with companies and other organisations located elsewhere in Europe.
- Influencing the importance attached to R&D strategies and the role of governance in facilitating the development of regional R&D capacity. Most of the case study examples demonstrated the role that EU R&D policies are playing here. Not only do EU R&D policies provide a means to stimulate research and innovation activity within a region where regional actors are active participants but they can also help to introduce new ideas and approaches from elsewhere. As North (1993) recognised – overcoming path dependency relies on receptive political markets which, in turn, depends upon the belief systems of the relevant actors. EU R&D policies have played a significant role in shaping these belief systems across the EU.

There is some evidence that within regions EU R&D policies can reinforce existing concentrations of activity. For example, in the NUTS 2 region of Cologne, much of the activity is focused on the cities of Aachen and Cologne. As one correspondent commented: "Due to the heterogeneous structure of the Cologne region the effects (of the Framework Programmes) cannot be identified for the whole region. The most intense effects can be identified around the cities of Aachen and Cologne. The Heinsberg district and Eifel area are not that much affected". Often this reflects the historic distribution of infrastructural investment. For example, in Liguria 138 of the 146 regional laboratories are located in the municipality of Genoa.

It can also reflect existing clusters of activity. For example, participation in the Framework Programmes in the Eastern Region of England is spatially differentiated.
In East Anglia a balance of FP funding can be seen between sectors such as Environment, Biotechnologies and Electronics; reflecting the strength of Higher Education Institutions (HEIs), multinationals and Research Institutions in this area, as well as the number of SMEs involved in the programmes that are spin offs from the University of Cambridge in particular. In contrast, Hertfordshire and Bedfordshire has seen much more technology and economic based projects funded under programmes such as Growth and EESD reflecting the large number of public and private research institutes based there. Whilst in Essex the presence of multinationals such as SmithKlineBeecham and Glaxo (who merged in 2000) is reflected in the large number of biotechnology projects recorded in the region.

Such concentration effects need not be seen as problematic and, in some cases such as in the development of Shannon in the Border, Midlands, West region of Ireland, can form a positive element of a development strategy. However, where the benefits of EU R&D policy instruments such as the Framework Programmes are tightly concentrated within a few organisations in a limited geographical area there is no doubt that the potential value to regional development is somewhat lessened. Promoting stronger spillover benefits through complementary policies can play an important role in realising these benefits. This was demonstrated in some of the case study regions, such as Aragon. Here there was good evidence of the Structural Funds working with regional intermediary bodies, in this case RACI (the Aragonese institutional network), to help diffuse knowledge and innovation activities beyond the regional centre which was the traditional focus for research activities.

7.6 Summary spatial analysis

Looking at the direct effects of EU R&D policies (Table 7.18 below) it would appear that their strongest functions are occurring at the regional (micro) and EU (macro) scale.

Table 7.18 Effects of Different Elements of EU R&D Policy

	Macro-level	Meso-level	Micro-level
Infrastructure and equipment	*	*	***
Technological capacity	**	*	***
Networking	***	*	***
Human capital development	**		**
Employment			*
Governance and strategy			*

Source: Summary of case study analysis material
Note: The greater the number of "*", the greater the effects felt at this level

Together these impacts are helping to achieve the EU's broader spatial objectives, particularly in stimulating the conditions for greater territorial cohesion. However, territorial cohesion is not the primary objective of EU R&D policies and EU R&D policies are currently achieving this in parallel with other objectives, principally the desire to make the EU the most competitive knowledge-based economy in the world by 2010 and the associated development of a European Research Area. Bringing these aims together is a crucial step for EU R&D policies and one which we address in the following section.

8.0 Conclusions

8.1 Overall conclusions of the study

It is now widely accepted that research can generate knowledge which, when transformed into new products and processes through innovation, can result in economic growth. This process is both cumulative and iterative and there are many points at which new knowledge can enter the system and be combined to create the much desired 'innovation'. In this respect the role of networks, linkages and spillovers are important elements in maximising the level of knowledge available and access to this.

In making the most of available knowledge the literature rightly emphasises the importance of the firms being able to interpret or 'absorb' the knowledge which is available. Having an R&D capacity within firms as well as sense and response capabilities is recognised as determining the extent to which individual firms can reap the benefits of generated knowledge. This capability may be in terms of the ability to access and understand codified knowledge but the strength of tacit knowledge, generated though personal contacts and developed through shared expertise (in David and Foray's model), is equally important.

Researchers are also now highlighting the importance of the institutional dimension to knowledge generation and exploitation. The socio-cultural context - as well as institutional and organisational relationships - all influence the propensity to turn ideas and inventions into new products and processes. In the National Innovation System, and Regional Innovation System, literatures these processes are regarded as fundamental differentiators of national and regional innovation(and thus economic) performance.

The EU, like many of its Member States, now stresses the role of R&D in stimulating economic growth. This is both as a means to stimulating greater global competitiveness, and so protecting and strengthening the living standards of EU residents over time, and as a means of achieving greater territorial cohesion within the Union. EU R&D policies are able to exert an influence at many levels in seeking to stimulate research and innovation. In this study we have focused on the role of EU R&D policies, namely the Structural Funds and the Framework Programmes.

In undertaking this work we have also examined the territorial strengths of the regions of the EU across a number of indicators. These demonstrate the concentration of R&D and innovation activity in a broad area closely approximating to the core or pentagon at the heart of the EU but including regions in the northern periphery of the EU. This picture of concentrated activity is heightened when one focuses on business related activity, particularly business expenditure on R&D. Strengths on the south-west fringe of the pentagon are though visible and, to a lesser extent, in the western periphery.

The emerging picture of the EU's R&D geography is more complex than a simple core-periphery analysis would suggest. The evidence also suggests that the complexity will increase in the future rather than lessen as most of the strongest rates of growth in key indicators have been registered in peripheral regions. Strong disparities do remain however and wider economic data suggests that the process of 'catch-up' of less-favoured regions is only weakly visible.

The complexity of the R&D picture across the EU suggests that some other means of grouping regions should be found. We have sought to combine the different indicators available to develop a typology of regions. Different statistical methods and different indicators naturally give different pictures of the EU territory. However, we have demonstrated that a cluster analysis using a broad set of readily available indicators can provide a valuable typology that might be used as a starting point for developing individual regional innovation strategies.

The different typologies demonstrate a broadly consistent picture which is that there is a small cluster of EU regions that can be regarded as leading lights in research and innovation. These are the EU's 'global champions'. These regions are to be found in the core of the EU (predominantly around the Centre Capitals Region and in Germany) and in the northern periphery. There is also a very long 'tail' of regions with average or below average performance in terms of research and innovation activity. These regions are broadly distributed with a concentration across the southern parts of the EU. The clustered groupings of these regions suggests that there might be merit in considering transnational programmes as part of a strategy to raise the research and innovation performance of the EU, a point we return to below.

This study has examined the territorial impacts of EU R&D policy. In doing so it has focused on the Structural Funds and the RTD Framework Programmes. We have found that EU R&D policy is becoming more significant, with more resources being dedicated to stimulating R&D activity across the EU. Some €10 billion of the Structural Funds (more than 7% of their total value) is planned to be spent on R&D activities across the EU between 2000 and 2006, with the RTD Framework Programmes contributing €15 billion between 1998 and 2002 and a further 17.5 billion between 2002 and 2006.

The spatial pattern of EU R&D policy expenditures are not evenly distributed. Whilst the Structural Funds broadly reflect the goals of territorial cohesion this is not universally the case, with the levels of expenditure planned, and occurring, in Greece for example being below the EU average. A stronger focus on strengthening R&D activity through the Structural Funds is visible in south-western Europe (particularly Spain, much of Portugal and the south west of France), the UK, Ireland and Germany.

On first sight the distribution of projects funded by the Framework Programmes appears to counteract territorial cohesion objectives, as economically stronger regions tend to have a larger number of firms and research organisations engaged in Framework Programme activities. However, closer analysis demonstrates that when economic strength is controlled for, and more particularly levels of R&D expenditure, many less favoured regions benefit disproportionately from the Framework Programmes.

EU R&D policies are demonstrably impacting on the spatial geography of R&D across the EU in a number of ways. Chief amongst these are the effects of making connections between firms and research bodies across the EU and the strengthening of the capacity of individual regions to participate in research and innovation activities.

The successes of EU R&D policies in stimulating the regional potential for research and innovation have included:

- The development of appropriate knowledge infrastructures
- Supporting the development of human resources
- Providing finance for R&D activities, and
- Stimulating the development of 'knowledge' networks and partnerships

From these successes it is hoped that employment and productivity gains will flow over the longer-term. Whilst some short-term impacts are already visible in this direction their magnitude is limited at the current time. The true impact of EU R&D policies though should be measured in terms of building a European Research Area and strong successes are visible in this area.

At the EU level the Framework Programmes are having a significant influence on stimulating the development of a European Innovation System through promoting linkages between researchers and companies located across the Union. These networks are actively stimulating knowledge exchange and innovation within their membership, with positive effects reported in home regions. EU R&D policy is making a strong contribution to building both individual skills and experience and to 'raising the game' of individual companies and organisations. The potential that these transnational networks offer in terms of wider spillover effects within home regions is substantial. However, current evidence suggests that the effects of this are in practice more limited.

Within individual regions the Structural Funds are also having significant impacts in raising absorptive capacity. They are achieving this through investing in knowledge infrastructures, improving the institutional frameworks for R&D and innovation in regions and through stimulating intra-regional knowledge exchange by supporting the development of networks of firms and their linkages with research bodies, such as universities. The raising of absorptive capacity has demonstrably succeeded in increasing the ability of particular less-favoured regions to participate more fully in EU and national R&D policy actions and so helps to achieve the wider spatial objective of encouraging territorial cohesion.

The detailed picture is, however, complex and demonstrates the distance that we have to go. In the case of the Framework Programmes the 3rd Cohesion Report recognises that Cohesion Countries accounted for around 17% of project participations in the 15 months to March 2003, equivalent to their share of the EU population and up from 16% in 2001. However, when the 3rd Cohesion Report turned to participation amongst all Objective 1 regions it found that half of all the projects were located in 8 of the 64 eligible regions.

