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Knowledge and the diversity of innovation systems: a comparative analysis of European regions

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Connaissance et diversité des systèmes d'innovation: une analyse comparative des régions européennes

Résumé

Cet article analyse la diversité des configurations régionales européennes en termes d'accumulation de connaissance et de performances socio-économiques. Notre hypothèse est que les liens dynamiques entre connaissance, innovation et performances sont spécifiques au contexte institutionnel au sein duquel interagissent des agents hétérogènes. Les études sur les systèmes nationaux d'innovation (Edquist, 1997) ont souligné le rôle du contexte institutionnel dans cette dynamique et identifient diverses configurations liées à ces systèmes nationaux. Ce cadre conceptuel, transposé au niveau régional, conduit à l'identification de systèmes régionaux d'innovation (Cooke, 2001) et souligne ainsi les limites des approches centrées sur la mobilisation d'un nombre limité d'indicateurs dans l'analyse des configurations régionales en termes de science, de technologie et de performances.

Cet article vise à dépasser les approches du type « tableau de bord » et expose une méthode d'identification de la diversité des trajectoires régionales et des systèmes d'innovation à l'échelle européenne. L'étude est réalisée au travers d'une analyse de données en mobilisant le cadre conceptuel « des systèmes sociaux d'innovation et de production " (SSIP) proposée par Amable, Barré et Boyer (1997). Un système social d'innovation et de production peut être défini comme une combinaison cohérente des différentes composantes du processus d'innovation : configurations Science-Technologie-Industrie (STI) articulées avec le système financier, les relations du travail, le système d'éducation et la formation et les performances économiques. Ce cadre peut être adapté au niveau régional en identifiant des arrangements locaux spécifiques, même si le concept de système peut manquer de pertinence à ce niveau spatial.

Une analyse de données (analyse en composantes principales, ANOVA hiérarchique) est conduite sur un échantillon de régions européennes défini selon les différents niveaux de la NUTS et repose sur trois sources principales (Eurostat, the Cambridge Econometrics database et OST (Observatoire des Sciences et des Techniques)). L'analyse comparative des profils régionaux et de leurs performances économiques permet d'identifier différentes configurations régionales en matière d'articulation entre accumulation de connaissance et trajectoires régionales. Notre hypothèse est que la croissance régionale ne relève pas d'un problème de « meilleure pratique » mais de la forme locale que peuvent prendre les complémentarités institutionnelles.

Mots-clé : Systèmes d'innovation, Economie de la connaissance, Diversité institutionnelle, Performances économiques régionales, Régions européennes.

JEL : R11, O2, O3, P5

Knowledge and the diversity of innovation systems: a comparative analysis of European regions

Abstract

The main goal of this paper is to shed some light on European regional diversity in terms of knowledge accumulation and socio-economic performances. Dynamic links between knowledge, innovation and performance are complex to address because they take place in different contexts, involving heterogeneous agents interacting through different institutions. Studies on national systems of innovation (Edquist, 1997) stressed the role of the institutional context in these dynamics and identify various configurations associated with these national systems. This conceptual framework, used at the regional level, leads to the identification of regional systems of innovation (Cooke, 2001) and thus underlines the limits of a regional scoreboard only based on high-tech indicators as it is usually proposed.
This paper constitutes a first attempt to propose a more exhaustive effort in characterizing the diversity of "regional knowledge an innovation systems " within Europe. The study is performed through data analysis using the conceptual framework of "social systems of innovation and production" (SSIP) proposed by Amable, Barré and Boyer (1997). A Social System of Innovation and Production can be defined as a coherent combination of different components referring to Science-technology-industry (STI) configurations articulated with financial system, labour relations, education and training and economic performances. This framework can be adapted at the regional level by identifying specific arrangements of each part of the system even if the concept of system is questionable at this level. The analysis is performed combining data from three sources (Eurostat, the Cambridge Econometrics database and OST (Observatoire des Sciences et des Techniques)) over a sample of NUTS-II european regions and using multivariate data analysis (principal component analysis, hierarchical anova). Putting together the SSIP and local economic performances allows defining different regional configurations in order to identify regional trajectories and patterns of articulation between knowledge dynamics and performance. Our hypothesis is that regional growth in not a problem of best practice but of coherent knowledge combination: institutional differences may lead similar (or different) STI structures to different (respectively same) performances.

Keywords: Regional Innovation systems, Knowledge economy, Institutional diversity, European regions, Regional economic performances.

JEL: R11, O2, O3, P5

Introduction[1]

Since the early 90's, there has been a growing interest into the subnational dimensions of innovation systems, partly because of a growing unsatisfaction with the relevance of the national level (Cooke, 2005). The theoretical as well as empirical concern with territorial dimensions of innovation encompasses a considerable range of research fields: local knowledge spillovers, innovative milieux, technological districts, Regional Systems of Innovation, Porter's clusters…A major issue addressed in this paper relates to the way to copy with the diversity of regional configurations of knowledge and innovation. The focus of existing litterature on some specific territorial models of innovation, combining spatial agglomeration, intensive and informal knowledge flows and networking leads to the conclusion that best pratices can be identified to foster innovation processes. This argument combines with a growing agreement that innovation, science and technology are growing sources of economic performance, at all (national, regional, local) levels. However, the strong institutional dimension (national, sectoral and regional levels) in the generation and dissemination of knowledge implies a strong possible remaining heterogeneity through coherent combination of different resources (sources of knowledge, intensity of interactions…) leading to various viable local configurations. As previously experimented on the French case in a precedent study (Carrincazeaux, Lung, 2005), we propose to adapt the Social Systems of Innovation and Production framework developed by Amable, Barré and Boyer (1997) at the regional level for European regions by identifying specific arrangements of each part of the innovation and production system.

A key feature of the research on Social Systems of Innovation and Production is the crucial role played by the concept of complementary institutions, allowing identifying a limited number of viable and stable configurations. This method allows addressing the diversity issue at two levels: firstly, by identifying which stable configurations result of the coherent combination of Science, technology and industry, at the European level. Secondly, by systematically addressing the issue of the economic performances of such regional configurations: do we observe differences in performances between regions with same STI structure? Do we observe differences in STI structures between regions with same performances? The paper is three parts made up: Firstly we propose a review of existing literature emphasizing the interest of implementing the SSIP method at the regional level. The second part of the paper presents some primary results of a systematic analysis of 135 European regions leading to a typology of Science-Technology-industry regional configurations in Europe. The third part proposes an analysis of the performances of the different STI profiles, and offers a discussion of the articulation between national and regional levels.

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1. The diversity of regional knowledge-related configurations : analytical framework

1.1. From Geographical Knowledge Spillovers (LKS) to Regional Systems of Innovation (RSI)

1.1.1. Knowledge tacitness and space-bounded knowledge flows

It has become increasingly recognized in the literature that spillovers of knowledge may have an important impact on innovation output. Moreover, considerable pieces of theoretical and empirical work stress the crucial role of geographical space in shapping knowledge spillovers. The main theoretical argument invoked to justify the existence of such "geographically mediated knowledge spillovers" relies to the intrinsic tacit nature of scientific and/or technical knowledge. Following the well-known distinction between explicit easily communicable knowledge and the tacit one (Polanyi, 1967), the current literature dealing with "the geography of innovation" (Feldman, 1994) assumes that most of strategic knowledge that spills over "*is highly contextual and difficult to codify, and therefore is more easily transmitted through face-to- face contacts and personal relationships, which require spatial proximity*." (Breschi and Lissoni, 2001a, pp.258). Von Hippel (1994) argues that "sticky" knowledge (ie contextual and uncertain knowledge) is best transmitted via face-to-face repeated interactions whereas Storper and Venables (2004) recently discuss four main features of face-to-face contacts: as an efficient communication technology, a way to solve some incentive problems ; a way of socialization and learning and a psychological motivation. In other words, knowledge " *is a public good, but a local one*" (Breschi and Lissoni, 2001a, pp. 258).

Grounded on the main hypothesis that physical proximity may foster local flows of knowledge, an increasingly convergent empirical literature aims at identifying such local externalities (Feldman ,1999 ; Autant-Bernard, Massard, 1999 ; Breschi, Lissoni, 2001b).

A first range of studies uses a spatially-modified version of the knowledge production function (Audresht, 2002). Contrary to the seminal work of Jaffe (1989) whose conclusions weakly supported the spatial proximity effect, most of subsequent studies identified a strong tendency for knowledge flows to be localized, even when taking into account some additional determinants of local innovation such as the firms size, the presence of producer services or the stage of the life cycle (Acs, Audrescht et Feldman, 1994; Audrescht et Feldman, 1996; Anselin, Varga, Acs, 1997).

Additionnal evidence has been brought using individual data on firms or patents citations. The seminal work of Jaffe, Trajtenberg and Henderson (1993), identifying the relationships between originating patents and citations, founds evidence of the localization of citations, after controlling for preexistent co-localization. Several studies address the issues of the channels by which knowledge spillovers are realized. Almeida and Kogut (1999) use data on the interfirm mobility of star patent-holders in the semiconductor industry and similarly conclude that the transfer of ideas associated with mobility patterns between firms is geographically confined. Darby and Zucker (1996) similarly emphasize the role of "star scientists" as a source of localized knowledge transfer.

A heated debate has emerged in the literature around the respective advantages of industrial/technological diversity or specialization. Whereas the original tests of the Marshall-

Arrow-Romer versus Jacobs externalities debate were performed using data on employment growth (Glaeser *et alii*, 1992; Henderson et al., 1995), Audresht et Feldman (1999) found evidence that diversity within cities across economic activities sharing a common science base was more conducive to innovation than specialization. Some similar results are obtained by Acs (2002) for United States, Massard et Riou (2002) for France and Andersson, Quigley, Wilhelmsson (2005) for Sueden.

Altogether, these studies suggest that strong local KS should exist. However, as stressed by Breschi and Lissoni (2001a) most of the results obtained do not really provide a demonstration of the existence of LKS, but rather some evidence that could be explained by the existence of LKS. More generally, the logical explanation supporting the LKS identification suffers of three main drawbacks.

(i) First of all, from most of theoretical work it appears that tacitness is not an intrinsic property of knowledge, but rather a property of how knowledge is transmitted. Tacit messages can be exchanged at a distance, depending on the level of mutual understanding of those who exchange. Conversely, codified knowledge is far from being accessible to everyone, as it crucially depends on the capacity of “translation” of people seeking to access to it. The codification of knowledge and the exchange of tacit messages thus appear to be often complementary (Steinmueller, 2000; Cowan, David, Foray, 2000).

(ii) The theoretical arguments generally invoked to justify the existence of LKS mix up some quite different mechanisms. Following the seminal marshallian concept of "industrial atmosphere" or local "buzz" (Storper, Venables, 2004), the main argument supporting LKS relies on the existence of pure technologic externalities arising through informal and unintended face-to-face contacts. But, as stressed by McCann and Simonen (2005), many authors adopt a very large and diffuse notion of local "buzz", including pecuniary externalities arising from the local mobility of human capital, the market of specialized services or technologic collaborations between firms and organisations. These are very different kinds of knowledge transfer mechanisms that must be clearly differentiated. For example, McCann and Simonen (2005) find that R&D formal collaborations between firms are more important in improving innovation performances at the local level than any other form of inter-firm relations, whereas Frisch and Franke (2004) found R&D cooperation to play "only a minor role as a medium for knowledge spillovers" (Frisch, Franke, 2004, pp. 253). The respective roles of pecuniary versus technologic externalities, of intended/formal versus unintended/informal flows, and the specific roles of human capital mobility and local entrepreneurship (Feldman, Audresht, 2004) are far from being clearly identified.

