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## Regional innovation systems in the Lisbon strategy

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### ABSTRACT

This contribution explores the framing of the concept of regional innovation systems within European economic policies. Regional innovation systems are analytically and empirically assessed within the policy context of the Lisbon strategy, with special reference to regional dimensions in the European Research Area. From both theoretical and empirical analysis it is concluded that RIS is not a one-dimensional concept. Although we adhere to RIS arguments as important determinants in economic development, the analyses presented in this article point out that the role of regional innovative capabilities must not be overemphasized. Economic development is in first instance dependent on national contexts.

### 1. Introduction

Across Europe, innovation is considered to be the most important driving factor behind sustainable economic development. The Lisbon strategy sets the economic agenda for the EU till 2010, and is aimed at closing the gap between Europe and its main global competitors, the United States and Japan. In March 2000, the European Council in Lisbon set out a ten-year strategy to make Europe the world's most competitive and dynamic economy through a knowledge-oriented strategy (CEC, 2000). The European Commission aims at closing competitive gaps between Europe and the United States and Japan by building an innovation oriented strategy around the concept of a European Research Area (ERA). According to the Commission, Europe suffers from three weaknesses in the light of its competitive position: insufficient funding, lack of an environment to stimulate research and exploit results, and the fragmented nature of activities and the dispersal of resources (CEC, 2000). To overcome these interrelated problems the Commission seeks to coordinate research and innovation policies within the concept of ERA, thereby taking into account all other relevant aspects of EU and national policies. The ERA concept combines the development of a European research policy with the creation of an 'internal market' in research. It thus aims at mobilizing knowledge, researchers and technology through the restructuring of the European research fabric especially by coordination of national activities. Regions are believed to play an important role in the ERA (CEC, 2001). Despite advances in information and communication technologies, geographical proximity is considered to remain an important factor in innovation processes, for example through the development of research infrastructure such as Science and Technology Parks and specialised equipment and facilities, regional networks of small and medium sized companies, clustered around universities and corporate R&D centres of (multinational) companies (CEC, 2001, p. 8).

Innovation strategies in economic development policies and the regional dimension in research and innovation are not a novelty however. The recent attention for innovation based growth cannot be attributed to conceptual breakthroughs and path breaking insights. Already in the beginning of the previous century, the Austrian economist Schumpeter presented his model of economic development in which creative entrepreneurs created temporal monopolies through innovation. Roughly two decades ago, Schumpeter's theoretical ideas served as theoretical basis for evolutionary models of economic growth (Nelson and Winter, 1982; Dosi et al., 1988). Basing on these insights, innovation is best to be considered from a system perspective. From a geographical perspective research on innovation in the late eighties and nineties focused in large degrees on explaining regional economic growth wonders like Silicon Valley (California), Emilia Romagna (Third Italy) and Baden-Württemberg (Southern Germany) thereby linking up to arguments which go back to Marshall's work on industrial districts (Marshall, 1919). Combining the system perspective with theoretical arguments on regional synergies in innovation processes, the school of regional innovation systems (RIS) defines the regional scale as the primal locus of innovation (Cooke et al. 1997).

The RIS concept, accordingly, has acquired a prominent position within European technology and innovation policy. The concept is expected to contribute to the Lisbon strategy by increasing Europe's overall competitiveness as an aggregate of knowledge-driven regional economic performances. In this contribution we will explore the ambiguities and tensions surrounding the RIS concept in the context of the Lisbon strategy. We are interested, in particular, in the way the concept is framed within policies of spatial-economic development and innovation, and how RIS arguments reveal their selves in empirical patterns on regional economic performance in Europe. The structure of the paper is as follows. Section Two focuses on the emergence of RIS in analytical and normative sense. Section Three discusses the way the RIS concept is used and interpreted within European policy. Here, we will focus on tensions between theoretical RIS elements and the translation of these elements in the policy agenda set out in the Lisbon strategy. In Section Five, we will elaborate these tensions from an empirical perspective. Here, we empirically explore the relationship between RIS concepts and the goals set in the Lisbon strategy in terms of regional economic development. Finally, we will draw some conclusions and policy recommendations.

## **2. The emergence of RIS as an analytical and policy concept**

Because of its co-evolution in academic as well as policy spheres, the concept of RIS has acquired simultaneously a strong analytical and normative connotation. In analytical terms, the RIS concept, in line with that of the learning region, is the outcome of an intellectual debate at the intersection of two bodies of work, that on the organisation and systemness of innovation on the one hand, and that on spatial agglomeration on the other (Morgan, 1997). Emphasising the role of interaction, localisation and embedding, the RIS concept thus gives an explanation of the resurgence of regional economies as structuring elements in global competition, as exemplified by alleged regional success stories such as Emilia-Romagna, Baden Württemberg, Route 128 and Silicon Valley. The analytical prominence of RIS elements centres around localized capabilities, such as specialized resources, skills, institutions and share of common social and cultural values (Maskell and Malmberg, 1999). Interaction and institutional embeddedness are considered as important drivers of regional competitive advantage. As Doloreux and Parto (2004, p. 9) state:

*The concept of RIS has no commonly accepted definitions but usually is understood as a set of interacting private and public interests, formal institutions and other organizations that function according to organizational and institutional*

*arrangements and relationships conducive to the generation, use and dissemination of knowledge.*

The normative prominence of the RIS concept is manifested by the way RIS has been turned into a policy concept. Especially in Europe, but also in other parts of the world, RIS is presented as a generally applicable concept to support regional development by stimulating innovation. The popularity of RIS in policy-making can be attributed to the way the concept fits in what is considered to be a new paradigm of regional policy oriented towards self-sustained, supply-side oriented measures aimed at improving regional competitiveness (Bachtler et al., 2003). In the European context, due to this new paradigm, innovation has become a core 'horizontal theme' deeply woven into the various initiatives and programmes in the field of industrial and regional policy (Landabaso, 1997), although the implementation of these new ideas remains patchy (Sanz-Menéndez and Borrás, 2001).