Whilst the overall impact that EU R&D policies have had on the territorial balance of the European Innovation System is admittedly limited it would be wrong to underestimate the gains that have been made. EU R&D policies have contributed to the development of stronger innovation systems in a number of less-favoured regions where the innovation systems were previously weak. The spatial balance of EU R&D policies is also supportive of spatial objectives such as the promotion of territorial cohesion, although, this has to be balanced with what is sometimes seen as a competing objective of stimulating the competitiveness of the EU economy as a whole.

What emerges most strongly from the study is the importance of the governance of the R&D system and particularly the focus of national and regional policy making. Where governance arrangements have been supportive of R&D activities stronger gains tend to have been made than where they are less supportive. Equally, the strengthening of governance arrangements through EU funded interventions, particularly the RIS/RITTS programme of actions, have demonstrably reaped benefits where the regional governance arrangements were receptive. Whilst EU policies can put initiatives and support mechanisms in place to stimulate R&D across the EU, and can encourage the development of R&D capacity in less-favoured regions, a concerted partnership is required between EU, national and regional actors if the benefits of this are to be realised.

A second lesson that has also emerged from the study is the complementary nature of the actions being instigated through the Framework Programmes and the Structural Funds. Yet, our case study analysis suggests, that practical integration of complementary measures through regional innovation strategies is the exception rather than the norm. This is unfortunate and a point that we develop further in our policy recommendations.

Overall, the impact of EU R&D policies is being most strongly felt in the increases in R&D capacity, which are occurring in many regions, and the engagement of less favoured regions in the European research space. Whilst we can argue strongly that EU R&D policies have had a positive impact on levels of engagement with research and innovation across the Union, the quantified results of this are harder to define. At one level this is because the immediate employment impacts of actions in these areas are very limited, they are an investment in the future. At another level it is because it is unrealistic to expect to see major impacts on indicators such as levels of R&D expenditure and levels of patent applications in the short-term, let alone on higher macro-economic indicators. The pursuit of territorial cohesion is a long-term goal and whilst we are moving in the right direction it is unrealistic to expect regions to 'catch-up' by virtue of their R&D programmes – let alone EU R&D programmes – although all can make a positive contribution.

8.2 Conclusions on the territorial impact of EU R&D policies

EU R&D policies are operating through two specific policy instruments: the Framework Programmes and the Structural Funds. These two instruments have distinctive objectives and so operate in two very different ways. However, we find that they are symbiotic in their efforts to develop the European Research Area46 as a territorial concept. This is apparent at two – interconnected and interdependent - levels:

- The widening of the European research space, and
- The strengthening of regional R&D capacity

[46] The European Research Area – as an objective of the Lisbon agenda – recognises the importance of the regional dimension of research and innovation within the European Union. It confronts the challenges of developing the research and innovation capacity of the EU as a whole. In seeking to provide a territorial dimension to the ERA – where different geographies are explicitly recognised - we might usefully speak of the European Research Space in order to avoid terminological confusion. In the remainder of this paper we refer to the European Research Area where we are speaking of the scope of the area where research might take place (conceivably the whole of the European Union) and to the European research space when we are speaking of where research actually takes place in practice.

Without widening and deepening the European Research Area the EU is unlikely to achieve its goals as set out in the Lisbon strategy. Without strengthening the capacity of individual regions the EU will not be able to widen or deepen the European Research Area. But the EU cannot strengthen the absorptive capacity of individual regions without also stimulating leading-edge excellent research. Balancing these interlocking objectives must be at the heart of any effort to promote territorial cohesion. Looking at the two bullet points in turn.

The Framework Programmes are contributing in a significant manner to the widening of the European research space. Whilst there is a recognised concentration of R&D activity in the core of the EU and the northern periphery the Framework Programmes provide a mechanism for institutions and enterprises in less-favoured regions to participate in high-level European research projects. This is evidenced by the disproportionately higher participation of organisations based in less-favoured regions in Framework Programme projects, allowing for factors such as GDP and R&D expenditure.

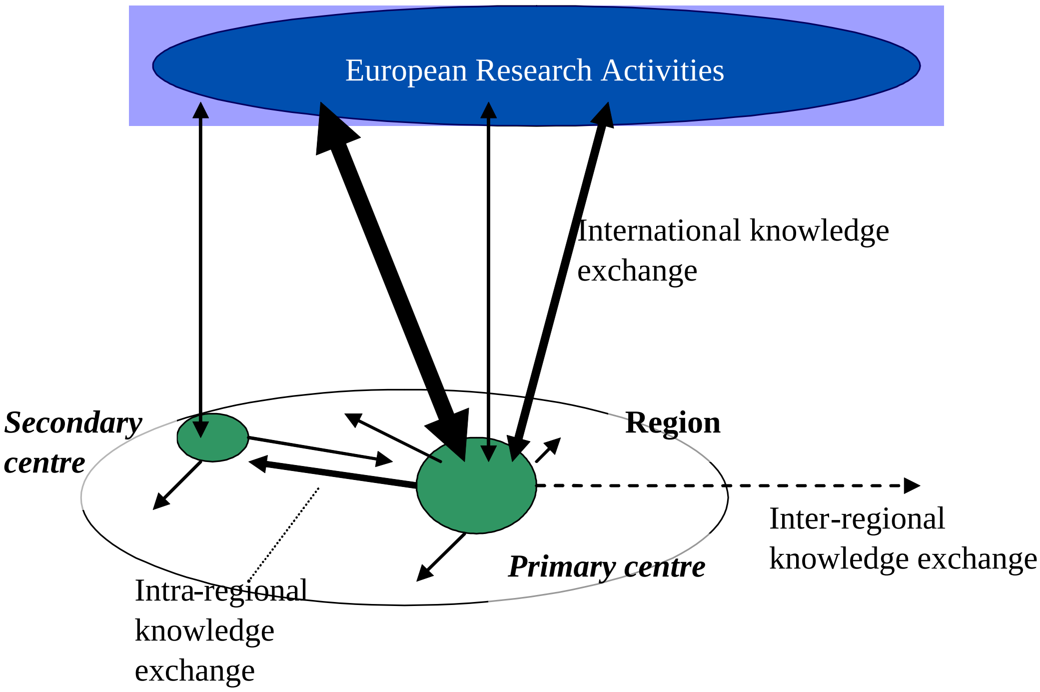
The Structural Funds make their own significant contribution to the widening of the European research space in that they provide a means by which regions are able to develop their capacity to participate in European-level research and innovation activities. Through stimulating the development of research and innovation capacity within less-favoured regions the Structural Funds are assisting firms and institutions within regions to take part in the Framework Programmes and so build their connections into the European Research Area in a very practical sense.

The second level at which this symbiosis can be seen is in the development of regional capacity for research and innovation. The important role of the Structural Funds in building this capacity has been well documented. Equally important is the role of the Framework Programmes in supporting projects that bring new knowledge and experience into a region so contributing to the building of future research and innovation capacity. In so far as the Framework Programmes are disproportionately benefiting less-favoured regions across the ERA then this will be having a positive impact on the development of the European research space.

However, we have noted that the benefits of Framework Programme participation are often highly concentrated within regions, and that the knowledge may be principally retained by the project participants themselves. Here again the Structural Funds can play an important role in developing the European research space through their actions to develop intra-regional networks and dissemination vehicles.

In essence we can view the combined territorial effects of EU R&D policies as firstly helping to build the capacity of places (centres) to undertake R&D activities, secondly stimulating the connections between these places and the Euroepan (and global) research arena and, thirdly, promoting knowledge spillovers that will continue to build research and innovation capacity within the region. This can be represented in the following schematic manner (Figure 8.1).

Figure 8.1 Schematic representation of role of EU R&D policies in territorial development



One of the key findings of our work has been the importance of the governance dimension in realising the opportunities that are available. EU R&D policies have to be used in a strategic manner if the potential territorial impacts are to be realised. Our case study evidence highlights the importance of taking a strategic approach to this and the valuable roles that EU R&D policies have also played in introducing, promoting and spreading examples of good practice around the Union. This in itself has played an important role in helping regions to engage more strongly in research and innovation activities and contributes to the expansion of the European research space.

If we take the widening of the European research space to mean the macro-scale referred to in the ESPON studies and the strengthening of the capacity of individual region's to undertake research and innovation to be the micro-scale then what of the meso-scale? As we have identified this is perhaps the forgotten territorial dimension of EU R&D policies. Is it important?

One means of looking at the meso-scale has been to consider territorial disparities within Member States. As we have identified, the effects of EU R&D policies on the balance of activities at this level tends to depend upon the focus of national policy. In some case EU policies have reinforced regional disparities within Member States in others they have helped to reduce their incidence. As EU R&D policy is an area of shared competence with Member Governments this is an area where EU R&D policy instruments themselves can have only limited influence.

The second means of looking at the meso-scale is as a description of trans-national areas within the EU. At present, this is most closely represented by the areas which form the basis of INTERREG III Community Initiative Programmes, such as the Baltic Sea programme area and the North West Europe programme area. This is an area where the EU does have competence.

At present this meso-scale does not feature strongly in EU R&D policies. However, as the ESDP has the objective of developing alternative Global Integration Zones across the European space it becomes a relevant area for our analysis. In terms of the distribution of participation in the Framework Programmes and investment through the Structural Funds there is no area of the EU where a strong overlap is occurring. There is no reason why this should overlap should occur as it is not an objective of either policy instrument. Analysis of the distribution of EU R&D policy actions, coupled with territorial strengths and weaknesses in the field of research and innovation suggest that potential areas that might form the focus of trans-national groupings include the northern periphery (including the Baltic New Member States), the south west of Europe (Portugal, Spain and south west France) along with a Mediterranean arc incorporating southern France and the north and central Italy. A trans-national approach might also consider the merit of identifying a western core (approximating to the old Central Capitals Region and including Ireland) and an eastern core (including Germany, Austria and parts of Hungary, Slovakia, Slovenia and the Czech Republic).