(iii) The role of physical proximity as a "mechanic" medium of knowledge transfer enhancing has been put into question, particularly through the work of the "proximity school" (Rallet, Torre, 2000, 2005 ; Gilly, Lung, 2003). Geographical proximity by itself do not appear to be necessary to favour knowledge transfers, even in the context of highly complex and/or uncertain knowledge (Freel, 2003). Conversely, the spatial clustering of firms does not imply substantial inter-firm interactions, but often relate to generic agglomeration economies (Gordon and MacCann, 2000; Rallet and Torre, 2005).

1.1.2. From physical to relational space : the "territorial models of innovation"

In contrast to studies of LKS, the family of "territorial models of innovation" (Moulaert, Sekia, 2003) developed since the 70's offers useful insights into the pre-conditions and channels leading to an effective role of the "local" upon innovation performances of firms. Initially developing in the context of the crisis of traditional regional policies in the 70's through the industrial districts school (Becattini, 1992 ; Paniccia, 2002), the "family" expands to the concept of innovative milieu during the 80's through the work of the GREMI (Aydalot, 1986 ; Camagni, 1991) and to the Porter's successful concept of clusters during the 90's (Porter, 1990). The profusion of concepts is even more pronounced when considering the "new industrial spaces" of the Californian school (Scott, 1988 ; Saxenian, 1994), the "local systems of innovation"(Kirat, 1993) or "technological districts" (Antonelli, 2000). In spite of the remaining diversity and somewhat confusion of theoretical approaches supporting these studies (Mac Donald, Bellussi, 2002 ; Moulaert, Sekia, 2003) one can identify some basic elements shared, at some degree, by most of authors[2].

• The relevance of socio-cultural preconditions for local-specific dynamics

A main feature of the industrial districts literature is the emphasis on socio-historic conditions supporting the emergence of some cultural proximity between the members of a local community. The "sense of belonging" and shared common values are often invoked as key elements explaining the capacity of local actors to interact (Cappelo, 1999 ; Cappelo, Faggian, 2005). Such an emphasis on cultural specificity is also present in the work of Saxenian (1994).

• The territory as a specific mode of coordination

As a consequence of the pre-existence of a sufficient degree of "institutional thickness" (Amin, Thrift, 1995), the intensity and stability of local interactions constitute a specific mode of coordination of economic activities. A main feature of the industrial districts and innovative milieu literature is the emphasis on cooperation as a rule of governance (Mac Donald, Bellussi, 2002). The intensive local relationships are based on trust and reciprocity, allowing for transaction costs reduction, improved division of labor and increased specialization and flexibility (Scott, Storper, 1988).

• The importance of local institutional dynamics

These approaches emphasize the centrality of local institutional dynamics insofar as they attempt to define the way in which a territory produces a specific arrangement of stable relations between territorial actors, based on a particular set of local conventions. Following Camagni (1991) a key feature of the distinctive nature of innovative milieu is the existence of dynamic collective learning processes that enhance local creativity and innovation, notably by reducing the dynamic uncertainty intrinsic to innovative activities (Kirat, Lung, 1999).

• Organized proximity versus spatial proximity

A major common feature of territorial models of innovation relates to the conception of proximity. A common conclusion emerges, stating that spatial proximity by itself does not provide a conducive environment for innovation, but that some specific territorialized systems provide such a favorable environment insofar as they are the support of a built "organized proximity" (Rallet, Torre, 2005). Rallet and Torre (2005) define organized proximity as "*the*

[2] An exhautive presentation of the different concepts is of course beyond the scope of this paper, the more so as some recent literature surveys have been published (Mac Donald, Bellussi, 2002; Moulaert, Sekia, 2003; Paniccia, 2002).

ability of an organization to make its members interact" (p 49). Two main raisons are stressed: the logic of "belonging", referring to the superior ability of members of a common organization to interact because of common rules of routines they follow; and the logic of "similarity", referring to the cognitive proximity of the members. A similar distinction is proposed by Cappelo (2002) through the concepts of relational capital and relational space (cappelo, Faggian, 1999) : the "local" matters only when being the support of some kind of relational proximity, encompassing synergy/cooperation among actors and a socialization of production.

As stressed by Rallet and Torre (2005), the territorial models of innovation refer to a fusion of the two main forms of proximities, by which organized proximity "activates" the geographical one. The most accepted explanation of the local dimension of relational/organized proximity thus refers to the embeddeness theory (Granovetter, 1973) : the existence of localized innovation cooperations is mainly explained by the fact that such cooperations develop between actors belonging to highly territorialized social networks, or to professional networks encouraged by local institutions (Grosseti, Bès, 2001; Grosseti, 2005).

A major and distinctive conclusion of the embeddedness approach is that geographical clustering of firms does not exhibit any intrinsic superiority in fostering knowledge flows and thus innovation performance : "*Geographical proximity is not so much an economic cause of agglomeration as a social effect of the embeddedness of economic relations in inter-individual relations*" (Rallet, Torre, 2005, p. 52).

As a consequence, the intersection between organized and geographical proximity is only one possible upon four : Supra-local organizations, as well as temporary co-localization of actors (or "nomad proximity"), also provide organized proximity (Rallet, Torre, 2005).

1.1.3. A broader and synthetic perspective: Regional Systems of Innovation

Since the early 90's, the concept of RIS has received considerable attention from academic researchers as well as policy makers (Doloreux, Parto, 2005). The approach of the regional systems of innovation (or RSI) has been developed at the intersection of the evolutionist theory of technical change and the regional economics. The evolutionist perspective on innovation is a common feature of the literature on National Systems of Innovation (Lundvall, 1992; Endquist, 1997) conceptualizing innovation as a social and interactive process, and thus emphasizing the role of the institutional context and the diversity of national arrangements. Alongside the focus on NIS, there has been a growing interest into the subnational dimensions of such systems, partly because of growing insatisfaction with the relevance of the national level (Cooke, 2005). Lundvall (1992), for example, argued that "*regional production systems, industrial districts and technological districts are becoming increasingly important*" (Lundvall, 1992, p. 3). The theoretical concern with territorial dimensions of innovation and learning processes combine with an increasing demand for implementation of innovation policies at the regional level (Doloreux, Bitard, 2005).

Even in the absence of a commonly accepted definition of the RIS (Doloreux, Parto, 2005), the main characteristic elements of the RIS literature can be sketched. A RIS can be depicted as a systemic and administratively supported interaction between the regional production structure (or "knowledge exploitation subsystem" in the terms of Asheim and Coenen (2005, p. 1177)) and a regional supportive infrastructure (subsystem of creation of knowledge according to Cooke and alii, 1998) made up of government or private research laboratories, technology transfer agencies, technology incubators, training systems, etc.

A key dimension of RIS is thus the institutional setting aiming to support firms in their innovation needs through systematic interaction and collective learning. The regional context in which these interactions take place is primarily characterized by informal institutions (norms, routines, trust...) (Cooke et al., 1998). A RIS is thus a system characterized by a high level of local interactions and interdependence. The focus on institutional arrangements is clearly underlying the definition of a RIS given by Cooke and Schienstock (2000, p. 273) as consisting of "*a geographically defined, administratively supported arrangement of innovative networks and institutions that interact regularly and strongly to enhance the innovative outputs of firms in the region*". As a consequence, the learning capability of the region must be clearly distinguished from the knowledge infrastructure (ibid.).

A distinctive feature of the RIS approach compared to previous territorial models of innovation is that it is primarily defined as a governance structure, administratively defined. The approach is thus extremely clear on the relevant space level and seeks to avoid both the issue of spatial boundaries and the problem of the diversity of the space scales: the area is defined as a place in which firms and innovation are supported by public or private decentralized organizations. The region appears to be a significant meso-level structure of coordination of economic activities, between the national and local levels, and is thus the level of governance adapted to the operation of a RIS as Asheim and Coenen (2005) point it out.

The RIS approach offers a broader and synthetic view on the local dimensions of innovation systems. On the one hand, it encompass most of key features of previous territorial models of innovation, such as the contextual and interactive nature of innovation processes, the centrality of local untraded interdependencies coming from embeddedness and the role of regionally concentrated networks and industrial clusters. On the other hand, through focusing primarily on the governance structure, the RIS approach avoids the issue of confining the analysis on a specific model of territorial developement, and thus allows for coping with the variety of regional configurations.

1.2. Issues in the identification of Regional Systems of Innovation

1.2.1. Global versus Local interactions

One of essential criticisms relates to the postulated character of local interactions within the majority of the territorial approaches. As illustrated by most of studies evoked previously, it is always possible to identify local interdependences as well as a certain local coherence, having previously identified the limits of such a "local system". The "proximity school" seeks to avoid this issue by taking the firm as the starting point of analysis. This allows deducing the role of space in relation to innovation activities and the relations of proximity which bind the firms, organizations and institutions. Space is not thus postulated any more, but built though it results from the superposition of various forms of proximity. The "local" becomes only one component of the innovation process, but not an inevitably and obligatory channel.

The main conclusions drawn from this field of work are that localization does not result inevitably in local interactions and that even the existence of local relations does not imply that the innovation process depends primarily on them: local and non-local relations are complementary in the innovation processes (Lung, Rallet, Torre, 1999). In this framework, the territory corresponds to a superposition (which can be only temporary) of forms of geographical and organized proximity (Bouba-Olga, Carrincazeaux, 2001).

Nevertheless, the firm organization-based approach does not make it possible to fully understand the dynamics of specific territories. It cannot be else than complementary with a more territorial-grounded analysis (Crevoisier, 2001). Only an approach combining the territorial, organizational and technological dimensions make it possible to appreciate the role of space in the innovation processes. The innovation systems can (and must) be analyzed at various scales which can be territorial or not (Malerba, 2002; Carlsson and alii, 2002).

The RIS approach is a good illustration in the way that it immediately integrates the existence of innovation networks which inevitably do not have only a local dimension. The regional system then becomes the starting point for a reading of the articulation between local and global dimensions of innovation and knowledge flows, which take place within a specific institutional context.

The debate turns therefore around two questions, corresponding to two levels of criticism.

On a first level, the debate relates to the degree of taking into account the relations external to the regional system. These relations can be largely underestimated in the analyses of localized systems, as typically in the clusters literature (Oinas, Malecki, 2002; Simmie, 2004) which has tended to "fetishize" local networks, according to Amin and Cohendet (1999). Theoretical works as well as case studies generally insist on local networking, learning and the role local institutions, but the external relations are often absent, according to Bathelt (2005). A growing number of case studies emphasize the crucial and often dominant role of external interactions over local ties, as in the case of aerospace clusters (Niosi, Zhegu, 2005) ; electronics in Toronto (Britton, 2003), Hollywood (Scott, 2002) the Britannic "motor sport valley" (Henry, Pinch, 2001) or Hertforshire innovative firms (Simmie, Sennet, 1999).

In the same way, Wolfe and Gertler (2004) stress the crucial role of external interactions in enhancing the development of local systems. As argued by Bathelt et al. (2004) "*the more the firms of a cluster engage in the buildup of translocal pipelines the more information and news about markets and technologies are 'pumped' into internal networks ant the more dynamic the buzz from which local actors benefit*" (p. 41). Some authors even suggest the possibility of a 'over-embeddedness' phenomenon (Uzzi, 1996, 1997), thus indicating that close local ties are only benefic to a certain extent (Bathelt, 2005).