In its transition from an analytical to a normative concept, the notion of a RIS is transformed into a kind of ideal model applicable to all regions, including less successful regions. Especially in the European policy context, which is characterized by a strong emphasis on social inclusion and cohesion issues, lagging regions play an important role as target group of regional innovation strategies as normative translations of RIS elements. Across Europe, the development of regional policy provides many intriguing cases of how the discourse of regional innovation is scripted into policies, programmes, and actions geared to laggard regions (CEC, 2001). As a policy concept, RIS has underpinned many practical applications in the field of, for instance, research-business collaboration, support for hi-tech spin-offs and start-ups, and clustering as well as more conceptual applications geared towards the drafting of regional innovation strategies (Landabaso, 1997, Oughton et al., 2002). In the European context, the EU has played a pivotal role, apart from providing funding, in developing and disseminating methods of regional strategy-making, the sharing of best practices, and the organisations of rounds of evaluation and feedback.

While the 'normative' use of the RIS concept can thus be considerable in rather favourable terms, there are serious doubts about the analytical basis of this achievement. On closer scrutiny, RIS applications appear to show little consensus about what are regarded key success factors (actors, institutions, relations, processes) and spatial attributes (local conditions, scale and scalar relations) (Doloreux and Parto, 2004). There appear to be as many, explicit or implicit, 'ideal models' of regional innovation systems as there are policy applications. Indeed, where common models have been distinguished, this tends to be based on the governance principles underpinning RIS applications, rather than the substantive dimension. A case in point is Cooke's (1998) distinction between 'dirigiste', 'grassroots' and 'network' RIS models, which characterizes the emphasis put on regional contingencies in learning processes (Oinas and Van Gils, 2001). Consequently, RIS applications should not be understood as a translation of a general model into a particular context. A better approach is to see particular applications as drawing selectively from a broad set of ideas concerning innovation, interaction, and space, as well as the role of different kinds of actors and governance, which are generally associated with the RIS concept. It is not so much the translation of a common RIS concept, but the selective invocation of the broad discourse on innovation and regional development, that underpins the use of RIS in policy-making and explains the wide variation in this usage (Lagendijk, 2005).

Within Europe, there is substantial variety in the way the RIS concept is understood and applied, notably at the regional level. Yet, within the realm of European innovation policy and regional policy, one can identify a dominant line of thinking bearing on the conceptualisation and application of RIS. Like the RIS concept emerged out of the intersection of two streams of thought, concerned with spatial agglomeration and systematic innovation, two EU policy areas,

regional policy and innovation policy, have jointly promoted its use. A good example of this intersection is the RIS/RITTS programme, supported by both DG Regio and DG Enterprise. The programme ran from 1996 to 1999 and was preceded by the RTP initiative, continued under RIS/RIS+. The two Directorates represent the two core objectives of the RIS/RITTS scheme: territorial cohesion through the reduction of spatial inequalities and strengthening Europe's overall innovative potential. While, in the context of the wide range of structural policies, regional innovation programmes presented just a fairly modest programme, they acquired substantial prominence because of the increased emphasis on innovation as the key to competitiveness, multi-level governance steered by subsidiarity, and strategic (public-private) partnerships as a way to create synergies in key resources. As indicated above, an actual theme is the relationship between the EU's push for a European Research Area (ERA), adopted in 2000 as part of the Community's science and technology policy, and regional policy (CEC, 2001). Regional processes of collaboration and partnering, notably between research organisations, business and public authorities, are considered to be vital for Europe's ambition to strengthen not only its scientific knowledge output in the European Research Area (ERA), but also its ability to exploit this knowledge commercially.

While the ERA agenda has provided further support for RIS developments as part of Europe's overall economic ambitions towards closing competitive gaps with other trading blocks in the world, the most important aim driving initiatives in the field of regional innovation support remains the aim of territorial cohesion (Hooghe, 1998; Sanz-Menéndez and Borrás, 2000). It is important to remember that there are not only political and social reasons underpinning this ambition. Reducing the extent of regional disparities across the Community is also expected to contribute to the success of the Common Market and hence to economic prosperity (Heraud, 2003). In combination with political pressures notably from Southern member states, this was the main motive to include the cohesion aim in the Single European Act of 1986. The RIS concept, in this context, should be seen as a kind of self-help and learning tool that is expected to propel local, self-sustained growth dynamics, especially targeted at lagging en peripheral regions:

*“These efforts aim on equipping less favoured regions with the appropriate capacity in order that they engage successfully in collaborative research endeavours throughout Europe, achieve a better transfer of research results in their economic fabric, help reducing the existing economic and technological gap with the most advanced regions and thus integrate better in a developing European research space” (CEC, 2001, p. 11).*

To encourage processes of interregional learning, the RTP-RIS-RITTS-RIS+ programmes have been accompanied by a whole series of measures oriented towards ‘mainstreaming’ of outcomes and knowledge transfer and dissemination of best practices, for instance through the ‘Innovation in Europe Network’ (IRE - [www.innovating-regions.org](http://www.innovating-regions.org)).

### **3. The framing of RIS within European regional and innovation policy**

Given the normative framing of RIS elements in European regional innovation policies, the question arises how this conceptual framing chimes with the analytical insights within RIS contributions. To make an assessment of the conceptual validity of RIS applications in European policies, we will focus on a selection of key premises that, in our view, have come to play a dominant role in the formulation and specification of the approach. Obviously, during its evolution, the EU regional innovation programme has been shaped and modified on the basis of

manifold insights and assertions (Sanz-Menéndez and Borrás, 2001). Yet the following three premises appear to stand out.

The *first* premise concerns the underlying notion of growth dynamics, as featured in the influential “Green Paper on Innovation” by the European Commission (CEC, 1995). In line with the prevailing ‘endogenous’ perspective on economic development, the region is considered a self-sustained, albeit open and dependent, site of economic development, characterised by a certain degree of internal coherence and power to act as a collective agent (Moulaert and Sekia, 2003). Key to the endogenous development model is innovation, which generally conveys a twofold meaning (Heraud, 2003). On the one hand, innovation is associated with knowledge production and applications that are ‘new to the (world) market’, often involving so-called ‘high tech’ activities. On the other hand, innovation can also refer to ‘soft’ use of knowledge in business activities, resulting in higher productivity and performance. The latter is exemplified, for instance, in the development of knowledge intensive services. In addition, Cooke (1998) makes a distinction between two subsystems of innovation processes. Knowledge generation and diffusion are mainly part of a subsystem dominated by public organisations, while knowledge application and exploitation are primarily part of a subsystem dominated by private organisations. Both types of innovation output and processes are represented in the RTD programmes and rationales.