Whether EU R&D policies should be seeking to develop trans-national areas of the European space is, though, a political question. From the perspective of research and innovation capacity (and activity) within the EU there are good reasons to encourage such areas where they are able to establish connections between actors in constituent regions that are greater than the sum of the individual parts. This may be due to a common culture, the ability to develop a critical mass of infrastructure, sectoral specialisation (such as trans-national clusters), high-level skills and experience or other factors. There is already some evidence of actors establishing cross-border co-operation arrangements, although only limited examples of this are available from our case-study analysis.

8.3 Policy Recommendations

We group our policy recommendations under three headings: those relating to the macro-scale of widening and deepening the European Research Area (developing the European research space); those related to the micro-scale of strengthening the research and innovation capacity of the EU's regions and those relating to the meso-scale of – potentially - strengthening identified trans-national research areas within the EU as a contribution to developing alternative Global Integration Zones. These are not separate objectives. They are deeply inter-connected and there is, naturally, some overlap in the recommendations for each scale owing to the symbiosis and inter-dependencies identified earlier.

8.3.1 Macro-scale - widening and deepening the European Research Area

The Framework Programmes should continue to focus on supporting the development of excellent research. They should continue to encourage firms and research organisations in less favoured regions to engage with these high-level research activities. These networks form conduits for knowledge exchange which boost the absorptive capacity of less-favoured regions. Together they form a functioning European Research Area. Care must be taken not to downgrade the quality of the research and innovation effort in pursuit of alternative objectives. This will not support the territorial development of the European Union in the long run.

The Structural Funds should continue to focus on strengthening the absorptive capacity of regions where this is currently underdeveloped. They should provide the means by which less-favoured regions are able to access the benefits of participating in the Framework Programmes over time. This might form one measure of regional success. This is a long-term effort and the multi-annual programmes of the EU provide a very positive framework in which this can occur.

The European Research Area will not realise its potential without a significant expansion in the level of business engagement in R&D activity. This is an accepted fact. We recommend that EU R&D policies should seek to encourage private sector participation in research and innovation activities. Constraints to engagement should be addressed and the capacity of regions with low levels of private sector activity particularly considered. The widening and deepening of the European Research Area will only occur once private sector engagement in research and innovation is more evenly distributed across the EU territory. There is a role here for both the Framework Programmes and the Structural Funds. Again this is a long-term aim, but one which must start immediately.

As a staging post towards securing the greater involvement of the private sector in R&D and innovation activities EU R&D policies should seek to energise the potential of Higher Education Institutions and public research and technology institutions within less-favoured regions. These can provide an important base for widening and deepening the European Research Area. We recommend that actions in this area are complemented by interventions to generate stronger knowledge spillovers from these actors.

One of the constraints to further widening and deepening the European Research Area is the concentration of high level research infrastructure in a limited number of regions. We recommend that EU R&D policies should continue to support the development of high-quality knowledge infrastructure across the Union. This is particularly relevant to the Structural Funds, which provide the means for this to occur.

We recommend that deeper studies are undertaken to establish the lessons that can be learnt from the different patterns of regional participation in different aspects of EU R&D policies. In particular we recommend further research in the case of Greece, Ireland and Spain. All demonstrate strong positive - but different - lessons in terms of the application of the Structural Funds or participation in the Framework Programmes.

8.3.2 Micro-scale - strengthening the research and innovation capacity of the EU's regions

As we have stressed the particular strengths of the Structural Funds and the Framework Programmes provide a solid base for building regional capacity in research and innovation. We recommend that these two strands of EU R&D policies maintain their focus on their individual and specific objectives within the overall context of developing the European Research Area.

That said, there is much to be said for harnessing the opportunities each offers and the advantages of this has been clearly demonstrated through the case study work for this study. We recommend that regional strategies seek to integrate all aspects of EU R&D policies in an explicit and complementary manner, working together to develop the absorptive capacity of the region.

At the regional level EU R&D policies should continue to:

- Seek to build the knowledge infrastructure of the region, in particular to use this as a means to access European knowledge networks rather than as an end in itself
- Seek to strengthen the knowledge and expertise available for research and innovation, in order that individuals can participate in European knowledge networks
- Seek to stimulate spillovers from high-level research actors, in order that participation in European knowledge networks brings benefits to the rest of the region and builds the capacity of others to then engage with European knowledge networks
- Seek to develop the ability of SMEs and large private enterprises to engage in research and innovation and to increase their levels of activity here

In seeking to spread good practice in strengthening regional innovation systems and building connections to the wider European innovation system the value of the work done by EU R&D policy in stimulating governance arrangements should be fully recognised. We recommend that EU R&D policies continue to support the strengthening of the governance arrangement for R&D policies within the regions of Europe. We recommend that one means of doing so would be to strengthen the mechanisms for the sharing of good practice between regions, in the same way as firms and research enterprises have benefited from knowledge exchange through pan-European networks.

We are clear in this study that there is scope for a stronger integration of EU Framework Programmes and Structural Fund actions on the ground, working alongside domestic policies. The mechanisms are available for this to occur, it is for the relevant authorities at a regional level to determine how best this can best be achieved. One area where the mechanism for stronger integration is in place but there has been little take up is the possibility of using Structural Funds monies, in areas eligible for support under Objective 1, to partly co-finance projects which are supported by the 6th Framework Programme. We include a special consideration of this here owing to a request to do so by the Monitoring Committee.

We have been unable to find evidence of this facility being used to any extent across the EU to date, and the evidence provided by Member States suggests that this reflects the lack of activity in this area. Given the importance attached to funding research projects in Objective 1 regions this appears a little surprising. We recommend that a detailed study is made of this particular arrangement. We do so for 3 reasons:

- Firstly, it may be that the arrangement is not being used owing to a lack of awareness of the facility.
- Secondly, it may be that the arrangement is not being used because there is no demand for the facility.

- Thirdly, it may be that the arrangement is not being used because the facility is complicated to access.

A priori, it would seem that such a facility should serve a valuable function in that it would help connect regions to European research networks and encourage higher levels of participation in the Framework Programmes from less-favoured regions. The facility not only recognises that partners in Objective 1 regions may find it difficult to raise the 50% co-finance required for shared cost projects under the Framework Programmes but it also 'levels the playing field'. In the absence of this facility researchers may be tempted to simply seek research funds directly from the Structural Fund owing to the higher rate of grant available. Not only might this lead to the duplication of research efforts across the Union but it will also reduce the connections of these researchers to European knowledge networks, as provided by Framework Programme projects. This will serve to reduce the overall benefits potentially available to the regional economy.

Given the impending agreement of the regulations governing the Structural Funds and the Framework Programmes we recommend a short focused study aimed at identifying which of the three scenarios is correct, or whether there are indeed other factors at play.

8.3.3 Meso-scale - strengthening identified trans-national research areas within the EU

In the context of an enlarged European Union we recommend that greater attention is given to the challenges, and opportunities, that identified trans-national areas face. This is an area where the EU has an important competence that is currently underplayed.

On balance we see the strengthening of the research and innovation capacity of the meso-scale as the responsibility of the Structural Funds, in the same way as it is the Structural Funds that are best placed to strengthen the capacity of individual regions. The Framework Programmes are focused on supporting the excellence of European research, within that overall objective they are providing a valuable role in widening the European research space and bring knowledge and expertise into regions which might otherwise not have access to this. They can perform a similar role in terms of developing the meso-scale within the EU.

We recommend that the development of trans-national capacity in research and innovation is fully incorporated as an explicit objective in the reform of the Structural Funds. We recommend that this forms a key element of the proposed trans-national co-operation strand.

If strengthening the meso-scale is a desirable objective then the importance of the governance dimension cannot be stressed strongly enough. This is presently a missing dimension and actions on the ground will remain ad hoc and fragmented unless there is a shared strategic framework within which they can be set. This has been clearly demonstrated in the context of regional innovation systems and there is no reason to doubt that the same is not true at the trans-national level.

Widening and deepening of the European Research Area is dependent on the continuing development of high-level research infrastructures, as we have identified. We recommend that this is done within the context of trans-national strategies, such as those currently developed for INTERREG IIIB programme areas.

Associated with this should be actions to secure more trans-national co-operation and learning between regions in ways that encourage the complementary use of the different instruments of EU R&D policies to promote both the widening of the European research space and the on-going development of the European Research Area.

Annexes

Annex 1: References and Bibliography

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Annex 2: Action taken to address gaps in EUROSTAT data and responses received.

Country	Data Requested	Contacts (Date)	Data received directly	Comment
Austria	• More recent regional R&D data (latest available was 1998) • HRSTC NUTS II • CIS-3 data	Statistics Austria (11/07/2003)	None	Official reply received on 12/08/2003 stating that the latest available data from an R&D survey date back to the year 1998. As such, no more recent data is available. Regarding CIS-3 data, the office indicated that due to a high non-response rate and "a rather low quality of the responses", Statistics Austria has not estimated innovation expenditure even on a national level"
Belgium	• Regional R&D expenditure and personnel • HRSTC NUTS II • CIS-3 data	*Service de la Production et de l'analyse des indicateurs de R&D*, BELSPO (11/07/2003)	CIS-3 data at national level (16/07/2003) Updates for 2001 of R&D expenditure data (30/09/2003)	Official reply received on 15/07/2004. No NUTS II R&D data is produced in Belgium. BES, GOV and PNP data are produced at NUTS I, but HES (and thus Total) is not available. This is because education falls under the responsibility of the Communities, not the Regions, which makes it impossible to produce consistent regional data.
Denmark	• More recent regional R&D data (latest available was 2000) • HRSTC NUTS II • CIS-3 data	Statistics Denmark (11/07/2003)	None	Reply received on 21/07/2003 stating the R&D expenditure data for 2001 and CIS-3 data is available at national level (NUTS II).