On a second level, when opting for directly spatial approach, the most difficult problem is undoubtedly that of the choice of the spatial level: local, regional or national systems of innovation? The literature on the national systems of innovation has developed in the 1990's parallel to the emergence of the question of the public intervention in the field of science and technology. Work of Lundvall (1988, 1992), Nelson (1993), Freeman (1995) or Howells and Wood (1999) among others, largely contributed to popularize the concept. Basically, the identification of these systems rests on the bringing together between innovation and institutions. Innovation relates to learning capacity and interactions whose form falls under a specific institutional arrangement (standards, rules, culture etc...). The national dimension of the system rests on the role of the state-nations in the definition of these institutions (political institutions, public intervention) and sense of belonging to the same community by language, history and the share of common values. This type of approach thus makes it possible to explain coherence between productive specializations, performances and innovation for various countries.

One thus could find problems extremely close between regional and national systems of innovation. Howells (1999), exploring the components of NSI that could operate at the regional level, finds three dimensions justifying the RSI approach : the long-term evolution and development of regional industrial specializations, the regional structure of government both in relation to its administrative set-up and in terms of legal, constitutional and institutional arrangements; and long-standing core/periphery regional differences in industrial structure and innovative performance within most of advanced countries.

The debate was gradually placed on the field of the political intervention and institutions. For Lundvall and al. (2002), local interactions have some importance in the production of innovation, but these regional interactions depend to a great extent on their national context, as these regional configurations remain primarily defined by institutions and policies implemented at the national level. Similarly Gertler (1997) argues that the regional perspective seriously underestimate the remaining vital role of national institutions. Conversely, Asheim and Coenen (2005) or Cooke (2004) defend the idea according to which the national technological policies showed their limits and that only a strictly regional approach should be adopted since it is the relevant governance level: the concept of national system of innovation is considered to be useful, but insufficient.

These debates show that various scales remain possible for the study of innovation systems, but that the question of the relevant scale of analysis seems without immediate theoretical answer. The problems of the relevant scale can only be treated within the framework of institutional analysis.

1.2.2. Sectoral versus regional innovation systems

The focus of the RIS approach on the regional dimension of innovation systems could underestimate the purely sectoral determinants of innovation and spatial organization of activities. In other words, the industrial composition of regional economies, in terms of knowledge base and technological specificities, strongly influences regionally accessible performances and/or trajectories. The theoretical proposition of Breschi (2000) constitutes an interesting attempt to spatialize the concept of technological regime initially introduced by Nelson and Winter (1982). A technological regime is defined as the combination of four fundamental factors: opportunity conditions, appropriability conditions, cumulativeness of technical change and the nature of the knowledge base. Each of these dimensions clearly influences the spatial organization of activities as well as possible regional outcomes[3]. The concept of spatial cumulativeness, defined as "*the degree of persistence with which the accumulation of innovative capabilities takes place within specific geographical areas*" (ibid., p. 217), illustrates the sectoral versus regional problem : if cumulativeness of innovation is high at the firm level, then the spatial concentration of innovation will only reflect the sectoral concentration resulting from innovative leader's selection and powerful entry barriers. On the other hand, if cumulativeness is high at the sectoral level, spatial cumulativeness will reflect regional-specific trajectories. The empirical study conduced by Breschi (2000) also reveals

[3] See Breschi (2000) for details.

that spatial cumulativeness of innovation[4] is strongly correlated with regional innovation performances. It also leads to the identification of three broad groups of technological classes that behave similarly in all countries :

- A first group combining a widening sectoral pattern (i.e. low concentration and high turbulence of innovators) with low spatial concentration and low spatial cumulativeness of innovative activities. (traditional classes)

- A second group combining a widening sectoral pattern with low spatial concentration and high spatial cumulativeness of innovative activities (including most of mechanical engineering industries)

- a third group combining a deepening sectoral pattern (high concentration and low turbulence of innovators) with high levels of spatial concentration and cumulativeness (comprising chemical and electronic classes)

Freel (2003), using the well-known taxonomy of sectors of Pavitt (1984) provides comparable insights into the sectoral-specific patterns of innovation and networking for small and medium firms.

1.2.3. How to copy with the variety of Regional Innovation Systems?

Initial research on territorial models of innovation and RSI has strongly focused on a limited number of case studies. As claimed by Doloreux (2002, p. 259-60), "*The RSI research agenda is still highly focused on metropolitan regions or successful regions. Indeed, we do not know how valuable this concept is and how effectively it can be applied to structure action–policy in remote areas*". A number of recent studies have thus focused on the diversity of forms of RIS, looking for a taxonomy of such systems.

A first and still dominant attempt to reflect the diversity of the relationships between the production structure and institutional set-up of a region is oriented towards the governance mode of regional technology transfer. Three main categories are identified in a similar way by Cooke (1998) and Asheim and Coenen (2005) :

- The "Grassroots" or "territorially embedded" RIS as labeled recently by Asheim and Coenen (2005) where firms base their innovation activity mainly on localized interfirm learning processes with market-oriented applied research and with low interactions with external knowledge infrastructure as well as supra-local coordination.

- The "regionally networked innovation systems" corresponds to a multi-scale governance at local, regional, national and global levels, with both a high degree of collective learning through inter-firm relationships and an interactive relationship with highly developed and regionally devoted knowledge creation and transfer infrastructures.

- the "dirigiste" RIS, also labeled "regionalized national innovation systems" by Asheim and Coenen (2005), comprise situations where most of the knowledge infrastructure as well as industrial structure is functionally integrated in a national or even global level, with a crucial

[4] Measured as the first-order autocorrelation coeficient of patents held by regions between 1978 and 1991.

role devoted to fundamental research and scientific activities, weakly connected to local firm-based innovation processes.

The usefulness of this classification is exemplified by the case studies compiled by Braczyk and al. (1998) when opposing the Bade-Wurtemberg (networked) to Tuscany (Grassroots) or Midi-Pyrenées (Dirigiste). However, this typology tends to promote the "regionally networked innovation systems" as an ideal type of RIS, cumulating the advantages of the localist mode (embeddedness and market-oriented innovation) and of the dirigiste one (R&D effot and science-industry relationships) . As quoted by Asheim and Coenen (2005, p. 1181) *"Similar to the regionalized national innovation system, the knowledge infrastructure plays an indispensable role. But in contrast to it, the cluster is not science-driven but market-driven. In comparison to the territorially embedded regional innovation system, the networked RIS often involves more advanced technologies combining analytic and synthetic knowledge"*. Cooke (2004) thus stress that most of regions initially classified in either the localist or dirigist categories tend to evolve towards a regionally networked mode, as for Tuscany or Midi-Pyrénées.

This raises a central debate addressed in this paper: to which degree can we theorize/observe a persisting diversity of RIS or a convergence towards some 'best practices'? Two main issues should be addressed :

(i) Firstly, the dynamics of RIS are not only tied to the regional governance structure, but also to the sectoral patterns of innovation. The regional configurations of innovation greatly depend on the heterogeneous regional industrial structure, leading to differentiated ways to innovate. The regional "performance" is thus no more a question of optimal governance structure (including the question of the global, national or regional level) but rather of *coherence* between industrial structure and the knowledge creation and diffusion set-up. For example, the typology proposed by Doloreux and Bitard (2005), following the work of Breschi (2000), cross the spatial dimension (agglomeration versus diffusion) and the sectoral pattern of innovation (widening versus deepening) to identify four possible configurations. An another attempt was made by Cooke (1998, 2004) to cross the governance dimension with a firm-related typology encompassing their size (SMEs versus BF), the nature and intensity of local inter-companies relations and their attitude towards innovation[5].

(ii) The relation between the economic performance and the differentiated characteristics of the different types of RIS must be addressed directly and more systematically. As a key assertion influencing policies implementation across Europe relates to the crucial role of innovation for regional competitiveness and the correlative shared objective of building regional "knowledge laboratories " (Cooke, Piccaluga, 2005), the remaining diversity in attained performances of RIS is of special interest, as well as the identification of distinctive types of regions exhibiting low performances.

Isaksen (2001) for example develops a typology of RSI according to the regional barriers to innovation:

- The “organizational thinness RSI" showing a lack of actors to enable collective learning,
- The “fragmented RSI” showing a lack of regional cooperation among actors,

[5]Cf. Cooke (2004) for details.

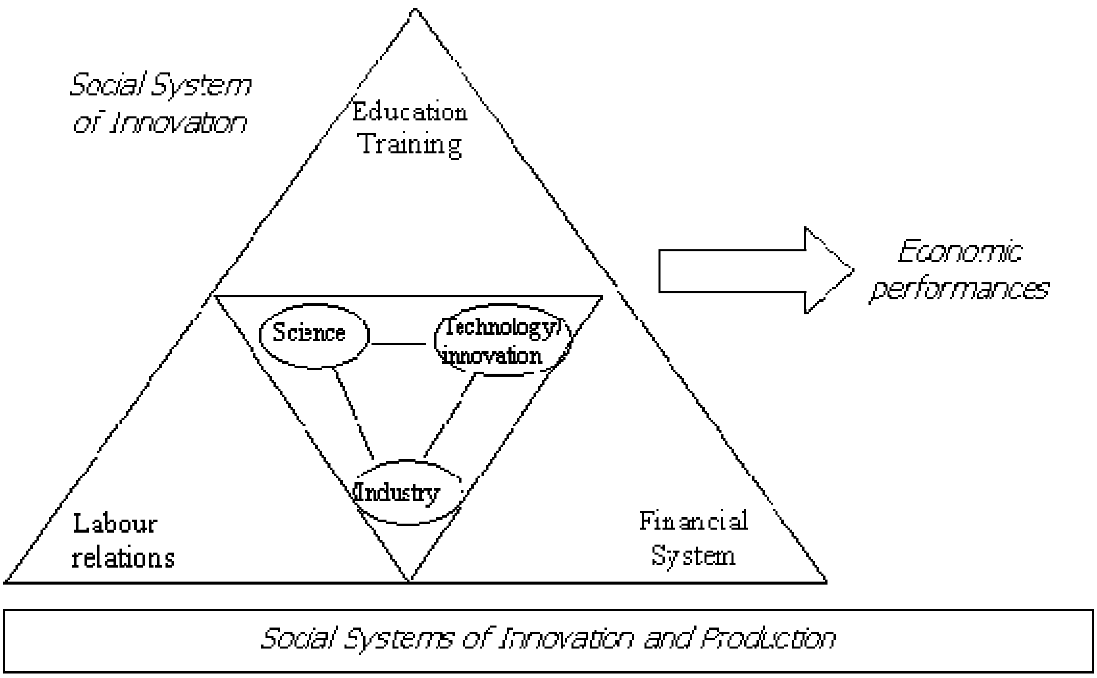
- The "Lock-in RSI", typically old industrial regions specialized in declining industries or technologies

1.3. Analyzing the diversity of regional knowledge-related configurations: implementing the Social Systems of Innovation and Production (SSIP) at a regional level

1.3.1 The Social Systems of Innovation and Production (SSIP) framework (Amable, Boyer, 1997)

The conceptual framework of "social systems of innovation and production" (SSIP) was initially proposed by Amable, Barré and Boyer (1997) in order to overcome several weaknesses of existing institutional approaches such as the National Systems of Innovation (NSI) studies, the "diversity of capitalisms" school or the regulation theory. In short terms, the SSIP methods aims at overcoming the tendency of most of the studies of NSI to concentrate on national case studies, thus identifying as many configurations as countries. While sharing a number of common features with the "diversity of capitalisms" school, the approach is more macro or meso-economic and thus less focused on the firm level (Amable, Petit, 2001). it's also more restrictive than the regulation theory in the set of institutions considered but shares the same ambition to analyse whole production systems.