A *second*, equally explicit premise revolves around the notion of regional innovation-based catch-up. Not only is the RIS concept expected to contribute to overall development across the Union, it will especially help less favoured regions to catch up with core regions. Moreover, given the significance of innovation and increased competitive pressure affecting Europe’s regions, this is seen as the most promising, if not the only possible, route for reducing disparities. In the words of the Commission:

*“The less developed regions have few chances catching up with the prosperous regions if they do not perform RTDI strategies comparable to the prosperous regions. Basically, they are equally exposed to all challenges stemming from globalisation and competition. Therefore, they have to pursue genuine RTDI approaches if long-term perspectives are sought. Thus, a cohesion policy that does not manage less favoured regions progressing fast on this track will fail in the long run. Only by fully exploiting the synergies between cohesion and research policy this goal could be achieved”* (CEC, 2001, p. 18).

The *third* premise, of a more implicit nature, is that centrally designed, albeit locally customised, policies can bring about the local institutional and cultural change required for enhancing regional innovative performance. This premise is based, on the one hand, on the idea that the key to local transformation lies in the fields of local cognition, interaction and joint strategy-making. These characteristics can be moulded and nurtured by ‘soft’ measures oriented towards the formation of coalitions, communication structures, and shared visions (Cooke and Morgan, 1998). On the other hand, such ‘soft’ changes can be induced by a set of centrally defined and monitored set of policy measures. In this context, European policies attribute an important role is attributed to cross-regional learning geared towards the dissemination and exchange of best practices and productive policy ideas. In the words of the Commission, *“adopting a single development model would be a mistake. Nevertheless the adherence to some general development principles seems useful, particularly in relation to research and innovation policies”* (CEC, 2001, p. 6). These premises give rise to various questions and dilemmas, individually as well as in relation to each other. In the remainder of this section we will focus on four interrelated issues that are particularly relevant for our discussion here: the generalisation of success, the wider spatial embedding of RIS, and the tensions between the policy aspirations of competitiveness and cohesion.

The first issue, which connects to the first and second premise, is the projection of developments observed in certain exemplary regions to all regions. Although Doloreux and Parto (2004, p. 17) summarize, “*all regions have some kind of regional innovation system, including not only regions with strong preconditions to innovation, but also old industrial regions (...), peripheral regions (...), rural regions (...) and regions in transition (...)*”. However, while the regional success stories mentioned earlier show marked indications of internal coherence and collective action, it remains a question to what extent these phenomena are also relevant for weaker regions (Peck, 2000). One problem is that weaker regions do not have the internal disposition to emulate success stories. In the words of Pavitt (1998, p. 562), “*the inability of the laggard regions to catch up in part reflects their inability to master better practice products and processes, because of inadequate R&D and related education*”. This problem is compounded by a strong focus of European regional innovation policies on high tech activities, a process strengthened by closer ties with the Framework Programmes. As the European Commission acknowledges itself, weaker regions tend to be caught in what is called a ‘low R&D trap’ (Vence et al., 2000). “The technological absorption capacity of these regions is thus weakened by a generalised non-participation in the new knowledge flows between the main RTD operators” (European Commission, 2001, p. 12). In terms of policy interventions, this results in what Oughton et al. (2002) term the ‘innovation paradox’, which results from “*the apparent contradiction between the comparatively greater need to spend on innovation in lagging regions and their relatively lower capacity to absorb public funds earmarked for the promotion of innovation and to invest in innovation related activities, compared to more advanced regions*”. This problem is compounded by the weak spending capacity of lagging regions (Heraud, 2003). Yet, in economic terms the innovation paradox does not really present a paradox. Rather, it is a policy dilemma resulting from the strong reliance of innovation processes on locally and nationally embedded conditions (Cooke and Morgan, 1998). According to Vence et al. (2000), lagging regions could benefit from a stronger orientation towards more mature activities, for instance by increasing the knowledge intensity in the improvement of basic business practices.

The second issue, of a more systemic nature, concentrates on the dilemma that where there are winners there are also losers, which should not only be understood in a positional but also in a relational sense. It is also due to the interdependencies between regions that some turn out to be more successful than others (Hudson, 1999). Projecting the development path of observed single units onto all units thus amounts to a ‘fallacy of composition’, that ignores systemic, and perhaps unavoidable, interdependencies at national and international level. The ambiguity of seeing regions as self-sustained engines of development, and, at the same time, as parts or nodes in a wider system of economic interaction, on the other, is also reflected in the discourses on European spatial development (Jensen and Richardson, 2004). The image of Europe as a cohesive and balanced space is juxtaposed with a the image of Europe as a space of flows with an important role for central nodes and, in particular, the competitive core contained by the ‘Pentagon’ London-Paris-Milan-Munich-Hamburg. To strike a balance between the agglomerative pull of the ‘Pentagon’ and the need for balanced development, European spatial policies address the development towards a polycentric network. By providing high-quality access and communication routes, such a network should be able both to foster further development of its core areas while at the same time creating development opportunities elsewhere. However, the idea that accessibility, including the strengthening of nodes in the periphery, will result in a spreading of growth dynamics is hardly supported (Van der Heijden and Veeneman, 1998). On the contrary, there is substantial evidence that enhanced communication infrastructure leads to more disparity between the core and periphery, or, at best, to the development of an ‘archipelago Europe’ (Hess, 2004). In various ways, hence, conceiving Europe as primary composed of a large number of regional growth engines, and assuming that improved

communication will lead to enhanced absorptive capacities in the periphery, is problematic. This raises, in particular, the question of to what extent we should assess the development of regional innovation systems independent from their national context. Indeed, one should be cautious comparing the EU as whole with Japan and the US, or with overemphasising interregional differences, while the real differences exist between the EU countries (Pavitt, 1998).