Country	Data Requested	Contacts (Date)	Data received directly	Comment
Finland	• More recent regional R&D data (latest available was 1999) • HRSTC NUTS II • CIS-3 data	Statistics Finland (11/07/2003)	Raw Regional R&D expenditure data for 2000 and 2001 Regional CIS-3 data (14/07/2003)	Regional CIS-3 data is available in Finland, a rarity in the EU.
France	• More recent regional R&D data (latest available was 1999) • HRSTC NUTS II • CIS-3 data	INSEE *Observatoire des sciences et des techniques* (OST) (11/07/2003)	None	Reply received on 18/07/2003. The OST was unable to provide any of the data requested. INSEE stated that they supply their most up to date information to EUROSTAT and that data should be obtained from EUROSTAT to ensure comparability of datasets.
Germany	• More recent regional R&D data (latest available is 1999) • HRSTC NUTS II • CIS-3 data	Federal Statistics Office (11/07/2003)	None	It was not possible to obtain more recent regional R&D data at the time of our request. No reply was received regarding CIS-3 data.
Greece	• More recent regional R&D data (latest available is 1999) • HRSTC NUTS II • CIS-3 data	General Secretariat of National Statistical Service of Greece (11/07/2003)	None	It was not possible to obtain more recent regional R&D data. No answer was obtained regarding CIS-3 data.

Country	Data Requested	Contacts (Date)	Data received directly	Comment
Ireland	• R&D expenditure NUTS II • R&D personnel • HRSTC NUTS II • Tertiary Education NUTS II • CIS-3 data	Central Statistics Office (CSO) Forfas (11/07/2003)	None	Following initial enquiries and follow-up, it emerged that comparable regional data (NUTS II) is not published for the indicators requested and thus not available to the project. (Mail from CSO - 14/08/2003). .
Italy	• More recent regional R&D data (latest available was 1999) • HRSTC NUTS II • CIS-3 data	Istat - *Istituto Nazionale di Statistica* (11/07/2003)	Regional R&D expenditure and personnel data for 2000 (15/07/2003)	Our request was forwarded to other members of staff within ISTAT, but no further responses were received regarding CIS-3 or HRSTC data.
Luxembourg	• More recent R&D data • HRSTC NUTS II • CIS-3 data	STATEC (11/07/2003)	Publication containing available R&D data (25/07/2003)	STATEC confirmed that R&D data for before 2000 are not available, as data was not produced. It was not possible to obtain CIS-3 data.
Netherlands	• More recent regional R&D data (latest available is 1999) • HRSTC NUTS II • CIS-3 data	Statistics Netherlands (11/07/2003)	Hyperlinks to R&D expenditure per province for 2000 (21/07/2003)	CIS-3 data were not available at the time of the request and more recent R&D personnel data (than that in REGIO) and HRSTC were not available.

Country	Data Requested	Contacts (Date)	Data received directly	Comment
Portugal	• More recent regional R&D data (latest available was 1999) • HRSTC NUTS II • CIS-3 data	*Observatório da Ciência e do Ensino Superior* (OCES) National Statistics Institute (INE) (11/07/2003)	Raw R&D expenditure data up to 2001 (31/07/2003)	Reply received from OCES on 31/07/2003. They were unable to provide regional R&D expenditure as a percentage of GDP as regional GDP figures had not been validated. Innovation data could not be supplied as it still had to be validated by Eurostat.
Spain	• More recent R&D expenditure data (latest available was 1999) • HRSTC NUTS II • CIS-3 data	*Instituto Nacional de Estadistica* (INE) (11/07/2003)	Links provided to data on INE website (R&D data for 2000, 2001) (22/07/2003)	Reply received from INE on 15/07/2003. The R&D expenditure and personnel data available on the website could be used to calculate indicators and update the database. No HRSTC or CIS-3 data was available.
Sweden	• Regional R&D expenditure data • HRSTC NUTS II • CIS-3 data	Statistics Sweden (11/07/2003)	National R&D expenditure data (16/07/2003)	Reply received on 17/07/2003 stating that "No regional data on R&D expenditure are available for Sweden". The CIS-3 data could not be provided directly, but had been sent to EUROSTAT. It is not clear whether regional CIS-3 data is produced for Sweden.
UK	• Regional R&D expenditure data • R&D personnel data • HRSTC NUTS II • CIS-3 data	Office for National Statistics (ONS) Department of Trade and Industry (DTI) (11/07/2003)	Regional CIS-3 data (NUTS I) received from DTI (30/07/2003)	R&D personnel data for all sectors are not available in the UK and R&D expenditure data is not collected by the level of NUTS I (Government Office Regions). The UK, along with Finland was able to supply regional CIS data.

Country	Data Requested	Contacts (Date)	Data received directly	Comment
Bulgaria	• Latest R&D expenditure and personnel data at regional level	National Statistical Institute (14/03/2003)	None	A reply was received on 25/03/2003. Regional data was available at the time of the request, but payment was required. Recent regional R&D data were subsequently obtained from the REGIO database update.
Cyprus	• Latest R&D expenditure and personnel data	Statistical Service of Cyprus (11/07/2003)	None	No reply received.
Czech Republic	• Latest R&D expenditure and personnel data at regional level	*Český statistický úřad* (14/03/2003)	None	A reply was received on 21/03/2003. Regional data was available at the time of the request, but not obtained directly. Recent regional R&D data were subsequently obtained from the REGIO database update.
Estonia	• Latest R&D expenditure and personnel data • Regional data (if available)	Statistical Office of Estonia (14/03/2003)	None	The national level is considered the most appropriate level of analysis for Estonia. The Statistical office considers the production of regional (NUTS III) data to be of limited value. Recent (2000) Estonian R&D data were subsequently obtained from the REGIO database update
Hungary	• Latest R&D expenditure and personnel data at regional level	Hungarian Central Statistical Office (14/03/2003)	None	A reply was received on 21/03/2003. Regional data was available at the time of the request, but payment was required. Recent regional R&D data were subsequently obtained from the REGIO database update.

Country	Data Requested	Contacts (Date)	Data received directly	Comment
Latvia	• Latest R&D expenditure and personnel data • Regional data (if available)	Central Statistical Bureau of Latvia (14/03/2003)	National (= NUTS II) R&D data received (20/03/2003)	Data supplied incorporated into database
Lithuania	• Latest R&D expenditure and personnel data • Regional data (if available)	Statistics Lithuania (14/03/2003)	National (= NUTS II) R&D data received (24/03/2003)	Data supplied incorporated into database
Malta	• Latest R&D expenditure and personnel data	National Statistics Office (11/07/2003)	None	At the time of our request, according to telephone conversations, R&D statistics were available for Malta. This situation may have changed subsequently, but no mention is currently made of this on the NSO website.
Poland	• Latest R&D expenditure and personnel data at regional level	Polish Statistical Office (14/03/2003)	None	No reply received, but recent regional R&D data were subsequently obtained from the REGIO database update.
Romania	• Latest R&D expenditure and personnel data at regional level	*Institutel National de Statistica* (14/03/2003)	None	No reply was received to our request for information, despite follow up. No regional level R&D data is available for Romania from EUROSTAT and to our knowledge such data is not produced.

Country	Data Requested	Contacts (Date)	Data received directly	Comment
Slovenia	• Latest R&D expenditure and personnel data • Regional data (if available)	Statistical Office of the Republic of Slovenia (14/03/2003)	None	No reply received, but recent R&D data were subsequently obtained from the REGIO database update.
Slovakia	• Latest R&D expenditure and personnel data at regional level	Statistical Office of the Slovak Republic (14/03/2003)	None	Reply received initially on 28/03/2003, but not subsequent reply. Recent regional R&D data were subsequently obtained from the REGIO database update
Switzerland	• R&D Expenditure • R&D Personnel • High Tech Manufacturing Employment • High Tech Services Employment • Tertiary Education	Federal Statistical Office (17/07/2003)	R&D expenditure and personnel at national level (17/07/2003) Employment by sector (18/07/2003) % of working age population with tertiary education (Level 0/1 and 2) (12/08/2003)	Confirmation was provided by email on 18/07/2004 that regional (level 2) data for R&D employment and personnel are not produced in Switzerland. The Employment data by sector provided proved to be incompatible with that used for other countries, so was not included in the database.

Country	Data Requested	Contacts (Date)	Data received directly	Comment
Norway	• R&D Expenditure • R&D Personnel • High Tech Manufacturing Employment • High Tech Services Employment • Tertiary Education	Statistics Norway (11/07/2003)	None	No reply was received to our email to Statistics Norway. No regional R&D statistics are available from their website and at the time of requests, relevant staff were on holiday.

Annex 3 Proxy data used in typology development

Proxy Data used for EPO Patent Applications (Per million - population)

UKC	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKD	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKE	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKF	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKG	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKH	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKI	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKJ	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKK	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKL	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKM	United Kingdom	NUTS 2 data (aggregated average) - 2000
UKN	United Kingdom	NUTS 2 data (aggregated average) - 2000

Proxy Data used for EPO Patent Applications (Per million - population)

BE	Belgique-België	NUTS 1 data (average for the regions)
ES43	Extremadura	Average used as a proxy from ES41 and ES42
ES62	Région de Murcia	Proxy used - ES61
FR63	Limousin	Average used as a proxy from FR61 and FR62
FR83	Corse	Average used as a proxy from FR81 and FR82
GR11	Anatoliki Makedonia, Thraki	NUTS 1 data - proxy from 1999
GR13	Dytiki Makedonia	NUTS 1 data - proxy from 1999
GR14	Thessalia	NUTS 1 data - proxy from 1999
GR22	Ionia Nisia	NUTS 1 data - proxy from 1999
GR24	Sterea Ellada	NUTS 1 data - proxy from 1999
GR25	Peloponnisos	NUTS 1 data - proxy from 1999
GR41	Voreio Aigaio	NUTS 1 data - proxy from 1998
GR42	Notio Aigaio	NUTS 1 data - proxy from 1998
GR43	Kriti	NUTS 1 data - proxy from 1998