Figure 1. Social systems of innovation and production framework (Amable, Boyer, 1997)



A key feature of the research on Social Systems of Innovation and Production is the crucial role played by the concept of complementary institutions, allowing identifying a limited number of viable and stable configurations among those resulting from the mechanic association of each institutional form considered in the analysis (Amable, 2000).

A SSIP can thus be defined as a coherent combination of different institutional components (figure 1). Amable, Barré and Boyer (1997) identify six institutional sub-systems: science, technology, industry (forming together the production and innovation system), financial system, human resources and education/training. The combination of these institutional forms led us to identify four idealised models of social systems of innovation and production, each one having its distinctive pattern of institutional complementarity and hierarchy : The market-based SSIP, the social-democratic SSIP, the meso-corporatist SSIP and the public SSIP.

1.3.2. The implementation of the SSIP method at the regional level

As previously experimented on the French case (Carrincazeaux, Lung, 2005), we propose to adapt the SSIP framework at the regional level by identifying specific arrangements of each part of the system. Compared with previous case studies of territorial models of innovation or RIS, this method presents several advantages.

(i) Focusing on a regional level does not here constraint to presuppose a high degree of internal cohesion or of functional autonomy, as would imply the concept of "regional system", since some of the institutional forms introduced in the analysis are still implemented at the national level. Insofar it's preferable to identify "regional configurations of innovation" resulting from the coherent combination of institutional settlements defined at various scales.

(ii) The concept of institutional complementarity can be useful to consider in a systematic way the articulation between the regional knowledge creation infrastructure and the sectoral-specific patterns of innovation of the industrial regional structure. As discussed previously, these sectoral patterns are influenced by fundamental factors like technologic opportunities, appropriability conditions, and cumulativeness of technical change, but also by sometimes sectoral-defined institutional forms concerning the concurrence regime, relations to customers or interfirm relationships.

(iii)) The concept of institutional complementarity allows identifying a limited number of coherent regional configurations, while much of the empirical work during the last decades has been concerned with a growing number of case studies, thus focusing interestingly on the specificity of each regional context but loosing in the generality of the principles.

(iv) The SSIP appears to be well designed for coping with the diversity of regional configurations. Putting together the SSIP configurations and local economic performances allows defining different regional configurations in order to identify regional trajectories and patterns of articulation between knowledge dynamics and performance. Our hypothesis to be tested is that regional growth is not a problem of best practices but rather of coherent knowledge combination: institutional differences may lead similar (or different) STI structures to different (respectively same) performances.

1.3.3. The integration of the spatial and urban structure of regions

A growing number of studies suggest that metropolitan regions are of crucial importance for the development of knowledge-intensive activities (Lapointe, 2004 ; Gaschet, Lacour, 2005). The correlation between urban size and the production of innovations is highly documented (Audretsh, Feldman, 1999; Audretsh, 2002; Acs, 2002 ; Carlino and al., 2001). The convergent studies of Brouwer and al. (1999) on the Netherlands and Andersson et al. (2005) on Sueden stress the crucial effect of the density of urban regions within each of these countries on the innovation outputs of firms. Brouwer and al. (1999) also find that metropolitan regions favour the occurrence of more radical innovations, whereas peripheral regions have a bias towards process innovation, a feature also stressed by Camagni and Cappelo (1998) for Italy.

The level of industrial diversity of metropolitan regions, as well as the stronger accumulation of human capital within these areas are often invoked to explain these regional differences, thus describing metropolitan regions as “nursery cities” well designed for the emergence and first stages development of new industries (Jacobs, 1967 ; Duranton, Puga, 2001 ; Henderson and al., 1992). Although most of the existing literature tends to justify the "innovative advantage" of cities (Audresht, 2002) from probabilistic mechanisms tied to local interactions' enhancement, Simmie (2003, 2004) interestingly describes metropolitan regions as key nodes for innovation activities, arguing that only urban regions combine a strong local knowledge base and high levels of connectivity to similar regions in the global economy, thus favorizing the access to non local resources as well as international collaborations.

Some recent contributions largely come to relativize the role of local interactions within metropolitan contexts, thus underlining the prevalence of more classical metropolitan externalities Two recent studies of Scottish clusters, respectively in biotechnologies (Leibovitz, 2004) and the audio-visual production (Turok, 2003), lead to similar conclusions: on the one hand the weakness of local interactions; on the other hand, the key role played by the access to human capital, specialized services, and to urban infrastructures.

The systematic analysis of localization factors of high-technology firms within large urban areas proposed by Fenkel (2001) leads to similar conclusions, as well as the study of Gordon and MacCann (2000) dealing with the sensibility to local ties of the main clusters located in London. Similar conclusions are advanced by Chantelot (2005) concerning the emergence of the urban clusters related to the ICT.

Some authors therefore stress the specificity of metropolitan innovation systems. Cappelo and Faggian (2005) find contrasts related to the dependence on local ties between Milan and Piacenza. Simmie & al. (2002), in a comparative study of five european urban areas, show that international trading advantages and the availability of a pool of specialists play a major role in all of them, the importance of local factors (suppliers, technology transfer institutions) been even negligible in the three open capital cities, Paris, Amsterdam and London.

Although the urban structure of a region cannot be considered as an institutional form, the introduction of urban size and related items in the regionalized SSIP framework thus appears to be important. Following the existing literature, we should expect to find two types of features:

(i) Some complementaries are expected between the urban structure of regions and their scientific, technologic and industrial profile. For industrial sectors or technological classes heavily relying on the availability of a diversified pool of skilled workers, metropolitan locations should be more suitable than others. The institutional complementarity between S-T-I and education could therefore be mediated by the spatial structure of regions.

(ii) As the literature suggests an important effect of urban density on innovation ouputs as well as on economic performance (Ciccone, Hall, 1996 ; Ciccone, 2002), we must control for this feature when addressing the link between regional institutional configurations and economic performances.

2. Identifying regional configurations in Europe

2.1. Method and data

2.1.1. SSIP at the regional level

The statistical approach presented here is a first attempt to identify systematically Social systems of innovation and production at the regional level. The systematic character aiming at comparing European regions is of course strongly limited by available data, but we also face some theoretical limitations.

The SSIP approach is based on the complementarity of different institutional blocs, conceptually defined, but actually thought at a macro level. The first main bloc is the Science-Technology-Industry (STI) one. This bloc is at the core of the analysis of SSIPs, the innovation process relying on the articulation of these three dimensions. Analysing STI configurations at the regional level can make sense but we immediately face the difficulty of the regional openness: can we assume STI complementarities at the local level for each technological domain or industrial sector? How to articulate local and global levels of complementarity? This raises the question of the critical mass of STI activities and symmetrically, the question of the pertinent spatial scale. We will retain an administrative definition of regions based on the NUTS and just try to look at the existence of apparent complementarities at this level.

Following the SSIP approach, the STI coherence must be articulated with human capital, productive organization and financial system. Human capital classically refers here to education and training, the organization of the educational system being central in the creation and dissemination of knowledge. We consider that the regional educational level can be accepted even if the educational system can have a strong national dimension based on history and state involvement.

The two other components are more difficult to consider at the regional level. Productive organisation and labour relations are often defined by national laws even if specific relations may exist at a more local level. Here again, countries may differ on institutional settings around the relation between State (law), firms' management and labour unions. The question of the specificity of local arrangements is a heavy one we won't deal with here as data to evaluate labour relations is only generated at the national level.

The same question arises when considering financial relationships and the financial system. The relative importance of financial markets or banking system is of major importance in this type of approach because it determines the possibility of long term financing, the compatibility between liquidity and demand characteristics (stability or new technologies), and also productive organisation (relationships between shareholders, managers and employees). These features are particularly nationally dependents, but it can have heavy consequences on local relationships between large corporations and SMEs, on the regional governance (dependence degree) and patterns of knowledge accumulation and dissemination (appropriability, secret). We can hardly assume a regional influence on this financial systems (except certainly for national metropolises), but regional knowledge dynamics are influenced by the financial system. Here again, the lack of regional data in this domain reflects its poor local relevance, but we will try to take the financial system into account by incorporating the presence of financial services as an indicator of financial potential for innovative activities.

Our analysis of SSIP at the regional level is then limited to STI and educational profiles. We add a qualification of the urban structure in order to take into account the role of cities in the process of creating new knowledge.

2.1.2. The statistical approach

The statistical qualification of regions is relative, each indicator being expressed as a ratio or a share aiming at neutralising size effects. This can lead to associate very different regions in terms of size or wealth, but this is exactly the aim of the analysis: identifying regional relative configurations in terms of coherent articulation of different blocs. The analysis of absolute differences is nowadays well documented in the European regional scoreboards.

Following the method presented by Amable, Barré and Boyer, the study consists in qualifying each region by a set of indicators used in a principal component analysis. This allows analysing the relative position of each region, according to the indicators selected, and identifying main configurations. A hierarchical classification on factorial axis is then used to construct a regional typology.

Our first objective is to construct a STI typology of European regions. The interpretation of the STI profiles through complementarities between each bloc first necessitates a separate analysis of these blocs. We perform successive classifications for scientific, technological and industrial configurations. These classifications are then used to interpret STI profiles. The following step integrates educational and urban profiles.

We finally compare these regional profiles with economic performances of regions in recent years.

2.1.3. Data sources and the regional level

If countries or regions provide well documented databases or specific case studies, we face much more problems when one wants to adopt a systematic approach. The more complete database on European Regions is provided by REGIO database from Eurostat that constitute our main source. This database is completed by Cambridge Econometrics for some industrial data, investment, GVA or compensation. We also use data from the French Observatory of Science and Technology (OST) for patents and scientific publications in European regions. For urban structure, we use the geographical information system provided by Eurostat (GISCO).

Facing an important lack of information for new entrant countries, we decided to limit our first study to UE15 regions.

The definition of scientific disciplines, technological domains and industrial sectors results of the availability of data. Categories remain rather broad and this must be kept in mind when interpreting specialisation or diversification of activity.

Another important question refers to the geographical scale we choose. Most information is available at the NUTS2 level, but European countries differ largely in their regional organisation. If NUTS2 level makes sense for France, Spain or Italy, it is not the case for Germany or United Kingdom for instance. Our approach being institutional, we wanted to take into account the administrative organisation of countries instead of the usual size criteria. This of course lead to compare very different regions and this will have to be deepen later. At this step we decided to adopt NUTS2 as often as possible, but NUTS1 or State level is chosen when this scale is more coherent with the definition of regional economic policy in certain countries or when data are not available at each NUTS level (this constraint is generally linked with administrative organisation). Regional levels adopted are presented in table 1. This lead to a sample of 142 European regions, later limited to 129 as a consequence of data availability (modifications of NUTS 2003 or regional specificities of islands and very small regions).