The third issue lies at the heart of the Lisbon strategy and concentrates on tensions between competitiveness aims and cohesion aspirations. Sanz-Menéndez and Borrás (2000) describe how, since the mid-eighties, RTD policies have been integrated within the broader European cohesion target. This has been accompanied with a normative shift towards political aims of social cohesion and reducing regional economic disparities in the context of social inclusion. Notwithstanding the laudable social ambitions, there is a danger that they regress into a political game primarily driven by regional and national pressure groups (Sanz-Menéndez and Borrás, 2000). In the end, the way the Commission invokes a welfare principle of catching up while trying to ensure global competitiveness remains deeply paradoxical (Jensen and Richardson, 2004). The double-face goal of ‘balanced development’ (Jensen and Richardson, 2004) or ‘balanced competition’ (Tewdwr-Jones and Morais Mourato, 2005) is, in various ways, ambiguous and even contradictory. As Lawton-Smith and Clark (2003, p. 865) argue, *“the Commission’s twin goals of competitiveness in the global economy and economic and social cohesion or convergence are not necessarily the same and may be contradictory. Inherently they comprise different policy positions: one is about winners and losers, while the other is about redistribution”*. In this respect the EU differs from the national level (Bachtler et al., 2003). Where, in line with the new paradigm of regional policy, most nation states have shifted their attention from spatial equalisation to regional competitiveness, European policies remain firmly dedicated to reducing spatial inequalities. The best one can expect, perhaps, is the provision of a kind of level playing field in which more peripheral regions inclined to knowledge absorption have good access to resources that will help them to enhance and strategically focus their absorptive capacities at least to keep up with developments elsewhere. In particular, such regions may be expected to acquire ‘good practices’ enabling them to compete in a more broad range of economic activities, rather than focusing solely on high tech sectors. Obviously, even a keep up scenario is far removed from a cohesion-based perspective of spatial balanced development across the Union.

The last issue deals with the steering possibilities of RIS, given the insight that regional development does not just involve economic but also institutional, social and cultural aspects. Even if the endogenous development model would provide at least a fitting ‘working model’ for policy interventions, it should do this in such away that lagging regions are able to ‘catch up’ with core regions, which is the crux of the second premise. While European policies, often more than national policies, have gone a long way in acknowledging the social, cultural and institutional embedding of innovation processes, it is nevertheless confronted with the rigidities that these dimension embody. As a result, while some good results have been achieved with helping less favoured regions to overcome some aspects of the low R&D trap, one cannot expect to be able to socially engineer the ‘absorptive capacity’ of peripheral regions across Europe. For as far as this is possible, the aim should be to develop a governance structure that provides the right mix between ‘bottom up’ initiatives and learning, and ‘top down’ facilitation and steering. Yet, perhaps ironically, the organisational capacities to develop such a governance model are currently more present at a national than at a European level. According to Kuhlmann (2001), therefore, it is likely that innovation policy will move towards a multilevel structure with a stronger role for national organisations and authorities. We may even see, according to Pohoryles (2002), a partial re-nationalisation of European innovation policy. The key question then becomes to what extent



such a more decentralised structure is willing and able to accommodate ‘balanced development’ aspirations at a European level, and escape from nationally driven interests and ambitions.

The RIS concept, in summary, is employed and elaborated in a complex multi-level and multi-actor world driven by a great number of interests and aspirations. The key challenge is to advance the notion of RIS in such a way that, on the one hand, it provides a common vision and action framework for innovation policies across Europe, while, on the other, it meets the economic and political reality of Europe of today. For our empirical research below, we distill two main themes out of the discussion here. The last two issues, that of spatial equalisation vs. regional competitiveness and the issue of steering, raise the question of *scale*. To what extent does, within the multilevel fabric of Europe, the national level still dominates. As we will explore in the next section, the most prominent development factor for regions continues to be their embedding in a national economic and political system. Secondly, the first two issues, that of strong variations in context and success factors of innovation, points at the significance of *diversity* (cf. Legendijk and Oinas, 2005). This diversity not only relates to knowledge inputs, but also on the relation between knowledge investments in the knowledge economy and economic outputs. Yet while the importance of diversity is generally acknowledged, it is generally dealt with through the adoption of generic typologies that are top-down, theoretically derived. What we will do in the next section is to approach the issue of diversity from a different angle, which is bottom-up, empirically driven.

#### **4. Empirical reflections on regional innovation systems**

In the past sections, we have explored the concept of RIS from an analytical and policy perspective. In this section, we empirically assess regional innovation systems in Europe through a statistical analysis of secondary data. Before we embark upon this exercise, a few words of caution are at their place. Multi-faceted concepts like RIS are difficult, if not impossible, to measure. Core elements of RIS are highly qualitative in nature and comprise elements which exhibit their economic value in unique learning contexts. However, there are some common features in regional development and policy actions that lend themselves to statistical analysis and that may shed light on specific aspects of broader, more complex phenomena which arise in particular learning context and development paths. On a European scale, in addition, we are confronted with some limitations in data availability. Although within the EU member states a coordinated innovation survey (the Community Innovation Survey) is conducted by Eurostat, which takes into account the systemness of innovation processes by including variables that specifically address indicators on cooperation innovation processes and dissemination of information, regional data are not yet available for every EU member state<sup>1</sup>. Nevertheless, there are some, more traditional, indicators available for the fifteen EU member states, which made up the European Union before May 2004 at NUTS-2 level, which are of some use for our purpose here. Although it is not possible on the basis of these data to empirically assess arguments concerning interaction of agents aiming at knowledge-oriented growth, the data do reveal some insight on the relation between knowledge inputs and economic output. In our analysis we can test whether such a relation exists, and at what spatial level this relation reveals itself. We cannot however, quantitatively assess the qualities of this relationship.

Regional indicators on knowledge inputs and economic output have been extracted from Eurostat’s NEWCRONOS database. In some cases, we had to manipulate the data so that

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<sup>1</sup> For national applications, see for instance Evangelista et al. (2002) (Italy; NUTS-2), Doloreux (2002) (Sweden; NUTS-2), Simmie (2003) (UK; NUTS-2) and De Bruijn’s (2004) shift-share potentiality estimates analysis of NUTS-5 regions in The Netherlands).

aggregations on NUTS-1 and NUTS-2 levels resulted in a corresponding national figure. Additionally, we confronted the regional data set with the national figures provided by OECD sources. The regional figures are derived from Eurostat, which are integrated within national frameworks provided by OECD sources<sup>2</sup>. The following variables were incorporated in the analysis:

- gross domestic product (GDP) per capita, 1995 to 2000;
- GDP per employee, 1995 to 2000;
- labour force with tertiary education levels as a share in the total labour force, 1999 to 2002;
- students attending tertiary education as a share in the total student population, 1999 to 2001;
- gross domestic expenditures on research and development as a share in GDP, 1995 to 2000.
- employment in high-technology sectors as a share in total employment, 1995 to 2000;
- employment in knowledge intensive services as a share in total employment, 1995 to 2000;
- employees participating in life-long learning, as a share in total employment, 1999 to 2002;
- number of patent application at the European Patent Office (EPO) per 1000 full-time equivalents, 1995 to 2000.