IT72	Molise	Proxy used - IT71
ITB	Sardegna	Proxy used - all Italia

Proxy Data used for Employment in High and Medium Tech Manufacturing

ES43	Extremadura	Average used as a proxy from ES41 and ES42
FR83	Corse	Average used as a proxy from FR81 and FR82
GR13	Dytiki Makedonia	NUTS 1 data - proxy from 2000
GR21	Ipeiros	NUTS 1 data - proxy from 2000
GR22	Ionia Nisia	NUTS 1 data - proxy from 2000
GR41	Voreio Aigaio	NUTS 1 data - proxy from 1997
GR42	Notio Aigaio	NUTS 1 data - proxy from 1997
GR43	Kriti	NUTS 1 data - proxy from 1997
IT12	Valle d'Aosta	Average used as a proxy from IT11 and IT13
PT14	Alentejo	Average used as a proxy from PT11 and PT13
PT15	Algarve	Average used as a proxy from PT11 and PT13

Proxy Data used for Human Resources in Science and Technology (core)

IT11	Piemonte	Average used as a proxy from IT12 and IT13

Proxy Data used for Employment in High Technology Services sector

DEE1	Dessau	Average used as a proxy from DEE2 and DEE3
ES22	Comunidad Foral de Navarra	Average used as a proxy from ES21 and ES24
ES23	La Rioja	Average used as a proxy from ES21 and ES24
FR83	Corse	Average used as a proxy from FR81 and FR82
GR11	Anatoliki Makedonia, Thraki	NUTS 1 data - proxy from 2000
GR13	Dytiki Makedonia	NUTS 1 data - proxy from 2000
GR21	Ipeiros	NUTS 1 data - proxy from 2000
GR22	Ionia Nisia	NUTS 1 data - proxy from 2000
GR24	Sterea Ellada	NUTS 1 data - proxy from 2000
GR41	Voreio Aigaio	NUTS 1 data - proxy from 2000
GR42	Notio Aigaio	NUTS 1 data - proxy from 2000
IT12	Valle d'Aosta	Average used as a proxy from IT11 and IT13

IT72	Molise	Proxy used - IT71
IT92	Basilicata	Average used as a proxy from IT91 and IT92
NL34	Zeeland	Average used as a proxy from NL31, NL32 and NL33
PT14	Alentejo	Average used as a proxy from PT11 and PT13
PT15	Algarve	Average used as a proxy from PT11 and PT13

Annex 4: Regional classifications by typology

The table gives cluster membership per region for the Z-score typology and both the K-means clusters and the 3[rd] cluster analysis generated using Genstat.

		K—means Cluster 1	**K—means Cluster 2**	**Z-scores**	**Cluster 3**
at11	Burgenland	1	1	1	4
at12	Niederösterreich	1	1	1	4
at13	Wien	3	2	5	3
at21	Kärnten	3	1	1	3
at22	Steiermark	3	1	2	4
at31	Oberösterreich	3	1	1	4
at32	Salzburg	1	1	1	4
at33	Tirol	1	1	2	4
at34	Vorarlberg	3	1	1	4
be1	Bruxelles/Brussels	2	4	.	.
be2	Vlaams Gewest	2	4	.	.
be3	Région Wallonne	2	2	.	.
de11	Stuttgart	5	5	5	5
de12	Karlsruhe	5	5	5	3
de13	Freiburg	4	3	3	3
de14	Tübingen	5	4	5	3
de21	Oberbayern	5	5	5	1
de22	Niederbayern	3	3	2	3
de23	Oberpfalz	4	3	3	5
de24	Oberfranken	3	3	2	2
de25	Mittelfranken	5	3	5	5
de26	Unterfranken	4	3	3	2
de27	Schwaben	4	3	3	3
de3	Berlin	2	4	5	3
de4	Brandenburg	2	2	2	2
de5	Bremen	3	2	4	4
de6	Hamburg	2	2	4	2
de71	Darmstadt	5	5	5	3
de72	Gießen	3	3	5	3
de73	Kassel	3	3	3	2
de8	Mecklenburg-Vorpommern	1	1	2	2
de91	Braunschweig	5	4	5	3
de92	Hannover	4	2	5	3

		K–means Cluster 1	K–means Cluster 2	Z-scores	Cluster 3
de93	Lüneburg	3	1	2	2
de94	Weser-Ems	3	1	.	4
dea1	Düsseldorf	4	3	.	2
dea2	Köln	4	3	5	3
dea3	Münster	3	3	.	2
dea4	Detmold	3	3	2	3
dea5	Arnsberg	3	3	2	2
deb1	Koblenz	3	2	.	.
deb2	Trier	.	.	.	.
deb3	Rheinhessen-Pfalz	5	5	.	.
dec	Saarland	3	1	2	4
ded1	Chemnitz	2	2	4	2
ded2	Dresden	2	2	5	3
ded3	Leipzig	2	2	4	2
dee1	Dessau	.	.	3	4
dee2	Halle	2	2	3	2
dee3	Magdeburg	2	2	2	2
def	Schleswig-Holstein	3	2	2	2
deg	Thüringen	2	2	2	2
es11	Galicia	1	1	1	4
es12	Principado de Asturias	1	1	1	4
es13	Cantabria	1	1	2	4
es21	País Vasco	2	2	5	2
es22	Comunidad Foral de Navarra	.	.	3	2
es23	La Rioja	.	.	2	4
es24	Aragón	3	2	2	4
es3	Comunidad De Madrid	2	2	5	2
es41	Castilla y León	1	1	2	4
es42	Castilla-la Mancha	1	1	1	4
es43	Extremadura	.	.	1	4
es51	Cataluña	3	2	2	2
es52	Comunidad Valenciana	1	1	1	4
es53	Illes Balears	1	1	1	4
es61	Andalucía	1	1	1	4
es62	Región de Murcia	1	1	1	4
es63	Ceuta y Melilla	.	.	.	.

		K–means Cluster 1	K–means Cluster 2	Z-scores	Cluster 3
es7	Canarias	1	1	1	.
fi13	Itä-Suomi	2	2	4	2
fi14	Väli-Suomi	2	2	5	2
fi15	Pohjois-Suomi	4	4	5	5
fi16	Uusimaa (suuralue)	5	4	5	1
fi17	Etelä-Suomi	4	4	5	5
fi2	Åland	.	.	.	.
fr1	Île De France	4	5	5	5
fr21	Champagne-Ardenne	1	1	1	4
fr22	Picardie	3	2	1	4
fr23	Haute-Normandie	3	2	2	4
fr24	Centre	3	2	2	2
fr25	Basse-Normandie	3	2	2	4
fr26	Bourgogne	3	2	2	4
fr3	Nord - Pas-De-Calais	1	1	1	4
fr41	Lorraine	3	2	2	4
fr42	Alsace	3	3	2	3
fr43	Franche-Comté	4	3	5	4
fr51	Pays de la Loire	3	2	2	4
fr52	Bretagne	2	2	.	3
fr53	Poitou-Charentes	1	1	1	4
fr61	Aquitaine	2	2	2	4
fr62	Midi-Pyrénées	2	2	5	2
fr63	Limousin	1	1	1	2
fr71	Rhône-Alpes	4	3	5	3
fr72	Auvergne	2	2	4	4
fr81	Languedoc-Roussillon	2	2	4	2
fr82	Provence-Alpes-Côte d'Azur	2	2	4	3
fr83	Corse	.	.	.	2
gr11	Anatoliki Makedonia, Thraki	.	.	.	4
gr12	Kentriki Makedonia	1	1	2	4
gr13	Dytiki Makedonia	.	.	.	4
gr14	Thessalia	.	1	1	4
gr21	Ipeiros	.	.	.	4
gr22	Ionia Nisia	.	.	.	4
gr23	Dytiki Ellada	1	1	1	4
gr24	Sterea Ellada	.	.	1	4
gr25	Peloponnisos	.	1	1	4
gr3	Attiki	1	2	2	4
gr41	Voreio Aigaio	.	.	.	4
gr42	Notio Aigaio	.	.	.	4
gr43	Kriti	.	.	.	4
it11	Piemonte	3	3	3	4

	K–means Cluster 1	K–means Cluster 2	Z-scores	Cluster 3
it12 Valle d'Aosta	.	.	.	4
it13 Liguria	3	1	2	4
it2 Lombardia	3	3	2	4
it31 Trentino-Alto Adige	1	1	1	4
it32 Veneto	3	1	1	4
it33 Friuli-Venezia Giulia	3	1	1	4
it4 Emilia-Romagna	3	3	2	4
it51 Toscana	1	1	1	4
it52 Umbria	1	1	1	4
it53 Marche	1	1	1	4
it6 Lazio	3	1	4	4
it71 Abruzzo	1	1	1	4
it72 Molise	.	.	1	4
it8 Campania	1	1	2	4
it91 Puglia	1	1	1	4
it92 Basilicata	.	.	1	4
it93 Calabria	1	1	1	4
ita Sicilia	1	1	1	4
itb Sardegna	1	1	1	4
lu Luxembourg (Grand-Duché)	2	2	4	2
nl11 Groningen	2	2	4	2
nl12 Friesland	1	1	1	4
nl13 Drenthe	.	.	1	4
nl21 Overijssel	3	2	2	2
nl22 Gelderland	2	2	4	2
nl23 Flevoland	3	1	3	2
nl31 Utrecht	2	2	5	3
nl32 Noord-Holland	2	2	5	2
nl33 Zuid-Holland	2	2	4	2
nl34 Zeeland	.	.	1	2
nl41 Noord-Brabant	5	3	4	1
nl42 Limburg (NL)	4	2	4	3
pt11 Norte	1	1	1	4
pt12 Centro (P)	.	.	1	.
pt13 Lisboa e Vale do Tejo	1	1	1	4
pt14 Alentejo	.	.	.	4
pt15 Algarve	.	.	.	4
pt2 Região Autónoma Dos Açores	.	.	.	.
se01 Stockholm	5	4	.	.
se02 Östra Mellansverige	4	4	.	.
se04 Sydsverige	5	4	5	.
se06 Norra Mellansverige	2	2	4	.
se07 Mellersta Norrland	2	2	.	.
se0 Övre Norrland	2	2	5	.