Table 1. Choice of the regional level

Country	Code	NUTS level	N level	Name
Austria	AT	2	9	States
Belgium	BE	1	3	Regions
Denmark	DK	0	1	
Finland	FI	2	5	Large areas
France	FR	2	22	Regions
Germany	DE	1	16	Lander
Greece	GR	1	4	Groups of development regions
Ireland	IE	2	2	Regions
Italy	IT	2	21	Regions
Luxembourg	LU	0	1	
Netherlands	NL	2	12	Provinces
Portugal	PT	2	7	Comissoes de coordenaçao regional
Spain	ES	2	19	Autonomous communities
Sweden	SE	2	8	National areas
United Kingdom	UK	1	12	Regions
Total			142	

2.2. Science, Technology and Industry profiles

Each of the three blocs is analyzed successively to define groups of regions around indicators for science activity, technological dynamism and industrial specialization.

2.2.1. Scientific profiles

European regional scientific configurations are analysed using 10 indicators linked to public research potential or scientific publications. Public funding indicates the scientific effort made in a region as scientific knowledge can be assumed as largely produced by public research.

Scientific publications measure the scientific production of the region. All indicators are calculated in relative terms in order to avoid a size effect and to compare regions according to their relative scientific profile.

Regional public research is described with 3 indicators (Eurostat, Regio database):

- Regional public (governmental institutions or universities) expenditures (% of regional GVA) indicate the local relative effort on scientific research;
- Public expenditures by researcher of the public sector gives an indication on the intensity of this effort;

- The share of public spending on total research (public and private) indicates the scientific orientation of the region or also “the lack” of private research compensated by public effort.

The total number of scientific publications (OST database) is weighted by regional population and indicates the scientific relative production of regions.

These indicators are complemented by the disciplinary orientation of publications. The share of regional publications is calculated for six main disciplines: fundamental biology, medicine, chemistry, physics, mathematics and engineering science. These domains are chosen in order to represent scientific orientation of the regional research. Other domains are also available, but the method of analysis would give too much importance on these specialisation indicators comparatively with the others.

The examination of correlations between variables shows that associations exist through regions on public research spending, relative number of scientific publications and publications in the fundamental biology domain. Specialisation indicators show that physics, chemistry and mathematics are negatively correlated with medicine, the same trend (but weakly) being observed between engineering sciences and fundamental biology.

This leads to the definition of the first factorial axis based on these oppositions, the following axis being more defined by specialisations in specific domains.

The first factorial axis identifies regions that are scientifically active (important ratio of scientific publications) in life sciences (fundamental biology and medicine) and in which public spending is relatively high (ratio of public spending on GVA). At the opposite are found regions active in more traditional scientific fields (chemistry, mathematics and engineering sciences). The second axis isolates indicators of public spending relative intensity (share on total regional spending and amount by researcher) and also publications in physics by opposition with medicine. This first factorial plane describes more than half of the total inertia around the opposition and complementarity between intensity of public research, scientific output, traditional scientific research and life sciences. The third axis give complementary information to this by opposing regions with high level of public spending by researcher and share of total research expenditure (ie predominance of the public sector) to those with a good publication level or public spending (in terms of %GVA). The following axes stress original tendencies apart from these general orientations, essentially based on scientific domain specialisation.

A hierarchical classification on factorial axes allows us to be more precise on these general configurations. We retain a seven class’s partition stressing the difficulty to clearly isolate numerous European regions being relatively closed according to our indicators of scientific profiles. Four classes appears relatively stable grouping regions apart from the main average tendency

Class 1 groups dynamic regions in life science (more than half of publications in biology and medicine) with the highest publication ratio, public funding and share. Regions from Sweden, Finland or Netherlands are paragons of this class with some regions from United Kingdom, France or Germany.

Class two groups regions presenting an “average” configuration: the publication level is just above the average (mean of 0,586 publication for 10000 inhabitant, 0,559 for all regions) and public spending also (in %GVA, the two other indicators of public spending intensity are below the average). No particular specialisation[6] appears, the share of each discipline being also close to the overall mean, but with higher values in four disciplines. This class appears equilibrated in terms of scientific domains (low specialisation) and scientific profile (public involvement or publications output)[7].

The third class is very close to the former. Variable means indicate a lower diversification among scientific disciplines (Medicine and engineering sciences are more frequent) and a higher share of public spending. We here find some national trends, class two being essentially composed of French, German, Belgian and also Spanish regions (respectively 14, 9, 2 and 8 regions over represented for these countries) although class 3 is composed of Britannic regions (7).

Classes 4 and 5 are characterized by a lower publication ratio. They differ on two others criteria: public involvement and scientific orientations. Class 5 represents regions with traditional scientific orientations (mathematics, chemistry, physics and engineering sciences) essentially from Spain (6 regions) or Portugal (3 regions). Class 4 exhibits a strong public involvement and a scientific diversification. Italian regions are more present in this class (8 of 15).

Table 2. Science: classification

Classes	N regions	Main orientations
1 – high scientific activity	21	Highest publication ratio, high public spending, specialisation on life sciences
2 – equilibrated regions : average science activity, diversification	36	Publication ratio above average, public spending in average, all scientific domains represented
3 – equilibrated regions, less diversification	20	Publication ratio above average, public spending in average, higher share of public sector and lower scientific diversity, medicine, engineering
4 – Low scientific activity, diversified domains	15	Publication ratio under average, high public presence (spending and share), all scientific domains represented
5 – Low scientific activity, traditional domains	27	Publication ratio under average, share of public spending, traditional scientific domains
6 – very low scientific activity	13	Very low ratio of publications, very weak public spending, specialisation on medicine

The sixth class exhibits the lowest relative publication rate and public effort in research with a specialisation on medicine (49% of publications in this domain against 34% on average). Regions of this class are essentially from Austria (4) and Netherlands (4).

2.2.2. Technological profiles

Three types of indicators are used to qualify European Regions technological profiles around R&D, human resources in science and technology and patents.

[6] Specialisation or diversification is of course dependant on the division used. As our fields are large enough, specialisation remains relative.
[7] Regions can also belong to this group because they don't fit well main configurations. A deeper analysis would of course reveals particular cases.

The intensity of private R&D spending is measure through the ratio of private expenditure on regional GVA. It classically indicates the relative intensity of R&D effort. This indicator is complemented by R&D intensity measured by employment (R&D employees on total employment).

Technological effort must be viewed in a broader sense and we also use EUROSTAT database on human resources in science and technology (HRST). We retain three indicators in this domain: HRST in total employment, the share of employment in high and medium-high technology sectors, and the employment share of intensive knowledge services.

The technological output is measured by the total number of patent applications (European patent office) per inhabitant and also the share of each technological field[8].

The examination of linear correlation among these variables on 129 European regions reveals a strong link between indicators of high technological activity. Indicators of R&D intensity are strongly linked with the number of patents per inhabitant and weakly with high tech employment share or intense knowledge services. Even if this doesn't represent a general law (according to imperfect correlation), regions well endowed with private R&D present also high values for patent applications and employment in high tech sectors and knowledge services (correlation are below 0,6 in that case). Patents in electric/electronics are positively associated with this configuration although the consumption/construction field is negatively correlated. The other fields doesn't exhibit strong correlations even if mechanical by example is always negatively (but weakly) correlated with high technology indicators.

These heavy trends on technology indicators clearly define an opposition between high technology-oriented regions and less technologically developed regions: the first axis of the principal component analysis illustrates this opposition and represents one third of the total inertia. The next axes give complementary information on patent specialisation: pharmaceuticals vs mechanics for axis two, industrial processes and chemicals vs instruments and electronics on axis three, etc. Regional technological configurations are mainly influenced by their technological potential firstly defined by the intensity of private R&D and propensity to patent. Patents fields only give secondary information on the regional specialisation.

The hierarchical classification isolates 7 classes more or less stable on average profiles according to specialisation on patents domains. The first axis determines 3 main classes from high intensity R&D regions (with high patent or HRST ratios and specialisation on electrics/electronics) to low technological intensity regions specialised on consumption/construction and mechanics. The intermediary group of regions is composed of 77 regions (on 129 retained for this analysis).

The subdivision in 7 classes follows this logic but incorporating different specialisations. The first class (10 regions) presents the highest values for R&D intensity, patent ratio and human resources (HRST, knowledge intensive services and medium/high tech employment ratios). These regions fit well the usual definition of high tech regions. They appear to be rather specialised on one technological domain: electrics/electronics represents near than 42% of total patents against 17,5% for the whole sample.

[8] the OST database provides classification of patents in 7 fields: electrical/electronics, instruments, chemicals/materials, pharmaceuticals/biotechnology, industrial processes, mechanics and household consumption/construction

Table 3. Technology: classification

Classes	N regions	Main orientations
1 – Intense technological activity, specialized regions	10	Highest rates of patent application, RD intensity, and human resources in S&T or knowledge services. Specialisation in the electric/electronic domain
2 – High technological activity, more diversified regions	17	High rates of patent application and RD intensity, high proportion of human resources in S&T and knowledge services. Patents domains : electric/electronics, instrumentation, pharmaceuticals
3 – Technological activity on average, process technology	9	R&D and patents on average, high presence of HRST. Patents domains rely on process technologies : chemicals, industrial processes and pharmaceuticals
4 – Technological activity on average, traditional technology	22	R&D, patents and HRST on average, specialisation on mechanics, industrial processes, consumption/construction
5 – Low technological activity and human resources, specialisation	25	R&D and patent ratios under average, human resources in S&T on average. Patents domains: specialisation on instrumentation and electrics/electronics
6 – Low technological activity and human resources, specialisation	20	Low R&D and patents ratios, human resources in S&T on average. Specialisation on pharmaceuticals and chemistry
7 – Low tech profile	26	Lowest values for R&D intensity, patents and human resources. Specialisation on consumption/construction and mechanics.

The second group (17 regions) presents a close profile in terms of human resources in technology but has lower values for R&D intensity and patent ratio. At the same time, these regions are more diversified associating with the electronic domain a high share of patents in instruments and pharmaceuticals.

These two “high tech” groups gather regions mainly from the North of Europe. Swedish and Finnish regions are over represented (respectively 4 and 2 regions) while we find only 2 German regions (Baden-Wurttemberg and Bayern) and one French region (Ile de France). The North of Europe dominates also the second class with 5 regions from United Kingdom, 3 for Germany and one for 5 other countries. 3 French regions and one Spanish are also associated to this group.

At the opposite, class 7 congregates what we could call “low tech” regions with the lowest values for R&D intensity, patent ratio or human resources, the main patent domain represented being consumption/construction and also (but the share is just above average) mechanics. This class mainly assembles regions from Italy, Spain, Greece or Portugal (with 3 Austrian regions). We find here the traditional opposition between North and South of Europe.

Intermediary situations are of course less clear. The fourth lasting classes combine low (classes 5 and 6) and intermediary (classes 3 and 4) values for technological level indicators with “specialisation” on patents domains.

Classes 3 and 4 differ on technological domains, the latter has important share of patent applications in traditional technology (consumption, mechanics) while the former associates average technological profile with chemicals, pharmaceuticals and industrial processes. This leads to higher mean values on human resources indicators and patent ratio for class 3 regions. Regions from Austria, Netherlands, Sweden and France are present in class 4.

More surprisingly, classes 5 and 6 draw around low technological indicators values and high tech domains specialisation: electrics/electronics and instruments for class 5, and pharmaceuticals and chemicals for class 6. These specific technological profiles concern some French, German, Italian and Britannic regions.

2.2.3. Industrial profiles

Qualifying industrial profiles of regions would imply to gather information on industrial specialisation, size distribution and also on the structure of the capital and ownership (decisional level, FDI etc.). Available data only permits to qualify specialisation, industrial diversity can only be approached by indirect measures.