For each variable, we incorporated both the situation in the most recent available year and the annual growth in the time series. Within the practical limitations the data impose, we are able to respond to the questions raised at the end of the previous section. First, a rotated factor analysis applied to the scores on the research and education indicators listed above is used to reveal what can be regarded as ‘independent pillars’ of the knowledge economy. Then, through cluster analysis the regional scores on these independent factors serve to develop a typology of knowledge regions in Europe. Obviously, whether this typology of knowledge regions can be regarded as a typology of regional innovation systems depends on the systematic relations knowledge inputs within these categories employ with economic output.

Second, following the arguments followed by Oughton et al. (2002), we assess national differences in economic indicators and the independent pillars of knowledge inputs. From an empirical perspective, Oughton et al. (2002, p. 99) base their justification for focusing on regional systems on the existence of more variation across regions in terms of R&D intensity and innovation activity than across nation states. However, attributing all variation between regions within member states does not tell us anything about a *systematic* influence of regional factors in knowledge-oriented strategies of regional economic development. As an analytical extension, we employed analyses of variance with both member states and region types derived from cluster analysis with economic output indicators as dependent variable.

The results of the rotated factor analysis are depicted in Table Two. A principal components analysis produced six factors with eigenvalues higher than 1, of which the correlation with the dependent variables is given in Table Two. In factor analysis, an eigenvalue of 1, the explanatory value of an average observed variable, serves as statistical criterion for a factor to be included in further analyses. In Table Two, factors are numbered along decreasing eigenvalues, so that the first factors are relatively robust compared with the others. In Figure Three, the factor scores are mapped across Europe. Factor 1, 2 and 5 relate primarily to the situation in 2000. Factor 1, labelled as ‘position in high technology sectors’ correlates strongly with employment in high technology sectors, expenditures in R&D and patent applications. The significance of this factor

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<sup>2</sup> The data set is built on regional data on NUTS-2 level for the fifteen countries which made up the European Union before May 2004 and are derived from Eurostat’s NECRONOS database, domain REGIO, and Eurostat’s Science & Technology database. As the national boundary conditions we used different OECD sources (Labour force statistics, National accounts of OECD countries, Education database), available at <http://www.oecd.org>. Employment figures are given in full-time equivalents, using a definition of 1750 working hours per year, to overcome national differences in employment definitions.

confirms our expectation that regions may differ greatly with respect to the role high tech activities. The factor shows moderately positive relationships with employment in knowledge intensive services and employees with tertiary education. The Southern part of Germany turns out to be Europe's hot spot for technological innovation. Scandinavian countries and Belgium also score well above average.

The factor labelled as 'development in high technology sectors' correlates strongly with the annual growth of the number of employees in high-technology sectors as a share in total employment. This factor, with an eigenvalue of 1.33, is less robust and is also connected positively to the development of human capital in terms of the growth of employees with tertiary education and people participating in life-long learning. Remarkably, the connection with the development of expenditures in R&D and patent applications is weak. There is a strong development of high technology sector across the Arctic Rim from Galicia towards Scotland plus some patches on the continent. The picture is different for non-technologically based innovation, as the second factor points out. This factor, labelled 'position in knowledge intensive services', is strongly connected to employment in knowledge intensive services and human capital in terms of tertiary education and participation in life-long learning. The factor relates moderately to expenditures in R&D. Scandinavian countries, the United Kingdom and the Netherlands have strong positions in knowledge intensive services, manifesting Northwest Europe's orientation towards professional services. Parts of Germany, Ireland, Greece and Spain have witnessed strong development of the factor 'development of knowledge intensive services'. This factor is strongly connected to the annual growth of employees working in knowledge intensive sectors and does not exhibit strong relationships with other observed variables.

Table 2 Factor analysis<sup>1</sup>, summary of results

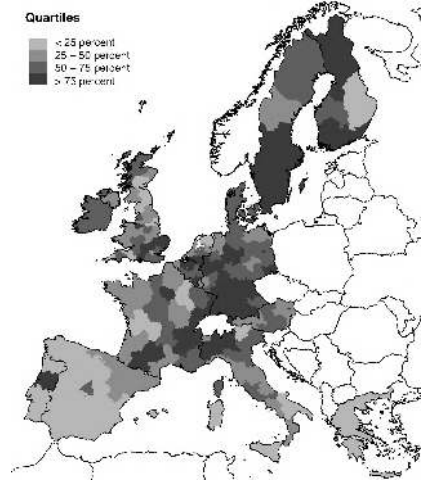
<b>Factor</b>	<b>1</b>	<b>2</b>	<b>5</b>	<b>3</b>	<b>6</b>	<b>4</b>
<b>Label</b>	<b>Position high-technology sectors</b>	<b>Position knowledge intensive services</b>	<b>Position education</b>	<b>Development high-technology sectors</b>	<b>Development knowledge intensive services</b>	<b>Development education</b>
Eigenvalue	3.53	1.67	1.06	1.33	1.01	1.28
<i>Dependents</i>						
Employment in high-technology sectors, 2000	<b>0.82</b>	0.15	-0.05	0.00	0.06	-0.29
Employment in knowledge intensive services, 2000	0.35	<b>0.83</b>	0.00	0.05	-0.02	-0.10
Employees with tertiary education, 2000	0.27	<b>0.66</b>	0.39	0.17	0.07	-0.17
Employees engaging in life-long learning, 2000	0.13	<b>0.85</b>	-0.05	-0.05	-0.16	-0.06
Students attaining tertiary education, 2000	-0.06	0.03	<b>0.86</b>	-0.06	0.01	-0.01
Expenditures in research and development, 2000	<b>0.81</b>	0.34	0.09	-0.09	-0.10	0.07
Patent applications, 2000	<b>0.89</b>	0.09	-0.06	-0.07	0.05	-0.06
Employment in high-technology sectors, 1995-2000	0.08	-0.01	-0.02	<b>0.82</b>	-0.02	0.25

Employment in knowledge intensive services, 1995-2000	0.08	-0.14	0.07	0.03	<b>0.86</b>	0.06
Employees with tertiary education, 1995-2000	-0.28	0.00	0.24	<b>0.57</b>	-0.28	-0.18
Employees engaging in life-long learning, 1995-2000	-0.12	0.08	-0.28	<b>0.62</b>	0.25	-0.23
Students attaining tertiary education, 1995-2000	-0.18	-0.09	0.26	-0.11	0.29	<b>0.61</b>
Expenditures in research and development, 1995-2000	-0.08	-0.10	-0.17	0.08	-0.05	<b>0.83</b>
Patent applications, 1995-2000	0.12	-0.42	0.23	0.06	-0.42	-0.07