		K–means Cluster 1	**K–means Cluster 2**	**Z-scores**	**Cluster 3**
8					
se09	Småland med öarna	3	2	2	.
se0a	Västsverige	5	4	5	.
ukc	North East	3	2	3	4
ukd	North West	3	3	3	2
uke	Yorkshire & The Humber	3	2	2	2
ukf	East Midlands	3	2	2	2
ukg	West Midlands	3	3	3	2
ukh	Eastern	4	4	5	5
uki	London	2	2	5	3
ukj	South East	4	3	5	3
ukk	South West	3	3	5	3
ukl	Wales	2	2	2	2
ukm	Scotland	2	2	2	2
ukn	Northern Ireland	1	1	2	2

. due to missing data cluster membership could not be determined

Annex 5: Summary of responses provided by Member States to ESPON Co-ordination Unit in reply to ECOTEC's query regarding Co-Financing of Framework Programme Projects.

MC responses on 2.1.2 request to identify appropriate contacts in each MS to provide information on the use of Structural Funds in co-financing projects in Objective 1 areas, supported by the 6th EU Framework Programme for Research and Technological Development.

Czech Republic	There is no central evidence of the projects, where would Czech project partners participate. The MC member has asked the Technological centre of the Academy of sciences of the Czech republic, www.tc.cas.cz, which acts as the national information centre for the european research and also deals with the statistics about czech participation in the framework programmes. Their respond was as follows: “The Technological centre receives from time to time some databases from the EC, which include the information about the participants, costs and demanded contributions. However, ways of cofinancing the project by the participants are not included. They think that even EC does not have the evidence about the cofinancing of the projects. Nevertheless they think, that there is no project from the 6th EU Framework Programme, where would czech participants received subsidy from the Structural funds”.
Germany	For Germany the MC member was not able to give the information requested. They stressed the that that Germany does not a Mr. 6EUFP with a total overview, but only single units which are responsible for each priority of the 6EUFP, but not for all projects in it. Only the COM would be able to give exact figures to the co-financing of projects. Concerning the priority transport we can say that we haven't had projects of 6EUFP with a cofinancing by the Structural Funds. The MC members was also informed that one can not expect to find such cofinanced projects in the other priorites of the 6EUFP, because this cofinancing was heaviliy discussed and will be a novum of the 7. EUFP.
Spain	Apparently the use at the same time of both EU sources of funding, Structural Funds and R+D, is very rare. Moreover, information on this issue can only be find in the regional

	administrations. The MC member is still in the process of getting the appropriate contacts in each of the Objective 1 regions.
Switzerland	The following contacts were provided: Website addresses of the State Secretariat for Education and Research and of the SwissCore (Swiss Contact Office for Research and Higher Education) which are the appropriate contacts for delivering information resquested - State Secretariat for Education and Research: http://www.sbf.admin.ch/htm/international/europa/frp/eu-frp-e.html <http://www.sbf.admin.ch/htm/international/europa/frp/eu-frp-e.html> - SwissCore: http://www.iglortd.org/swisscore.htm <http://www.iglortd.org/swisscore.htm> Please note that Switzerland signed a Research agreement between Switzerland and the European Union valid since 1st January 2004.

ANNEX 6: TOWARDS A METHOD FOR THE TIA OF EU R&D POLICY

The aims of the assessment

The main focus of the ESPON projects is on the question of how spatial impacts and incidences of sector policies match with spatial and territorial development goals that have been formulated by the spatial planning ministers of the Member States and the European Commission. These are, broadly, set out in the ESDP and the 3rd Report on Economic and Social Cohesion. In the case of EU R&D policy, they are also contained in a series of Communications relating to the European Research Area (ERA), as referenced previously.

At the outset, it should be noted that many of these spatial objectives have been introduced subsequent to the policies themselves. Consequently, the analysis can assess incidence and impact, where visible, but should not be used to construe success or failure of the policies under consideration. It can, of course, offer pointers for future policy orientations in the design and implementation of EU R&D policies.

One of the primary objectives of the Terms of Reference is to develop methods for the territorial assessment to sectoral policies (in this case EU R&D policy). In addition, the Terms of Reference for this project identify four elements for special consideration:

- How far does the R&D (policy) address the emerging border and integration problems taking into account the variety of regions and the arriving enlargement? Does the R&D policy provide adequate accessibility in the regions of the EU and Europe?
- What spatial effects are expected in terms of current and future R&D policy?
- How far does the R&D policy support the concentration of development corridors, consider the concept of polycentric development, and which further spatial effects are emerging?
- How far does the R&D policy affect the spatial diffusion of innovation and knowledge in Europe?

We develop the methodology for undertaking this assessment in the following section.

The TIA Concept

The concept of Territorial Impact Assessment (TIA) has generated strong interest at a European scale since the term was introduced in the ESDP. The ESDP did not define what it meant by TIA, restricting itself to suggesting that this might be useful in the context of large infrastructure projects and when developing integrated strategies for the management of environmentally sensitive areas.

Work led by the UK Government[1] on behalf of the European Commission and the Member States has demonstrated the close links between TIA and other assessment frameworks, particularly Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA). It has also demonstrated that TIA is undertaken in practice in a number of Member States (Austria, Germany, Finland and Belgium among them) although techniques and approaches vary.

For our current purposes, we take the concept of TIA to mean a tool or procedure for assessing the impact of proposed spatial development activities against spatial policy objectives or prospects for an area. Present references to TIA have largely been in the context of assessing the impact of plans and projects. It is less often used in the context of assessing the impact of policies. It is primarily a tool for the ex ante assessment of proposed activities.

Building on the concepts of SEA we can see TIA as "the formalised, systematic & comprehensive process of evaluating the (territorial) impacts of a policy, plan or programme and its alternatives, the preparation of a written report of the findings, and the use of the findings in publicly-accountable decision making" (after Therivel et al., 1992). In a similar vein, we can use the terminology of the OECD to describe TIA as any defined process by which decision makers take account of potential territorial impacts during the formulation, revision or appraisal of plans, programmes or policies (OECD/DAC, 1997).

In considering the development of a robust methodology it is important to ensure that TIA becomes an effective tool for influencing the design of policies and programmes, and not a *post hoc* justification for actions already proposed. In practice it should be able to identify:

- the positive and negative territorial effects of a policy, plan or program, and
- the means to accentuate the positive effects, and reduce or avoid the negative ones.

It is important to stress that, like SEA, TIA should be seen as an aid to decision-making, rather than a decision-taking mechanism in its own right.

Approach to the assessment

The scope of the assessment is directed at the two principal instruments of EU R&D policy:

- The RTD Framework Programmes, (for a description please see Section 4.2)
- The Structural Funds, particularly the ERDF, (for a description please see Section 4.3).

[1] Territorial Impact Assessment: A submission to the Committee on Spatial Development (2000)

TIA can cover different scales and aspects of decision-making. In the case of the EU's R&D policies it is useful to consider this as a tiered approach, as Sadler and Verheem recognise in the context of SEA. This should seek to identify EU-scale (macro) effects; trans-regional (meso) effects and regional (micro) effects. In this manner we are also able to reflect the guidance offered by TPG 3.1.

Within the context of the Framework Programmes and the Structural Funds we need to distinguish between policies, programmes and projects. Each operates at a different scale.

The Framework Programmes represent policies and programmes that operate at a European scale. Trans-regional and regional effects largely occur through the incidence of projects. In contrast, the Structural Fund instruments set the policy context at the European level, which are translated into regional (and sectoral) programmes – with their own priorities and policy mix set in the context of the instruments, which in turn provide the framework for projects. We illustrate this in Table 43 below.

Table 1 Scale of Operation of Framework Programmes and Structural Funds

	EU-scale	***Trans-regional***	***Regional***
Framework programmes	Policies Programmes	Projects	Projects
Structural Funds	Policies	Policies Programmes	Programmes Projects

The TIA approach thus needs to differentiate between the assessment of both scale effects (e.g. EU-level effects) and other effects of policies, programmes and projects. We have not given strong consideration to assessing the territorial impact of individual projects within this study, although its importance is recognised in this methodology. Our analysis is based upon an aggregate assessment of where projects are located (ie the implementation of policies and programmes).

Whilst it would be possible to undertake a separate TIA of the two components of EU R&D policies (Framework Programmes and Structural Funds), it would be better to do both together. Key questions for assessment at the different scales are summarised in the table below:

Table 2 Key Questions for assessment

	EU-scale	***Trans-regional***	***Regional***
Key questions for assessment	How will the balance of R&D activity across the EU be affected by EU R&D policies?	Do EU R&D policies contribute to the development of successful inter-regional co-operation arrangements?	How will R&D activities be influenced within a region by the combination of EU R&D policies?

		Do these arrangements contribute to the development of complementary economic zones?	

In developing the TIA methodology we draw heavily on the accepted approaches developed for SEA. This consists of the following stages:

1. Listing the objectives of the policy or programme
2. Analysing the existing objectives for territorial development
3. Identifying the baseline conditions
4. Describing the measures contained in the policy or programme
5. Identifying other plans or programmes that may have an influence
6. Undertaking a cumulative impact assessment
7. Specifying feasible alternative policies and assessing their territorial effects
8. Identify measures to mitigate any undesirable consequences
9. Undertaking consultation
10. Recommendations towards an optimal approach
11. Monitoring arrangements and evaluation

(Adapted from Khadka, 1996 and World Bank Sourcebook Updates, 15 1996)

Many of the latter stages relate to the development of policies, plans or programmes following an initial impact assessment, as such they are of less interest to this study, although they should be seen as part of the overall methodology. In the development of tools and techniques for TIA, TPG 3.1 has provided a useful framework around which to order the proposed TIA methodology. In this they identify 6 key stages:

- Identification of the output to be registered, measured and appraised
- The types of indicators to be used
- The goals that are referred to
- How the analysis is to be performed
- What is the concept applied of ‘territorial’
- What do the results look like

We have taken this framework, together with elements of the more general approach already described to suggest the following approach:

1. Listing the spatial objectives (or goals) of the policy or programme;
2. Analysing the existing objectives (EU, trans-regional or regional) for territorial development;
3. Identifying the baseline conditions:
    a. Outputs to be registered;
    b. Indicators to be used;

4. Describing the measures contained in the policy or programme;
5. Identifying other plans or programmes that may have an influence;
6. Undertaking a cumulative assessment:
    a. Techniques to be used.