We first qualify regions by the internal share of main sectors of activity: agriculture, construction, manufacturing, services and non market services (Cambridge econometrics database). Regions are also characterized by their manufacturing specialisation (Regio database): we calculate the manufacturing employment share of 9 sectors. We also use the same sector ventilation for the relative share in terms of number of units. The comparison between employment and number of units gives indirect information on sectoral concentration. This is complemented by the theil index to evaluate sectoral diversity at the regional level (performed on employment and number of units). We add the share of regional employment in financial and transportation services in order to be more precise on services specialisation.

Table 4 – Industry: classification

Main groups (4 clas.)	8 classes	N regions	Main orientations
Services and industrial diversity	1	32	Manufacturing mainly on electronics, chemicals, food and wood/publishing. Financial services
Services and industrial concentration	2	8	Transportation equipments, electronics, and wood/publishing. Financial and transportation services
Manufacturing diversity	3	14	Main sectors (employment concentration) : transportation equipments, electronics , mechanics, and chemicals
Non market services and manufacturing diversity	4	9	Manufacturing diversification (employment concentration) but on more traditional sectors : electronics, mechanics, metallurgy, mining and wood industries
Manufacturing, traditional sectors	5	27	Metallurgy, mechanics and chemicals
Non market services and agriculture, food industry	6	15	Agriculture, food and mining. Coexistence of SMEs and large units
Agriculture, food and construction	7	5	Extreme configurations: share of agri. and construction, very low manufacturing share and poor diversification (Food, mining, textile).
Manufacturing, specialized textile	8	19	Higher share for manufacturing, diversification but unequal distribution of size among sectors. Domination of textile industry.

The analysis of regional industrial configurations is consequently based on 27 variables.

Weak correlations between variables indicate a great diversity of industrial configurations. Correlations between main sectors' share just indicate a (weak) negative link between agriculture or manufacturing employment and services. Units and employment shares exhibit correlations when they rely on the same sector but this association between the number of establishments and employees at the regional level depends on sectors: textile, wood and mechanicals have higher correlations than food, chemicals, metallurgy and electronic sectors revealing some regional specific tendencies for manufacturing concentration. On the contrary, Theil indexes are not well correlated with other indicators.

These unclear tendencies are illustrated by the principal component analysis, axis being not always clearly defined. Nevertheless, the first factorial plane represents regions around the share of main sectors.

The first axis opposes regions in which agriculture and construction represent a higher share of total employment, manufacturing employment being often concentrated in food and textile industries, with regions more diversified in manufacturing (mechanicals, electronic and transportation equipments) and with a high share of services in the total employment. The second axis isolates regions with a significant share of manufacturing employment and differing on services share. Variations around these main sectors give 37% of the total inertia (first factorial plane). Regional differences on mixed manufacturing specialisations are captured by the following axes.

The classification of the 129 European regions considered is articulated around this logic (main sectors and different manufacturing specialisations). The first significant partition isolates 4 large groups. Regions characterized by an important share of manufacturing employment (mean of 21%) are also more diversified on manufacturing sectors (highest Theil index performed on units number, medium when calculated on employment[9]). The most frequent manufacturing sectors are mechanicals, metallurgy, chemicals, electronics and transportation equipments. At the opposite, food and textile industries are underrepresented.

The second class groups regions with an important share of services activities (associated with a high share of transportation or financial services) and a medium diversity in manufacturing sectors. Electronics and wood industries present a higher share of manufacturing in these regions.

The third main class is defined by the important share of non market services (public presence in education or healthcare) and manufacturing specialisation on food, chemicals and metallurgy. An important feature is the difference between the two measures of the Theil index: manufacturing employment is rather well distributed among sectors (diversity above average), but on the contrary, the number of units is unequally distributed (weakest Theil index for this group). This indicates a strong unequal distribution in plant size among sectors. The share of employment being high for metallurgy and chemicals by comparison with the number of units, we can infer concentration is high for these sectors in regions belonging to this group.

Finally, agriculture employment share dominates (average of 10,6%) in the last group of regions. This essentially penalises services share. The construction sector and textile and food industries have relative high values on average in this group.

[9] If concentration is higher on employment than on establishment number, regions may have some important units on some specific sectors.

These main tendencies help the interpretation of the 8 classes we retain for this classification presented in table 4.

The most important feature of this analysis of industrial structure is certainly the heavy dominance of country specificities in the determination of classes. Some classes heavily rely on regions belonging to the same country: the third class corresponds to German regions (14 on 16), the fourth class to Scandinavian regions (5 from Sweden and 4 from Finland) and the sixth class is dominated by French regions (9).

Inequalities of industrial development are found with the overrepresentation of Italy, Spain, Portugal and Greece in classes 7 and 8.

We find more diversity in other classes. Class 5 of manufacturing (traditional industries) regions is mainly composed of French regions (11), but regions from Belgium, Spain, Austria and Italy are also associated to this class. Class 1 congregates regions from UK, Netherlands and Ireland but most countries are represented in this class. Class 2 is less country specific and groups main metropolitan regions.

2.3. STI synthetic profiles: regions and nations

The following step consists in interpreting STI complementarities at the regional level. We performed the same statistical method on the 129 European regions using the 50 variables associated with the 3 blocs (Science, Technology and Industry). The 11 classes obtained are interpreted in the light of the dominant classes to which regions belong in the previous individual bloc analysis.

2.3.1. Which complementarities at the STI level?

The statistical method allows grouping regions according to their relative originality facing average trends. Table 5 presents the correspondence between the 11 STI classes and previous analysis. Regional STI configurations rely on different logics that we try to interpret.

Class 1 exhibits a strong association between high scientific activity, high or very high technological activity and high share of services and electronic industries. These 6 regions are first defined by their relative high share of services (globally, but mainly in finance) and intense knowledge services, high level of publications and patents, intensity of private and public research. **These regions are knowledge intensive** in that sense. These regions exhibit also a high **coherence between technology and industry** with a high specialization on **electronic** industry associated with propensity to patent in the same domain. A second coherence appears between **science and technology** with publications in **life sciences** and patents in the pharmaceutical domain.

Class 2 is close to the former in terms of scientific activity, but technological activity is very high for these regions and industrial activity is more diversified. These regions are **highly knowledge intensive** (R&D public or private intensity, very high publication and patent levels) and diversified on the scientific side, technological activities being more specialized in electronics. The share of intense knowledge services is also very high. Industrial activity appears also diversified with a high share of activity in electronics, mechanical and transportation. This specialization is very coherent with the high share of patents in the electronic domain. These regions can be qualified as **high tech regions specialized in electronics and mechanical industries**.

Class 3 presents an original STI structure with most of regions in high scientific activity class but also with low (or average) technological activity. The industrial typology offers more diversity (regions belonging to classes 1, 2, 4 and 6), the only common character being the share of services (market or non market). These regions present actually high share of public research associated with a high level of publication essentially in fundamental biology. If the technological activity is low (low private R&D and patents), the share of patents in pharmaceuticals is high. On the industry side, if no particular specialisation appears on average, these regions have a high share of intensive knowledge services and of human resources on science and technology. This profile seems to be **science pushed in the domain of life sciences** (publications and patents in biology and pharmaceuticals).

The coherence of class 4 is mainly based on industrial profiles. Scientific profiles are generally on average but low and high science levels are also present. On the technological side, diversity of profiles is higher but specialisation is often on chemicals and pharmaceuticals. The main characteristics of these regions are industrial diversity and the share of services employment. One more important feature is the correspondence between high employment share in chemicals and patents in chemical and pharmaceutical domains. This profile is then defined by the share of **services, industrial diversity** and technology/industry **complementarity around chemicals**.

Table 5. STI profiles

Classes	Science	Technology	Industry	N	Paragons	STI
CLASS 1	1 – High scientific activity, life sciences	2 – High technological activity, electr, instr, pharma.	2 - Services (finance) and industrial concentration (elect, publishing)	6	London, Paris, Stockolm, Wien, Berlin, Bruxelles	**Metropolitan regions**
CLASS 2	1 – High scientific activity, life sciences	1 – Very high technological activity, electr.	4-Non market, services and Manufacturing diversified (trad. Industries) + cl1 and cl3 : Indus. Diversity	8	Sweden, German, Finnish regions	**North high tech specilised regions**
CLASS 3	1 – High scientific activity, life sciences	6 – Low technological activity , process (Pharma, chemic.)	1 - Services and industrial diversity (elect, chemic., wood, publishing) or concentration (cl2, electr. Publishing)	13	Netherlands and others	**North regions, services and high scientific activity**
CLASS 4	3 – Average scientific activity, lower diversity, medicine, engineering	Contrasted technological activity : 2 – High technological activity, electr, instr, pharma. but also 5-6 specialized chemicals/pharma.	1 - Services and industrial diversity (elect, chemic., wood, publishing)	23	UK and heterogeneous	**Services and industrial diversity**
CLASS 5	2 – Average scientific activity, diversification	5 – Low technological activity, instr., electr.	3 – Manufacturing, diversified on chemic., transp., electr., meca.	11	German regions	**German profile**
CLASS 6	2 – Average scientific activity, diversification	5 – Low technological activity, instr., electr	5- Manufacturing traditional sectors (food, mec, metal) and 6- Non market services	18	French regions + 1 from Netherlands and Ireland)	**French profile**
CLASS 7	5 – Low scientific activity, traditional domains	4 – Average technological activity, traditional technology	5- Manufacturing traditional sectors (food, mec, metal), 4- Non market and trad. Industries	17	Heterogeneous	**Traditionnal regions**
CLASS 8	6 – Very low scientific activity, medicine	4 – Average technological activity, traditional technology	heterogeneous : 5- Manufacturing traditionnal sectors (food, mec, metal) + 1- Services and industrial diversity (main sectors : elec, chemic, wood, publishing)	6	Regions from Netherlands and Austria	**Low urbanized regions from Austria and Netherlands (NUTS level effect?)**
CLASS 9	4 – Low scientific activity, diversification	7 – Very low tech activity	Construction, 8 - Manufacturing, specialized textile and 6-non market services + agro food	13	Spain and Italy	**Low tech South regions**
CLASS 10	5 – Low scientific activity, traditional domains	7 – Very low tech activity	8- Manufacturing, specialized textile	9	Spain, Italy, Portugal	**Textile and manufacturing South regions**
CLASS 11	4 – Low scientific activity, diversification	7 – Very low tech activity	7- Specialized agriculture, food, construction	5	Greece	**Agricultural South regions**

The industrial profile is also the basis for grouping regions in the fifth class. Scientific profiles are low or on average but diversification of scientific domains is the rule. Technological profiles are more contrasted, low technological profiles are dominant but some regions originate from high tech or average classes. The existence of this class relies mainly on **industrial diversity**, main sectors being chemicals, mechanics, electronics and transportation equipments. The association of publications in physics and chemicals or patents in chemicals (and also on instruments with lower share) in these regions draw a picture of **strong industrial profile coherent with scientific and technological orientations**, reinforced by a high share of employment in high and medium technology sectors and of human resources in science and technology.

Class 6 reveals a close scientific profile but with different orientations (mathematics and chemicals). Technological orientations are less homogeneous for regions in this group and the only significant feature is the share of patents in mechanicals. Here again, industrial profiles are determinant. If regions in his group belong to the same industrial classes (traditional sectors or non market services), the common character is the important share of food and chemical industries. In this case **complementarity seems to be between science and industry**, no common trends qualifying technological profiles.