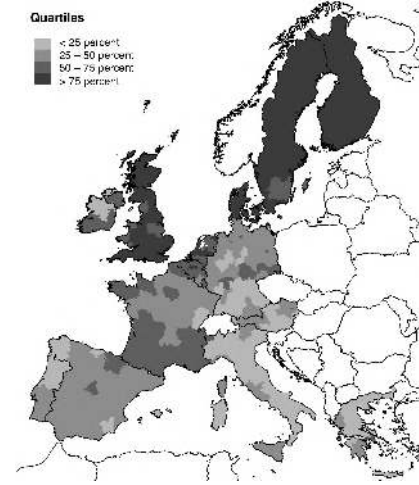
<sup>1</sup> Extraction through principal components analysis; Varimax rotation with Kaiser Normalization

Source: TNO, on the basis of Eurostat and OECD

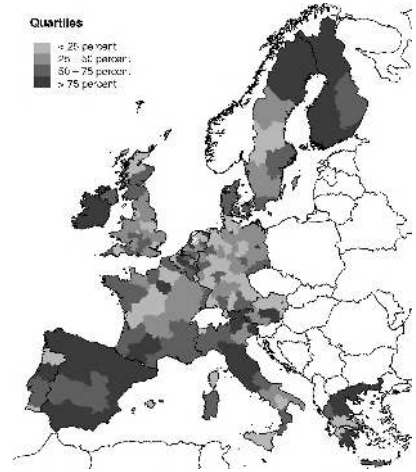
Figure 3 Regional factor scores



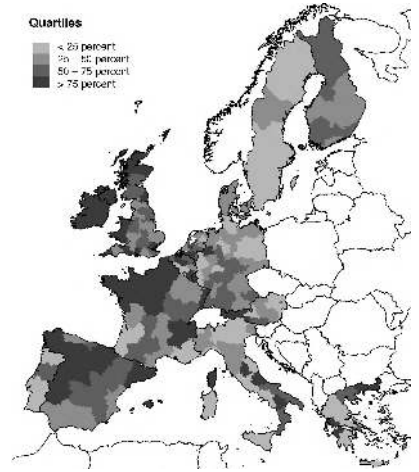
a) Position in high-technology sectors



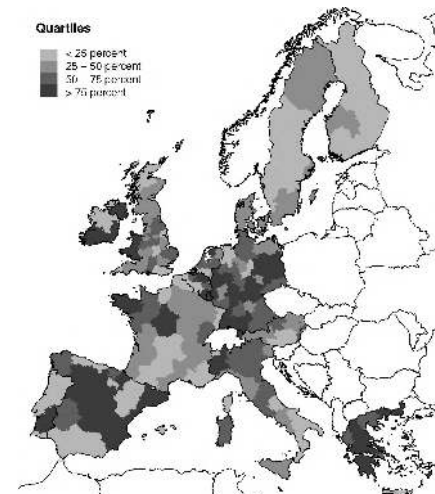
b) Position in knowledge intensive services



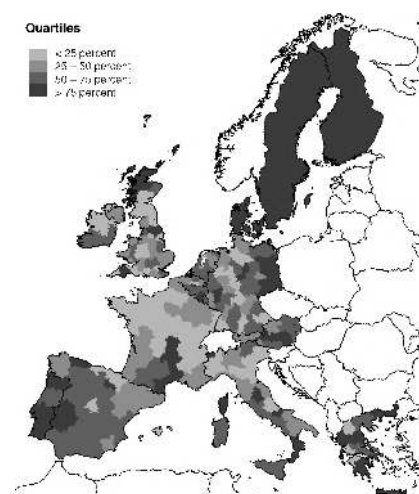
c) Position in education



d) Development of high technology sectors



e) Development of knowledge intensive services



f) Development of education

Source: TNO, on the basis of Eurostat and OECD

Remarkably, the factor labelled ‘position in education’ scores strong in peripheral regions, notably in Northern Scandinavia, Ireland, Spain and Greece, which can be interpreted as a sign of catch-up across large parts of the Mediterranean. The factor relates strongly to the number of students attaining tertiary education, as a share in total student population. The factor which we labelled ‘development in education’ has strong relations with the development of expenditures in R&D and the growth of the number of students in tertiary education programmes as a share in the total student population. Finland, Greece, the Eastern part of Germany and parts of Spain score relatively high.