In the following section we outline the selected method for the territorial impact assessment of EU R&D policies, together with some alternative dimensions for further consideration.

Analysis

Stage 1: Identification of goals

The identification of goals, or objectives, should form the first step in any formal TIA. Without an identification of goals then the process of determining whether the results of a policy are negative or positive is much more complicated. The policy objectives of the ESDP, coupled with those which can be discerned in the Communication "The Regional Dimension of the European Research Area[2]" provide a guide in this respect.

It must be stressed that these are identified spatial objectives, these are not necessarily the primary goals of either the Structural Funds or the Framework Programmes. We assess this point in a little more detail under Stage 4.

EU Level Spatial Objectives

- Wide-ranging integration of knowledge-relevant policies, such as the promotion of innovation and research and technology development into spatial development policies, especially in remote or densely populated areas
- Fostering networking among companies and the rapid diffusion of innovations, particularly through regional institutions that can promote innovations
- Supporting the establishment of innovation centres as well as co-operation between higher education and applied R&D bodies and the private sector, especially in economically weak areas.
- Expansion of the strategic role of metropolitan regions and 'gateway' cities, giving particular attention to the development of peripheral regions of the EU
- Facilitating Objective 1 regions to take part effectively in collaborative research projects to develop their human S&T resources.
- To broaden the technological absorption and creative capacity of Objective 1 regions.

Indirectly EU R&D policy might also support the following objectives of the ESDP:

[2] COM (2001) 549 Final

- Strengthening a polycentric and more balanced system of metropolitan regions, city clusters and city networks
- Improvement of the economic basis, environment and service infrastructure of cities, particularly in economically less-favoured regions, in order to increase their attractiveness for mobile investment
- Support for the economic development of towns and cities in less favoured regions
- Strengthening small and medium-sized towns in rural areas as focal points for regional development and promotion of their networking

Trans-regional Spatial Objectives

- Strengthening of several larger zones of global economic integration in the EU, equipped with high-quality, global functions and services, including the peripheral areas, through trans-national spatial development strategies
- Strengthening co-operation on particular topics in the field of spatial development through cross-border and trans-national networks
- Promoting co-operation at regional, cross-border and trans-national level; with towns and cities in the countries of Northern, Central and Eastern Europe and the Mediterranean region; strengthening North-South Links in Central and Eastern Europe and West-East Links in Northern Europe

Stage 2: Identification of existing objectives for territorial development

There are two ways of looking at this Stage. In the case of the introduction of a new policy then existing policy objectives should be examined to assess whether these are complemented, duplicated or contradicted by the new policy's goals. In the case of assessing the implementation of a particular policy (such as those of the Structural Funds or the Framework Programmes) a similar assessment can be made.

In the current case, we examine the combined actions of the Structural Funds and the Framework programmes on common territorial goals. However, as we have previously identified, EU policies are only a small part of the total intervention by public bodies for support of R&D activities. The territorial dimension to these national or regional policies will have a strong influence over the territorial impacts of EU R&D policy.

In this analysis, we have not been able to undertake a comprehensive assessment of the territorial influence of these policies. To do so would require a resource allocation beyond that which has been available to the study team. We have been able to make a qualitative assessment to shed light on this issue and can deduce certain conclusions from the results of the assessment exercise. These have been used to inform the study's conclusions.

At a regional-level, it is, naturally, not possible to list the various goals that influence the implementation of EU R&D policies, for they can vary greatly. Any methodology for TIA adopted at the regional-level should identify these goals in order that regional-level effects can be assessed adequately. The analysis undertaken may shed light on where further consideration should be given at a regional scale.

It is appropriate at this stage to identify the relevant unit for territorial analysis. The methodology should stipulate the definition of the territorial areas concerned. This may be done statistically or might be considered in a qualitative manner, depending on the level of rigour required. The work undertaken for this study has demonstrated the difficulty of gathering data at a consistent territorial scale across the EU for a wide range of indicators. In some instances the appropriate scale of operation is NUTS 1 in others it is NUTS 2, occasionally it might be NUTS 3.

In this assessment of the effects of EU R&D policy, we have taken a pragmatic view based on NUTS 1 and NUTS 2 areas. In part this reflects the availability of data but is also a reflection of the scale of operation over which R&D players regard themselves as having influence. For example, in the UK, where NUTS 1 data has been used, the Regional Development Agencies (RDAs) operate at the NUTS 1 scale and 41% of Higher Education Institutes regarded this area as their priority for business interactions (with a further 40% reporting that they focused on an area as defined by themselves)[3].

Stage 3: Identifying the baseline conditions, including existing trends

Baseline analysis is an integral part of TIA. It is essential that we know what the current situation is, if we are to make an assessment of the potential effects of EU R&D policies. Specifying the baseline is, though, more complex in that it should focus on those areas that might be influenced by the objectives of the programme; or in themselves influence the achievement of objectives or incidence of policy activities.

The territorial outputs that we are interested in relate to the desired results of the R&D policies, namely:

- An increase in the capacity of regions to undertake R&D (measured in terms of infrastructure; personnel and (as a proxy) expenditure)
- Increasing the number of regions in Europe that contain leading research and innovation capacity
- Reducing disparities in levels of R&D activity between regions
- Promoting the transfer of knowledge from those regions that are generating high quality research outcomes to other parts of Europe

The range of indicators that are relevant in the case of assessing the effects of EU R&D policies are those that reflect R&D capacity and those that reflect the capacity of a region to undertake 'innovation'. The latter is an extremely difficult concept to quantify and any quantitative measures must, by necessity, be both proxies and indicative.

[3] DfEL et al 2004 Higher Education – Business Interactions Survey

Table 3 Indicators of R&D and Innovation Capacity

R&D Indicators	Indicators of "Innovative Capacity"
• R&D expenditures as a percentage of regional GDP (in millions of national currencies, in millions of euro, and as a percentage of gross domestic product) for the whole economy, for the business enterprise sector (BES), government sector (GOV), higher education sector (HES), and private non-profit sector (PNP); • R&D personnel as a percentage of the labour force, for the business enterprise sector (BES), government sector (GOV), higher education sector (HES), and private non-profit sector (PNP); • Employees with Tertiary level education working in a Science and Technology Occupation (HRSTC).	• Employment in High Technology and Medium High Technology Manufacturing as a percentage of total employment; • Employment in High Technology Services as a percentage of total employment; • Percentage of the Working Age Population (aged 24-65) having successfully completed some form of tertiary education. •

It would of course be valuable to measure R&D outputs as well as capacity. These can come in the form of Patents (for which a measure has been included as part of our core indicators); research publications; licensing agreements or 'spin-out' companies. However, gathering reliable data on these points is exceptionally difficult and so they are not considered further at this point.

Key objectives of EU R&D policy are not measurable by standard indicators. In particular this includes the strengthening of linkages between firms and between firms and universities. Equally, gathering data on the development of the research infrastructure across Europe tends to have to be done on a region by region basis: a significant undertaking when assessing the territorial affects of policy across Europe, unless activity is monitored on a common basis and the results of this exercise collated. This does not appear to be occurring with respect to some aspects of EU R&D policy.

Assessing the impacts of EU R&D policy, whether on firm formation rates, employment generated, output produced or incomes received, is methodologically very difficult, as highlighted earlier. The complexity of potential macro-economic modelling exercises is further increased by the need to distinguish between the effects of EU R&D policy and other interventions operated at a national or regional scale, such as R&D tax credits for example.

In developing a baseline, it can be helpful, where data quality allows, to use statistical techniques to order the data and capture the principal issues facing European regions. To this end, a number of techniques can be used including:

- Multi-criteria analysis
- Factor analysis
- Cluster analysis
- Comparative benchmarking or profiling of regions

At a regional level, the assessment of baseline conditions may be attempted in the same manner as at an EU-level or it can focus on specific objectives. In principle regional assessment may be more straightforward, as the data collection is a less costly exercise and can be informed by European averages. In addition, more qualitative data can be collected more simply as a basis for determining what actions are required to support the relative strengths or weaknesses identified for the region.

Stage 4: Describing the supported activities

Assessing the territorial effects of EU R&D policy requires an analysis of the particular measures that are included within the policy or programme. It is the combination, and application of, these measures that will translate into the territorial effects of EU R&D policy. The incidence of these activities will influence the overall territorial effects of these policies. The Fields of Intervention (FOI) identified as eligible for support through the ERDF provide a starting point for this activity, together with the various actions eligible for support through the Framework Programmes. We have also included considerations from pilot or innovative actions.

Spatial objectives are not necessarily the principal goals of the Framework Programmes, and R&D actions are merely part of the actions potentially supported through the Structural Funds. Consequently, an assessment needs to be made of the extent to which these actions support the different territorial goals or objectives of EU R&D policy. An indicative assessment of this is set out in Annex 7. From this base, it is possible to identify what effects might be present and require further exploration.

Stage 5: Identifying other influential plans and programmes

The territorial effects of EU R&D policies will also be influenced by the investment decisions of the public-sector, potentially set out in relevant plans and programmes, and those of the private-sector. The latter element is more difficult to assess on an *ex ante* basis, although levels of past investment may offer some guide as to the future.

On a region by region basis we have examined the influence of relevant plans and policies though the case study analysis undertaken as part of this research. This has demonstrated the degree to which EU R&D policy is complementing and supporting regional actions, and vice versa.

Stage 6: Undertaking a cumulative assessment of the effects of EU R&D policy

There are 3 elements to the cumulative assessment

- Firstly a locational analysis has been undertaken, assessing the geographic distribution of EU R&D policy
- Secondly a policy analysis has been undertaken, assessing the extent to which EU R&D policy might address identified spatial goals
- Thirdly, a qualitative impact assessment has been undertaken, examining the extent to which EU R&D policy appears to address identified spatial goals in practice.