Class 7 groups regions around traditional science, technology and industry. The level of scientific and technological activity is low or on average, and these regions belong essentially to manufacturing classes (traditional sectors). This class is very coherent from science to industry with publications in engineering sciences and physics, patents on mechanics and industrial processes, and specialisation on mechanics and metallurgy. These regions present a **STI profile based on traditional industries**.

Class 8 is very specific: the six regions grouped have for only common feature a very low scientific activity (scientific publications and public spending in R&D). They present much more diversity on the technological and industrial side.

Classes 9 and 10 are very close to each other, associating low scientific and technological activities and traditional industrial sectors. The share of public sector in the scientific domain (indicating a real public effort but also the poorness of private R&D) for class 9 regions, and the pre-eminence of textile industry in class 10 explain this grouping. We can observe similar trends for the last class in terms of science and technology, the share agriculture and food industry being its main originality.

2.4. Complementarity between STI profiles, educational and urban structures

The method used here can't give us strong evidence of a systemic dimension of regional configurations observed. We just shed some light on systematic (and relative) differences between regions. Nevertheless, some clear profiles emerge from this analysis.

Some regions (classes 1 to 3) are clearly knowledge intensive on science and technology, but they differ on the domain and the nature of complementarities between blocs. Class one of high science and technology regions, presents a double coherence between S&T in the life science domain and between T&I in electronics with rather high industrial concentration. Class 2 groups also high tech regions, but more specialised in electronics (T&I). Regions from class 3 are more "science push" in the domain of life sciences. All these regions are rather diversified, but they show a high share of STI activities around electronics and life sciences. These three classes represent 21% of UE15 population, but 29% of GDP.

Classes 4 and 5 are defined by industrial diversity complemented by services and a T&I orientation in chemicals for class 4, a strong coherence between technological and industrial diversity better characterizing class 5. These two classes represent about 40% of UE15 population and GDP.

Traditional industrial orientation and the share of food industry define class 6 with an apparent coherence between science and industry on food and chemicals (about 10% of UE15 GDP and pop.). A strong STI coherence is noticed for class 7 around more traditional industries (also 10%).

The last three classes group low tech regions with specialisation mainly in textile, agriculture and food industry. These regions represent almost 17% of UE15 population, but 9% of GDP.

We of course must note that all this configurations are dependant from our initial choices on NUTS level (spatial scale) and science, technology and industry definitions. Specialisation is generally higher when the geographic scale is smaller and sectoral division more precise, this may lead to weaker complementarities. This certainly explains the existence of class 8 composed of low urbanized regions from countries for which NUTS2 level implies some "little" regions. It is nevertheless interesting to find these complementarities in regions administratively defined.

In order to deepen our analysis, we observe complementarities between STI and educational profiles, and we also try to better characterize our regional level by the urban structure.

Education and formation are analysed through regional indicators on population or active population highest educational attainment based on International Standard Classification of Education (ISCED - Regio database).

Four indicators are used for the educational level of the regional population (expressed in share of population): the total number of students, students in primary and secondary educational level, students in tertiary education and students in vocational programmes whatever the educational level.

The same indicators qualify the regional economically active population (educational level as a share of active population): primary and secondary educational level attained, upper and post secondary (non-tertiary) level and tertiary level.

We also take into account life-long learning through the participation of adults aged 25-64 in education and training (share of total population). We finally include the share of core HRST in total HRST (ie HRST educational level corresponding to occupation). This indicates the ability of the regional system to offer occupation corresponding with educational level.

If we compare regional STI profiles with regional educational profiles, we always notice a strong coherence of profiles. Regions belonging to the three first STI profiles (science and technology knowledge intensive regions) generally also belong to high educational profile classes. Industrial diversity of classes 4 and 5 is associated to the share of vocational programmes. Conversely, low tech profiles are associated to low educational levels.

The urban structure of European regions is analyzed using a set of indicators calculated from the STEU coverage of GISCO. This database provides an estimation of the population of each urban agglomeration of more than 20000 inhabitants. The urban structure of each region is described by a set of five variables measuring the share of the urban population of each region in a size interval: from 20000 to less than 100 000 inhabitants ; from 100 000 to less than 500 000 inhabitants; from 500 000 to less than one million inhabitants; from 1 million to less than 5 millions inhabitants; cities of more than 5 millions inhabitants.

In addition the degree of polarization of the local urban structure is approximated by computing the share of the largest urban area of the region in the urban population (*first city weight*)

The hierarchical classification leads to an eight-class partition. The first class regroups logically the two main European world cities regions: London and Paris. The classes 2 and 3 relate to metropolitan regions, ie regions with a high degree of urbanization and at least one city above one million of inhabitants. The class 2, labeled " Polarized metropolitan regions" is characterised by a pronounced concentration of the regional population in the largest urban area, with a degree of polarization equal to twice the mean value (0,9) whereas regions belonging to the class 3, labelled " Reticulated metropolitan regions", exhibit a more balanced structure, their first metropolis accounting for less than 50% of the urban population (0,47). The classes 4 to 7 follow a similar polarized *versus* balanced contrast for two categories of regions. Classes 4 and 5 regroup regions with an important regional metropolis of similar mean size around 700 000 inhabitants (716 000 inhab. mean value for class 4-regions and 666 000 mean value for class 5-regions) whereas class 6 and 7 relate to medium size cities systems with a first urban area around of 250000 inhabitants. The last class regroups very low urbanized regions.

Table 6. STI profiles, education and urban system

Paragons	STI	Educational profile	Urban profile	Regional configuration
London, Paris, Stockolm, Wien, Berlin, Bruxelles	**Metropolitan regions**	6 – High educational level	5-Capital metropolises	**Knowledge intensive metropolitan regions**
Sweden, German, Finnish regions	**North high tech specilised regions**	7-1– High and medium educational effort and level	3 – Balanced medium-size cities system	**Knowledge intensive specialized regions (electronics)**
Netherlands and others	**North regions, services and high scientific activity**	6-1– High and medium educational effort and level	3 – 4 Medium-size cities system	**Science push regions**
UK and heterogeneous	**Services and industrial diversity**	8 – High educational effort – vocational	7 – Reticulated metropolitan regions and Regional metropolises	**Diversified metropolitan regions**
German regions	**German profile**	2 – Medium regions – vocational	3 – Balanced medium-size cities system or reticulated regional metropolis	**Industrial regions specialized in medium technology industry**
French regions + 1 from Netherlands and Ireland)	**French profile**	1 – Medium regions	3 – 4 Medium-size cities system	**Low urbanized regions with medium scientific activity**
Heterogeneous	**Traditionnal regions**	Heterogenous	3 – 4 Medium-size cities system	**Traditionnal industrial regions (mecanic, metallurgy)**
Regions from Netherlands and Austria	**Low urbanized regions from Austria and Netherlands (NUTS level effect?)**	2 – Medium regions – vocational	1 – Low urbanized regions	**Low urbanized regions specialized in traditional technologies**
Spain and Italy	**Low tech South regions**	3 – Low educational level	3 – 4 Medium-size cities system	**Peripheric regions - specialized in textile and food industry**
Spain, Italy, Portugal	**Textile and manufacturing South regions**	3 – Low educational level	Medium-size cities system and regional metropolises	**Traditionnal industrial regions (textile)**
Greece	**Agricultural South regions**	3 – Low educational level	3 – Balanced medium-size cities system	**Peripheric regions – specialized in agriculture**

The most surprising and unexpected feature is the strong association inside STI profiles of regions belonging to the same country or European macro-regions. Most of French, German or Britannic regions are grouped in only one class, the two first countries defining a unique STI profile. The third last classes are essentially composed of South European regions. Conversely, North European regions dominate classes 2 and 3.

Three classes are more diversified in that sense. The metropolitan profile actually groups capitals of 6 countries underlying the particular role of this metropolitan function. The same diversity is observed for diversified metropolitan regions profile from STI class of

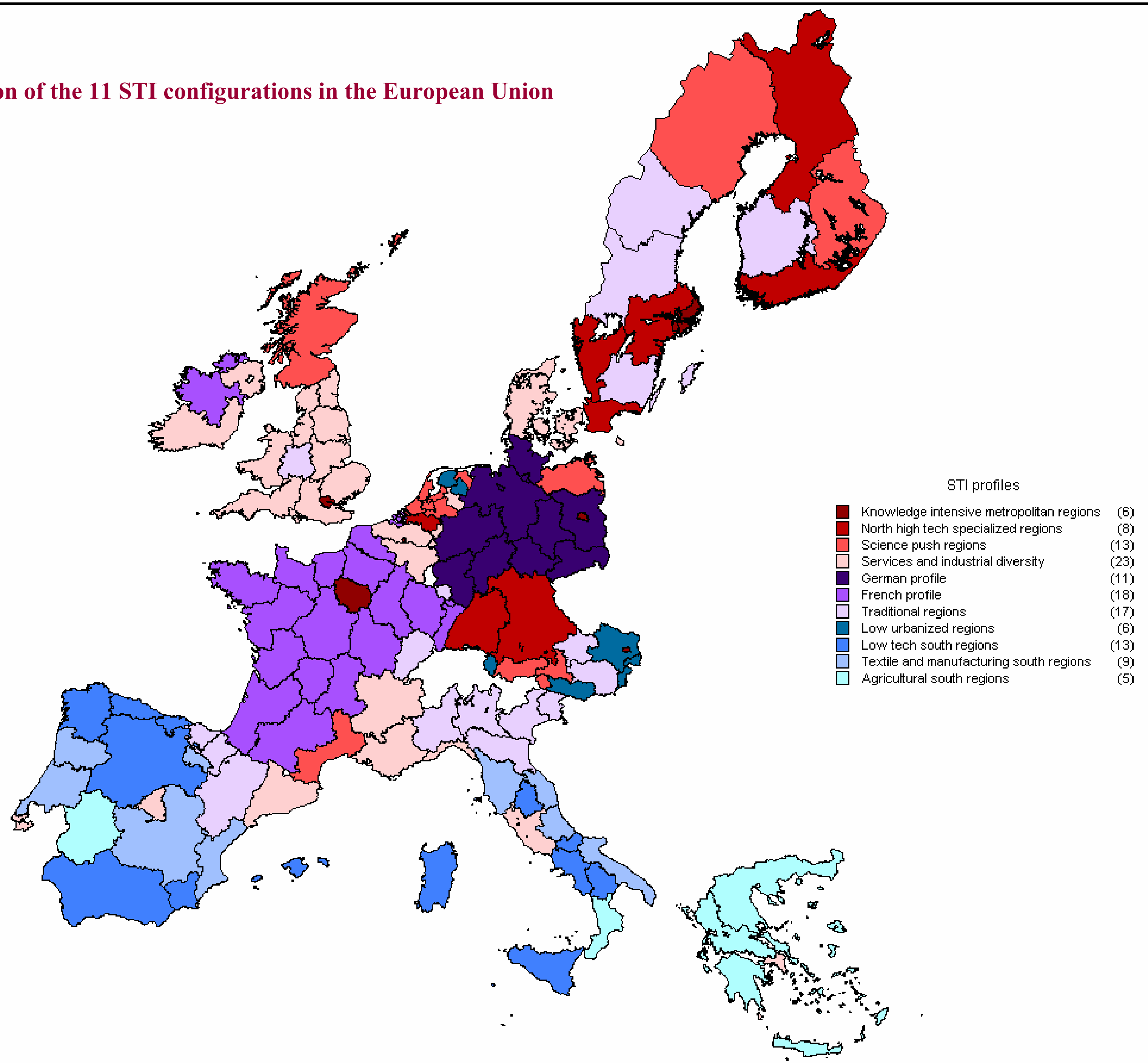
Services and industrial diversity. It seems that only metropolitan dynamics take some regions apart of countries specificities. The exception would be traditional industrial regions also belonging to different countries. We also must notice that regional inequalities in South European countries are clearly underlined by our typology (figure 2).