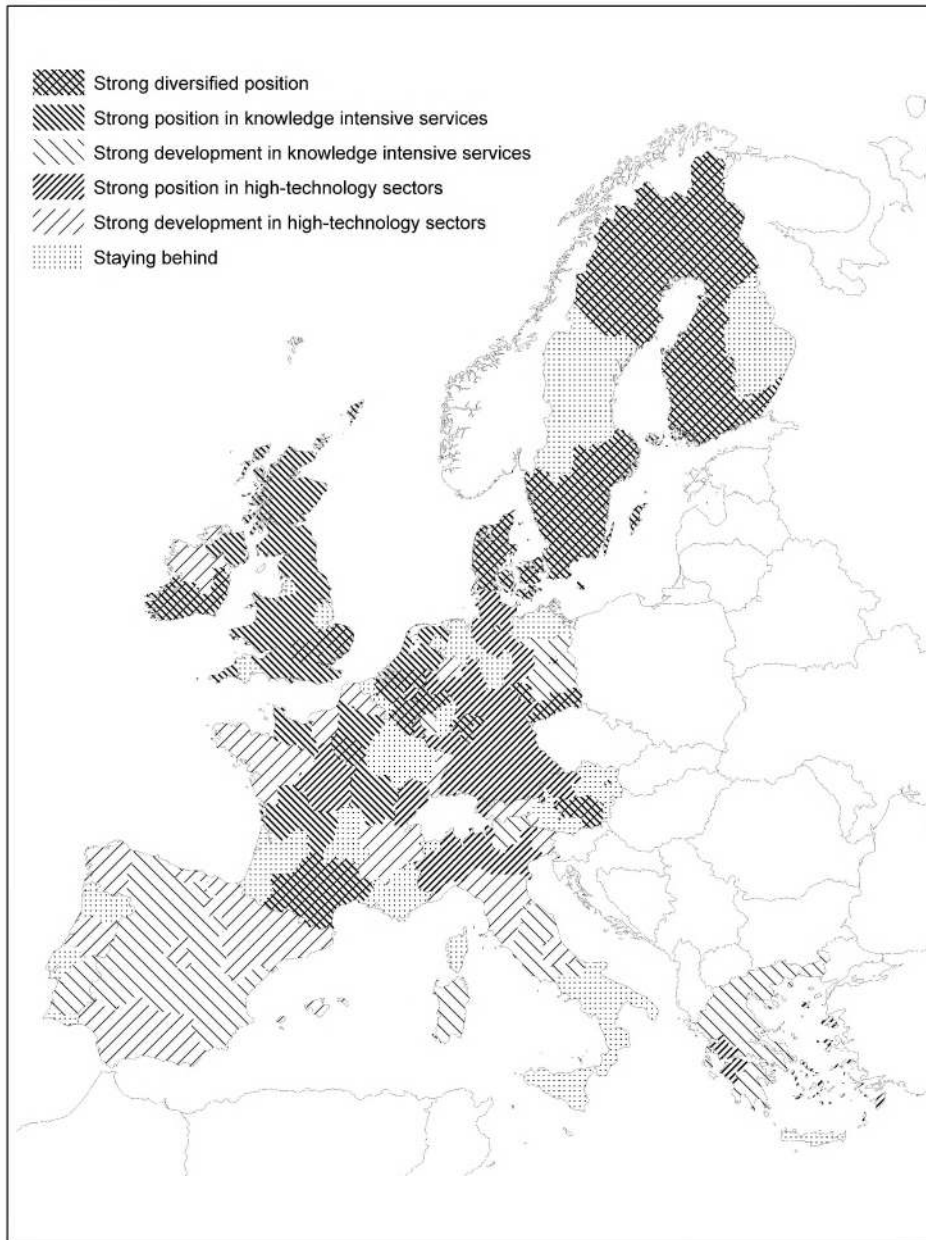
Cluster analysis provides insight into the distinguishing features of types of knowledge regions. Cluster analysis minimizes heterogeneity in the scores of variables between cases in a predefined number of categories while at the same time maximizing homogeneity within these clusters. Preconditioned by a number of six categories the results, summarized in Table Three, are produced. To eliminate disruptive effects of outliers on the results of the analysis, we performed the cluster analysis on the basis of rankings in factor scores, with low numbers representing relatively high scores. The six resulting categories are mapped in Figure Four. Regions which stay behind in the knowledge economy score below the median on every indicator, except in the development of education. Regions with a strong position in high technology sectors score relatively strong on the position of high tech sectors and the development of knowledge intensive services. Regions which have a strong position in knowledge intensive services also score well on the development of high tech sectors. So, in Europe, among the hot spots of innovation, we can identify a tendency towards diversification of knowledge intensive activities. Regions which already have a strong diversified structure perform relatively well on a broad range of indicators. Only on the development of high tech industries and knowledge intensive sectors they perform slightly below the median score. Catch-up areas in high technology sectors have also a strong performance on the position of education. Regions with a strong development in knowledge intensive services score well above the median on education indicators.

Table 3 Cluster analysis, summary of results

Cluster	1	2	3	4	5	6
Label	Staying behind	Strong development high-technology sectors	Strong diversified position	Strong development knowledge intensive services	Strong position knowledge intensive services	Strong position high-technology sectors
<i>Mean rank in factor scores (N = 207)</i>						
Position high-technology sectors	124	118	45	164	128	57
Position knowledge intensive services	123	138	62	143	42	156
Development high-technology sectors	147	49	113	133	73	109
Development education	67	156	55	62	139	139
Position education	147	44	61	60	121	156
Development knowledge intensive services	164	129	113	48	108	50
N	37	26	36	26	47	35

Source: TNO, on the basis of Eurostat and OECD

Figure 4 Typology of knowledge regions in Europe



Source: TNO Environment & Geosciences, on the basis of Eurostat and OECD

Figure Four reveals a combination of national patterns, sub-national regional patterns and macro-regional patterns. The United Kingdom and The Netherlands are predominantly based on knowledge intensive services. Germany, especially the Southern part of the country, is, like the Northern part of Italy, specialized in high technology. Scandinavian countries have a more diversified structure of knowledge inputs. Mediterranean countries are catching up; some parts in technology based activities, some parts in innovative services. The Eastern part of Germany is catching up in knowledge intensive services. More heterogeneous patterns in can be distinguished in France, Belgium and Austria. In effect, notwithstanding the sizeable group of underperforming regions, on the whole these results appear to be in line with what can be interpreted as a pattern of balanced development.

Table Four summarises the results of the analysis of variance within economic output indicators across NUTS-2 regions in the EU-15, and the variance across regions within our typology of European knowledge regions. In the analysis 206 NUTS-2 regions in fifteen member states and in six knowledge region types are involved. The upper part of Table Four reveals a strong national impact on welfare, in terms of gross domestic product per capita in 2000, and competitive strength, in terms of gross domestic product per full time equivalent. The F-statistic is significant for all output variables, considered both from the position in 2000 and from the development in the period 1995 to 2000. These results only partially confirm the results of earlier research by Oughton et al. (2002), in which a similar analysis of variance within and across EU member states was performed. In contrast to Oughton et al. (2002), we did not correct gross domestic product per capita for national differences in purchasing power. We do not see a reason to assume that interregional differences within countries (such as rural-urban divides) are less influential than purchasing power differences across nations within the fifteen EU member states on which we based our data set. As a result the impact of national differences on welfare as depicted in Table Four is larger than the figure found by Oughton et al. (2002, p. 99), who assessed the impact of member states at an F-value of 5.8.

The impact of the knowledge region typology, revealed in the lower part of the Table, is more ambiguous. F-values are statistically significant for welfare and competitive strength, in terms of the position in 2000. From a dynamic point of view, in terms of the development of gross domestic product per capita and full time equivalent, the impact on competitive strength proves significant, but only at the five percent level. This is a first indication that the diversity on the 'input' side does not translate in a corresponding variation on the output side.