Whilst a quantitative assessment of the impact of EU R&D policy may be desirable we found that the methodological difficulties of undertaking this, coupled with limited observable effects that can be directly attributed to EU R&D policies at a regional scale, too challenging to be useful.

1 Locational analysis

The locational analysis of the incidence of activity supported through EU R&D policies has been based on the number of projects supported in the case of the EU's Framework Programmes and planned expenditure in the case of the Structural Funds. The particular focus has had to be taken for pragmatic reasons regarding the availability of data.

This provides a European scale analysis of the geographic distribution of EU R&D activity. This has then been set against the analysis of the current areas of strength and weakness in the EU to assess the extent to which policies reinforce these or seek to overcome disparities. This is done both through primary data analysis and through using secondary sources where original research was not feasible within the bounds of this study.

2 Policy analysis

As a starting point, a policy impact matrix can be used to assess the likely effects of the policies adopted in the programme. This identifies the extent to which different activities are aligned to different goals. Table 46 sets out an example of how this might be done, providing an assessment of the policy focus on R&D issues.

Table 4 Policy Impact Matrix

Policy outcomes[1]	Potentially affected R&D goals (+ = positive effect, - = negative effect)										
	Physical capital				Social capital		Human capital				R&D projects
	Communications infrastructure	Science Park development	Research Institute development	Regional accessibility	University-business networks	Regional innovation system	Trained researchers	Researcher mobility	Skilled workers	Management expertise	Research projects in Universities and companies

[1]list the products, activities and/or events that the programme policies will bring about

In addition, a territorial assessment of the planned programme priorities and measures is required. This identifies the extent to which policies are targeted on, or likely to benefit, particular areas. This may range from 100% to 0%. The assessment may be undertaken quantitatively - where financial information - is available or qualitatively, based upon proportionate analysis (such as distribution of resident population, unemployed, businesses or other relevant target groups) and expected targeting. We have included spatial objectives within the policy assessment tool.

When assessing the anticipated territorial effects of policies at a regional scale, it is useful to examine other domestic policies, which may influence the distribution of resources within the region. These may range from other financial interventions directing the location of Structural Funds to land use planning documents which may prevent development in some areas or encourage it in others. We have not incorporated this scale of analysis within our TIA work.

3 Impact assessment

Based upon the anticipated results of programme policies – as summarised in the policy Impact Matrix - an impact assessment exercise can now be undertaken. This may draw upon quantitative techniques or qualitative techniques, or a mixture of the two, depending upon the level of detail available. *Inter alia*, potential quantitative techniques include:

- Macro-economic modelling
- Multi-criteria analysis techniques
- Cluster analysis.

The essential element of each is assigning change values to identified indicators as a consequence of EU-policy actions.

As there is limited information on the potential impacts of Framework Programmes and, indeed, Structural Fund Programmes – both for reasons of scale effects and monitoring at the regional level - we feel that qualitative techniques should be favoured to avoid the dangers of spurious accuracy. Qualitative techniques rely upon identifying the direction of change and the magnitude of that change on identified indicators as a result of the policy actions proposed.

An alternative matrix approach (which might be used in parallel to that in Table 43 above) can be used to identify areas for further analysis, and, potentially, the identification of alternative options. In this instance, the programme effects are taken in their entirety and their significance for different policy goals assessed, as illustrated in Table 47 below.

Table 5 Qualitative approach to assessing effects of EU R&D policies

	Effects of EU R&D policies on EU and inter-regional territories					Examine further[1]
	Significant and positive	Significant and	Moderate and positive	Moderate and	Not significant	
Wide-ranging integration of knowledge-relevant policies, such as the promotion of innovation and research and technology development into spatial development policies, especially in remote or densely populated areas						
Fostering networking among companies and the rapid diffusion of innovations, particularly through regional institutions that can promote innovations						
Supporting the establishment of innovation centres as well as co-operation between higher education and applied R&D bodies and the private sector, especially in economically weak areas.						
Expansion of the strategic role of metropolitan regions and 'gateway' cities, giving particular attention to the development of peripheral regions of the EU						
Facilitating Objective 1 regions to take part effectively in collaborative research projects to develop their human S&T resources.						

	Effects of EU R&D policies on EU and inter-regional territories					Examine further[1]
	Significant and positive	Significant and	Moderate and positive	Moderate and	Not significant	
To broaden the technological absorption and creative capacity of Objective 1 regions.						
Strengthening a polycentric and more balanced system of metropolitan regions, city clusters and city networks						
Improvement of the economic basis, environment and service infrastructure of cities, particularly in economically less-favoured regions, in order to increase their attractiveness for mobile investment						
Support for the economic development of towns and cities in less favoured regions						
Strengthening small and medium-sized towns in rural areas as focal points for regional development and promotion of their networking						
Strengthening of several larger zones of global economic integration in the EU, equipped with high-quality, global functions and services, including the peripheral areas, through transnational spatial development strategies						
Strengthening co-operation on particular topics in the field of spatial development through cross-border and transnational networks						
Promoting co-operation at regional, cross-border and transnational level;						
Promoting co-operation with towns and cities in the countries of Northern, Central and Eastern Europe and the Mediterranean region;						
Strengthening North-South Links in Central and Eastern Europe and West-East Links in Northern Europe						

[1] in principle all negative effects should be examined further as might insignificant effects if this is in an area identified as a particular need in the European or inter-regional analysis

Statement of effects

Based upon the above analysis, whether quantitative or qualitative a statement of effects should be made. This should include a summary of all positive and negative effects of the programme on the area(s) concerned, based on identified goals. In addition to the simple statement of effects, the statement should also include proposed mitigation measures to offset identified negative effects. A format for such a statement is included in Table 48 below.

Table 6 Form of statement

	Effect	Mitigation	Comment
Negative effects			
Positive effects			

Reporting the results

The results can be summarised in the form of a report detailing the main identified impacts. This should also include a statement of the effects of the programme and, where undertaken, an assessment of the different options considered. A format for summarizing the advantages and disadvantages of different options is set out in Table 49 below.

Table 7 Summary of advantages and disadvantages of options

Options	Advantages	Disadvantages	Uncertainties
1.			
2.			
3.			

Based upon this report it is suggested that a consultation exercise is then held to discuss the merits of different options and the results of this exercise are then formulated into a revised programme.

ANNEX 7: Assessment of the extent to which R&D policies support the different territorial goals

Note that tables below do not take into account proportionate spend, nor does it differentiate between local expenditure and that by national and regional bodies.

Interventions directly targeted on supporting R&D goals

R&D policy interventions	***Promoting the physical capital for R&D and innovation***	***Promoting the human capital for R&D and innovation***	***Promoting the social capital for R&D and innovation***	***Promoting R&D projects***
Research projects based in universities and research institutes		*		***
Innovation and technology transfers, establishment of networks and partnerships between businesses and/or research institutes		*	**	
RTDI Infrastructure	***			
Training for researchers		***		
Supporting shared-cost research actions				***
Supporting SME engagement in R&D		*	*	**
Disseminating the results of R&D projects		*	*	**
Supporting the mobility of researchers		**		*
Overall	*****	******	*****	*******

Interventions that might indirectly support R&D goals

R&D policy interventions	***Promoting the physical capital for R&D and innovation***	***Promoting the human capital for R&D and innovation***	***Promoting the social capital for R&D and innovation***	***Promoting R&D projects***
Investment in physical capital (plant and equipment, cofinancing of state aids)	*			
Business organisation advisory service (including internationalisation, exporting and environmental management, purchase of technology)			*	
Enterprise advisory service (information, business planning, consultancy services, marketing, management, design, internationalisation, exporting, environmental management, purchase of technology)			*	
Shared business services (business estates, incubator units, stimulation, promotional services, networking, conferences, trade fairs)	*			
Developing educational and vocational training not linked to a specific sector (persons, firms)		*		
Workforce flexibility, entrepreneurial activity, innovation, information and communication technologies (persons, firms)		*		
Telecommunications infrastructure and information society	*			
Information and Communication Technology (including security and safe transmission measures)	*			
Services and applications for SMEs (electronic commerce and transactions, education and training, networking)		*	*	
Overall	*	*	*	

Annex 8: List of Indicators Developed and Datasets Provided to the ESPON Database

1.1.1. R&D Indicators

- R&D expenditures as a percentage of regional GDP (in millions of national currencies, in millions of euro, and as a percentage of gross domestic product) for the whole economy;
- R&D personnel as a percentage of the labour force (in full time equivalents, head counts, and as a percentage of the labour force) for the whole economy;
- Patent Applications and High Tech Patent Applications to the European Patent Office (total number of applications, number of applications per million people in population, and number of applications per million people in the labour force) for the whole economy
- Employees with Tertiary level education working in a Science and Technology Occupation (HRSTC) as a % of Labour Force.

1.1.2. Indicators of "Innovative Capacity"

- Employment in High Technology and Medium High Technology Manufacturing as a percentage of total employment;
- Employment in High Technology Services as a percentage of total employment;
- Percentage of the Working Age Population (aged 24-65) having successfully completed some form of tertiary education.

1.1.3. EU Policy Indicators

- Project Participations in the EU R&D Framework Programmes
- Field of Intervention data for planned Structural Fund expenditure in the field of RTD

Annex 9: Indication of Performance Indicators Achieved

Number of performance indicators achieved

Number of spatial indicators developed: - in total covering - the EU territory - more than the EU territory	 8 8 8
Number of spatial indicators applied: - in total covering - the EU territory - more than the EU territory	 8 8 8
Number of spatial concepts defined	-
Number of spatial typologies tested	1
Number of EU maps produced	12
Number of ESDP policy options addressed in that field	8

Annex 10 Structural Fund Data

For information purposes we include the datasets used for the analysis of Structural Fund activity in the filed of R&D (FOI 18) in a separate annex.

Annex 11 Maps, Figures and Tables Contents

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