This typology finally more or less fits the “models” of capitalism identified by Amable (2004) and also the well known opposition between North and South of Europe, but it also underlines specific profiles based on the specific role of metropolises.

Table 7 – STI profiles and countries

Country	N regions	Metropolitan regions	North regions, services and high scientific activity	North high tech specialised regions	Services and industrial diversity	German profile	French profile	Traditional regions	Low urbanized regions (NUTS level effect?)	Low tech South regions	Textile and manufacturing South regions	Agricultural South regions
Austria	9	1	2					2	4			
Belgium	3	1			2							
Denmark	1				1							
Finland	4		1	2				1				
France	21	1	1		2		16	1				
Germany	16	1	1	2		11		1				
Greece	4				1							3
Ireland	2				1		1					
Italy	18				2			5		6	4	1
Netherlands	12		6	1	2		1		2			
Portugal	3				1						2	
Spain	16				2			3		7	3	1
Sweden	8	1	1	3				3				
UK	12	1	1		9			1				

Figure 2. Localisation of the 11 STI configurations in the European Union



3. STI profiles and performances

The relation between economic performances and the differentiated characteristics of STI regional profiles must be addressed directly and more systematically. As a key assertion influencing policies implementation relates to the crucial role of innovation for regional competitiveness, the remaining diversity in performances of regional configurations is of special interest, as well as the identification of distinctive types of regions exhibiting low performances.

3.1. A first look on the diversity of performances of STI regional configurations

Since economic performance cannot be clearly defined through only one indicator, we adopt a multidimensional approach of regional performance, combining a range of traditional indicators: Labor productivity in manufacturing (2003); GDP per capita (2003); GDP annual growth rate (1995-2003); Employment annual growth rate (1995-2003); Unemployment (2003); Unemployment annual variation (1995-2003).

Table 8. STI configurations ranking for a range of performance indicators

Regional STI-EU configurations	GDP per capita (2003)	Productivity (2003)	GDP ann. growth rate (95-03)	Unempl. (2003)	Employment ann. growth rate (95-03)
Low urbanized regions specialized in traditional technologies	7	11	2	1	5
Low industrialized regions with medium scientific activity	8	7	9	7	7
Traditional Industrial regions (Mecanic, Metallurgy)	4	5	10	2	8
Knowledge intensive specialized regions (electronics)	2	3	4	5	6
Diversified metropolitan regions	5	4	3	3	3
Industrial regions specialized in medium technology industries	6	2	11	9	11
"Science push" regions	3	6	6	4	2
Knowledge intensive metropolitan regions	1	1	8	8	10
Peripheric regions - specialized in textil and food industries	9	9	5	10	1
Traditional industrial regions (textil)	10	8	7	6	4
Peripheric regions - specialized in agriculture	11	10	1	11	9

3.1.1. The good performances of knowledge- intensive STI configurations for GDP and productivity levels…

Table 8 provides a systematic ranking of STI profiles according to their mean performances for a range of indicators. When looking to level indicators, knowledge-intensive configurations exhibit strong performances for GDP per capita and labor productivity. The three best performing profiles are those with science and/or technology intensity: "Knowledge intensive metropolitan regions"; "Knowledge intensive specialized regions" and "Science push regions". Although differences remain low with some performing more traditional regions when considering GDP, they are more pronounced for labor productivity.

3.1.2. …But more diversity for growth and employment performances

More diversity arises when considering growth and employment indicators, at two levels. Firstly it appears that different STI configurations can attain similar performances: for example the highest growth trends are founded to be those of peripheral regions whereas knowledge intensive metropolitan regions have low performances. A similar pattern can be observed for unemployment and employment growth.

Secondly, good performances for GDP and productivity levels often combine with poor growth and employment trends, as for Knowledge intensive metropolitan regions.

3.2. National or regional performances? some insights through an ANOVA model

However a major issue arises when considering regional performances independently from the national contexts. The evidence suggests that regional attainments are narrowly tied to national trends. In addition some STI configurations are dominated by regions belonging to the same country, as shown by table 7. This feature clearly implies that some of the regional trends shown previously could simply reflect national macroeconomics features. Interestingly, regions belonging to low performing countries and exhibiting low or medium trends could actually present high marginal performances, and conversely…

Table 9. Two factors ANOVA results: Fisher tests for the global significance of country and STI factors

	(Country)	*STI Configuration*	*Global model*	
	Fisher Stat.	*Fisher Stat.*	*Fisher Stat.*	*R^2*
Labor productivity (2003)	2,19**	3,12***	3,23***	0,41
GDP per capita (2003)	3,88***	10,41***	7,84***	0,63
GDP annual growth rate (1995-2003)	17,40***	2,033**	12,31***	0,73
Employment annual growth rate (1995-2003)	11,68***	1,268	9,83***	0,68
Unemployment annual variation (1995-2003)	7,06***	1,76*	6,17***	0,57
Unemployment (2003)	4,07***	6,47***	7,23***	0,61

***, **,* respectively denote significance at 1%, 5%, and 10% levels

In order to clearly separate regional performances from national trends we can introduce a two independent factors ANOVA model :

$$P_{ij} = \alpha + \beta_i + \delta_j + \varepsilon_{ij} \qquad (1)$$

Where P_{ij} denotes the value of a performance indicator observed for a STI profile *i* in a country *j*; β_i denotes the effect specific to STI configuration *i* (i=1,..,11) and δ_j the effect of belonging to the country *j* (j=1,..,15).

Such an ANOVA model allows to produce two types of statistical tests :

- Fisher tests of the global relevance of each of the two dimensions, national and regional
- Individual estimates of parameters β_i and δ_j can also be drawn.

The Fisher tests shown by table 9 show that, after controlling for national trends, STI regional configurations still matter and lead to differentiated performances. This is especially true for level indicators: GDP per capita, productivity, but also for unemployment. But this no more valuable for employment dynamics, the three Fisher tests for employment and unemployment dynamics being insignificant.

When looking to individual parameters estimates for STI configurations (table 10), the results lead to conclusions somewhat different from those raised by average performances' analysis.

For example, the knowledge-intensive specialized regions exhibit the best performances even for GDP growth or unemployment, contrary to what was indicated by a crude look to average STI values. Even for GDP level and productivity, "marginal" performances are higher after controlling for national contexts.

Table 10. Two factors ANOVA results: Estimated parameters (with Student t) for each STI configuration

STI configurations	*Labor productivity (2003)*	*GDP per capita (2003)*	*GDP growth (95-03)*	*Unempl. (2003)*	*Employ growth (95-03)*	*Unempl variation (95-03)*
Low urbanized regions specialized in traditional technologies	-327	-12,58	-0,24	-1,17	0,09	-1,73
Low industrialized regions with medium scientific activity	-1639,06***	-10,47	-0,82***	-1,38	-0,25	-2,21**
Traditional Industrial regions (Mecanic, Metallurgy)	-36	5,05	-0,34	-3,19***	-0,03	-0,69
Knowledge intensive specialized regions (electronic)	2441,67***	25,41***	0,923***	-3,9***	0,60**	0,83
Diversified metropolitan regions	134	-6,07	-0,19	-1,43	0,24	-0,44
Industrial regions specialized in medium technology industries	193	28,17***	0,65	-1,69	0,03	-0,43
"Science push" regions	-50	6,38	-0,02	-0,51	0,18	-0,56
Knowledge intensive metropolitan regions	1876,73***	64,42* **	0,21	1,11	0,06	2,46**
Peripheric regions - specialized in textil and food industries	-903	-33,21***	-0,06	4,61***	-0,05	1,35
Traditional industrial regions (textil)	-744	-24,12***	-0,14	-0,62	-0,13	-0,02
Peripheric regions - specialized in agriculture (not estimated)	-946	-43,0***	0,02	8,16***	-0,75***	1,45

***, **,* respectively denote significance at 1%, 5%, and 10% levels

The STI versus national configurations issue finally raises an interesting hypothesis relating to the complementarity between STI profiles and national institutions. If the institutional complementarity applies to internal STI coherence, it should also apply to external coherence with national institutions/regulations. To test this hypothesis, we can estimate a modified version of the ANOVA model (1) , including an additional interaction term between STI profiles and countries:

$$P_{ij} = \alpha + \beta_i + \delta_j + \beta_i \delta_j + \varepsilon_{ij} \qquad (2)$$

Interestingly, as shown by table 11, this interaction term is significant for most of the indicators tested, except for GDP and employment variation. This suggests that some complementarity may exist between STI configurations and national settlements. Further work will be needed to identify the diversity arising from institutional complementarity between regional and national levels.

Table 11. Two factors with interaction ANOVA results

	Country	*STI*	*Country*STI*	*Global model*
	Fisher Stat.	*Fisher Stat.*	*Fisher Stat.*	*Fisher Stat.*
Labor productivity (2003)	2,17**	3,22***	2,25***	3,18***
GDP per capita (2003)	4,23***	10,80***	1,44	4,91***
GDP annual growth rate (1995-2003)	19,51***	2,25**	2,10***	8,54***
Employment annual growth rate (1995-2003)	8,46***	0,98	0,49	4,40***
Unemployment (2003)	4,50***	6,82***	1,80**	5,07***
Unemployment annual variation (1995-2003)	8,09***	3,494***	2,47***	5,28***

***, **,* respectively denote significance at 1%, 5%, and 10% levels

Conclusion

This paper is a first attempt to identify European regional configurations using the SSIP framework. We would have expected much more systematic indicators in order to better qualify knowledge and institutions, but they are not available at the European level. Search for complementary databases remains hitherto deceiving.

The method developed here is coherent with the objective of identifying regional knowledge configurations and complementarities. The analysis must be deepen in identifying stable configurations, mainly around sectoral dynamics in which complementarities have appeared. This implies to go further in the analysis of regional trajectories and evolution of configurations. It may be difficult facing the lack of time series for all indicators used here.

The systematic character of this approach allows identifying diversity in STI profiles, but also diversity in the articulation between STI profiles and economic performances. Performances can be highly contrasted inside a same profile, and some profiles may lead to unexpected performances according to the traditional conception (high S&T profiles leading to low performances). These trends have to be analysed going back to individual cases, in order to understand why some regions or profiles exhibit unexpected performances. It can be performed through a deeper analysis of data, but case studies would certainly give more valuable information.

The approach leads to identify broad profiles for European regions: North European high tech regions, South European traditional regions, National profiles (French, German or UK), industrial profiles and metropolitan profiles. These profiles are rather coherent with the different types of capitalism identified at the country level by Amable (2004) or Amable, Barré and Boyer (1998), but metropolitan profiles aren't national. Moreover, some capital metropolises don't pertain to same profiles and this must be better understood. As our profiles are mainly based on the science/technology/industry dimension, these results have to be analysed in details to understand why regional and national classifications appear convergent. Two questions must be addressed here: firstly, how to explain our classification and regional belonging to specific classes, and secondly, how to articulate regions and nations?

The articulation of national and sub-national levels is a key question here as we find a statistical effect in the association of regional profile and national dimension in regional performances. As pointed out in our literature review, sectoral (technological regimes) and national dynamics (local/global articulation) must be integrated at the heart of the analysis of regional knowledge trajectories.

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