Table 4 Analysis of variance in economic output across NUTS-2 regions in EU member states and across NUTS-2 regions in knowledge region types, summary of results

	Variation			F <sup>1</sup>
	across nations	across regions within nations	total	
<i>EU member states</i>				
Gross domestic product per capita, 2000	5496	4695	10191	16.1**
Gross domestic product per employee, 2000	40176	19443	59618	28.3**
Gross domestic product per capita, 1995-2000	6259	4579	10838	18.8**
Gross domestic product per employee, 1995-2000	5021	7536	12557	9.1**



*Region types*

Gross domestic product per capita, 2000	7109	3082	10191	17.4**
Gross domestic product per employee, 2000	44760	14858	59618	13.2**
Gross domestic product per capita, 1995-2000	10345	493	10838	1.9
Gross domestic product per employee, 1995-2000	11791	766	12557	2.6*

<sup>1</sup> \* indicates significance at the 5 percent level; \*\* at the 1 percent level

Source: TNO, on the basis of Eurostat and OECD

Unlike Oughton et al.'s (2002) interpretation of the sizeable volume of variance within countries as an indication of the relevance of RIS arguments, we do not evaluate differences in knowledge inputs and economic output within nations as an indication of a systematic relationship between regional knowledge strategies and regional economic performance. The only sound conclusion we can draw from the results, given the high value of F, is that nations matter strongly. To further examine the impact of knowledge region types and EU member states on interregional differences in economic output, we performed a factorial design with nation and region type as independents and economic output, in terms of welfare and competitive strength, as dependent variable. The results are summarized in Table Five. The interaction between member states and knowledge region type is not significant for all four dependent economic output variables. Again, the results point to a high significance of national variation and a relatively weak influence of the regional typology. What we see accordingly is a pattern in which national systems make a genuine difference to regional performance, while empirically derived profiles of knowledge input prove to be less significant.

Table 5 Analysis of variance in economic output across NUTS-2 regions in EU member states and knowledge region types, summary of results

	$F_{NIS}^1$	$F_{RIS}^1$	$R^2$ (adjusted)
Gross domestic product per capita, 2000	9.1**	4.1**	58.5
Gross domestic product per employee, 2000	18.9**	1.8	68.9
Gross domestic product per capita, 1995-2000	17.6**	1.0	58.8
Gross domestic product per employee, 1995-2000	7.9**	0.7	41.0

<sup>1</sup> \*\* indicates significance at the 1 percent level

Source: TNO, on the basis of Eurostat and OECD

**5. Conclusions and outlook**

Regions play an important role in Europe's aspirations of a 'balanced development' trajectory that should also boost Europe's competitive position in the global economy. Much is expected from nurturing regions as core sites of innovation, inspired by the notion of Regional Innovation Systems (RIS) and through the development of regional innovation strategies. In this paper, RIS arguments have been unpacked and confronted with common insights into the role and nature of innovation strategies. We have identified four tensions within the political framing of RIS

strategies within European policies; (1) the projection of success stories to all regions, (2) the denial of systemic interdependencies in network and national economies, (3) the tensions between cohesion and competitive strength, (4) the steering possibilities attached to RIS arguments. Finally, two core themes emerging from this conceptual discussion – the significance of the national level and diversity – have been further explored through statistical analysis.

What are the results? On the Lisbon ambitions we can be brief. In line with other empirical studies, as well as recent observations EU-wide, regional performance data underline that the original Lisbon targets are overambitious. Even in the booming years of the late nineties, only a few regions achieved growth rates going in the direction of closing the gap with the world's main competing blocks, while a substantial amount of regions even failed to narrow the gap. Moreover, what the more detailed scrutiny of innovation data shows is that European innovation policies should not focus solely on technological innovation and R&D. Our analyses demonstrate that the gap between Europe and other trading blocks is especially wide in terms of human knowledge capital. Education and training should thus, even more than now, be the prime target of development policy. Furthermore, the examination of knowledge regions across Europe reveal strong differences in specialisation patterns in the knowledge economy. Large parts of Europe are focused on non-technological elements of the knowledge economy. In the same sense that the knowledge economy is not limited to technological innovation and expenditures in R&D, the European Research Area is not restricted to conventional technological hot spots in the European Union, such as the Southern part of Germany. While Europe's centre continues to focus on high-tech activities, the North-western corner is further specialising in knowledge intensive services. Taking a successful, intermediary position, Scandinavian countries prosper on a more diversified basis.

In terms of cohesion, our empirical typology of European knowledge regions points to a process of catch-up in the Eastern part of Germany and across Mediterranean countries. However, these patterns are to some degree countered by continuing spatial disparities in the knowledge economy. To what extent these developments are in line with the political aim of cohesion across the European Research Area cannot be assessed on the basis of our analyses here. This will require further research. However, what the result do not endorse is a systematic impact of knowledge region types on economic performance. There is no significant relationship between different types of RIS, as emerging through the dataset on knowledge input, and the data on competitive strength and welfare. Yet, there is a strong influence of the national level. At first instance, economic development is determined within a national context. The way in which RIS arguments are economically relevant within these national contexts remains an issue deserving more attention.

If we go back to the conceptual analysis, these results come as no surprise. The European policy discourse has tended to portray Europe's regions as 'engines' driven by particular forms of local knowledge dynamics, based on high-tech or knowledge intensive clusters. Moreover, it has trumpeted EU's capacity to facilitate and boost innovation strategies, whether within a European 'research space' or through regional programmes. Behind this promise stands a *national* reality, of *national* education and research systems, business systems and territorial agendas. Europe, through its extensive subsidy flows, may help to reduce regional discrepancies. Yet it is doubtful to which extent it can form a polycentric, and inclusive system of 'regional engines', that are more embedded in a 'European Research Area' than in a set of national systems. In terms of policy development, these results seem to warrant a shift in the governance of spatial innovation policies across Europe. In what way and to which extent has been the subject of some initial discussion (Kuhlmann, 2001). So far, what we can notice is that the rather fuzzy incorporation of RIS insights in the EU's spatial and economic strategies can be attributed to the way the region

has been caught between a pluriform set of ambitions (notably competition and cohesion), pursued at various spatial levels (notably through national and EU contexts). These points should be properly addressed by future governance models.

A final word about the provision of regional statistics. Currently, as indicated above, the empirical data available at European levels do not take into account the relational dimensions required for the analysis of 'interactive' innovation systems, although the Community Innovation Survey, coordinated by Eurostat, provides already a rich data set. Some countries have started to create more detailed and relevant data at the regional levels. Yet, Europe-wide, an extension of the coordination beyond national borders, from the design of the questionnaire to issues of data availability, remains wanting.

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