FROM CONCEPT TO POLICY:

BUILDING REGIONAL INNOVATION SYSTEMS IN FOLLOWER REGIONS

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ABSTRACT

In the spirit of "The Lisbon strategy", public policies are redirecting support from investment-driven policies to knowledge building as the main driver for competitiveness and innovation. This re-orientation poses different challenges to regions and RIS concept may be the central element, simultaneously goal and toolbox, for devising innovation promotion policies. The RIS framework stresses the need to combine a systemic and inclusive view of innovation along with territorially embedded specificities. In this paper we explore how to operationalize the concept of RIS in terms of innovation policy, arguing against a "one size fits all" approach. Concentrating our analysis on follower regions, we bridge the concept of RIS with the structural deficiencies and challenges posing to this kind of regions, for which innovation policy should seek an adequate combination between science push and demand pull perspectives. We also address the importance of taking advantage of the catching-up status, building upon R&D cost-advantages and clustering around external initiatives as well as the correction of important constraints to the construction of a RIS.

Keywords: Innovation, Regional Innovation Systems, Innovation Policy, Follower Regions.

JEL codes: O18, O31, O14, O33.

INTRODUCTION

European follower regions (such as "convergence regions" but also "competitiveness and employment regions" that are still far from the technological and development levels that characterize frontier regions) need to respond in the next programming period of Structural Funds to a strong challenge in what concerns competitiveness and innovation. Following Lisbon Agenda and the change in the global competitiveness framework, these regions face a new demand to knowledge-oriented regional development policies, demanding new organisational capabilities. Building a Regional Innovation System (RIS) seems to be an adequate global objective for policy in these regions. However, besides the vagueness of RIS concept, it is necessary to operationalize the concept of RIS in terms of innovation policy, arguing against a "one size fits all" approach.

In the first section, we discuss the concept of RIS and we try to identify the main difficulties that may arise when we want to move from the concept to policy. The second section discusses the specific features and innovation challenges of "follower regions" and its implications in what concerns RIS as a policy tool. The third section is dedicated to a more detailed analysis about the feasibility of innovation policies based on the concept of RIS. Working on concrete elements took from four relevant cases of "follower regions" (Norte and Centro regions in Portugal and Cantabria and Galicia regions in Spain), we discuss the above mentioned feasibility using, as a matrix for analysis, the taxonomies of RIS elaborated by Asheim and Cooke. Finally, in the fourth section, a summary of conclusions is elaborated, emphasizing the constraints that should be eradicated in order that RIS could be an effective tool for implementing the competitiveness-oriented strategies.

SECTION 1 – THE REGIONAL INNOVATION SYSTEM CONCEPT: MAIN RESEARCH ORIENTATIONS AND INTERMEDIATE CONCLUSIONS

The regional innovation system (RIS) concept is recent but will probably become one of the most influent one, in the next years, namely for the design of regional development policies. First, there is no doubt that the RIS concept was in great part derived from the former concept of National Innovation System (Freeman, 1987 and 1995; Lundvall, 1992; Nelson and Rosenberg, 1993). Following Saviotti (1997), an innovation system

can be defined as a set of actors and interactions that have as the main objective the generation and adoption of innovations. This definition recognizes that innovations are not generated just by individuals, organizations and institutions but also by complex patterns of interactions between them. So, within an innovation system we can define their elements, the interactions, the environment and the frontier.

The relevance of national innovation systems is related with the fact that the national dimension captures relevant aspects for the innovation process (namely, the policy and regulatory framework, the scientific, educational and training framework, national economic and geographical environment, legislation, and others).

As referred by Cooke (2001), the recent idea of RIS results from some convergence between works of regional scientists, economic geographers and national systems of innovation analysts. RIS have its relevance based on the fact that proximity plays a major role on networks and interactions density; this fact is in general attributed to the tacit nature of a relevant part of knowledge. Tacit knowledge "is best shared through face-to-face interactions between partners who already share some basic commonalities: the same language, common "codes" of communication and shared conventions and norms…" (Asheim and Gertler, 2005, p. 293) The regional dimension also generates a more "focused" knowledge basis, as a cumulative result of the clustering of economic and innovation oriented activities. Asheim and Gertler develop analogous arguments and do not hesitate to stress that "the more knowledge-intensive the economic activity, the more geographically clustered it tends to be" (Asheim and Gertler, 2005, p. 291).

Besides the cognitive and normative dimensions of RIS, that can present different degrees of intensity, the political dimension should however not be excluded. Cooke (2001) refers "region" as a key component of a RIS, considering it as a meso-level political unit set between the national or federal and local levels of government that might have some cultural or historical homogeneity but which at least had some statutory powers to intervene and support economic development, particularly innovation. This political dimension has a major relevance on the perspective, discussed below, of constructing regional innovation systems in follower regions.

Difficulties associated to the use of RIS concept as an operational regional policy tool remain important. First of all, there is still some degree of vagueness of the concepts of innovation systems and of the limits established between national and regional systems.

This is mainly a consequence of the unstable causality relations identified for the factors determining innovation at national and regional level. As it is stressed by C. Edquist (2005: 183-184), when we don't know yet very well what are the main and decisive drivers of innovation, it is better to work with very broad and comprehensive concepts of NIS and RIS. The rationale is simple. As the knowledge on the determinants of innovation is incomplete and fragmented, it would be dangerous to exclude the potential factors not yet analyzed in depth. However, from the state of recognizing what are the main factors which are present in innovation processes to the possibility of having a clear and solid causality model of innovation in concrete territories and economies there is a great distance to be accomplished and a lot of work to do. To accept the diffuseness of the concept is a defensive way to overcome the difficulties of the empirical research. But as far as the RIS is concerned, the relevant question is how to combine the diffuseness with the systemic nature of the concept. Some crucial and concrete questions should be addressed in order to use RIS concept as a policy tool in concrete territories: i) What are the components of the system? ii) What are the relations among them? iii) What are the activities (the function) of the system? iv) Are the boundaries of the system relatively to its environment clearly defined?

In particular, the emergence of RIS within a national context generates additional complexity in terms of components, interactions, activities and boundaries. At a conceptual level, it seems crucial to define some criteria in order to allow a more clear distinction between NIS and RIS. A misunderstanding about the boundaries of a RIS can generate, at the policy level, very high coordination costs.

Another set of difficulties arise by the fact that the RIS concept can be applied to quite different specific regional contexts. Even within a strict knowledge-based economy perspective, regions differentiation is important because the knowledge base of the existing productive sectors is not the same everywhere and this affects the comparative relevance of actors and interactions. Institutional frameworks can differ. As pointed out by many, cumulativeness and path dependency are important characteristics of technological capabilities.

At this point, our major concern is to stress the biased orientation of the research literature on RIS to experiments evolving in regions belonging to nations situated at the technological frontier or in very fast catching-up countries. The research on NIS and RIS in less developed countries and regions is in its childhood. United Nations is now

fostering a more stable field of research in less developed countries. The paper by Phil Cooke about the interpretation of innovation systems as public goods in less developed countries (P. Cooke, 2006) is a very important indicator of the new interest in extending the concept to countries usually approached through the diffusion of technical and technological knowledge. The same could be said about the efforts led by Lundvall in extending the innovation approach to emergent economies. This is the direct consequence of recognizing that institutional and organizational experiments were the main factors responsible for the high performing technological trajectory of some emergent countries, principally the Asian ones.

In sum, we may say that the use of the RIS concept as a regional policy tool needs a prudent approach[1]. The theoretical foundations of the concept and of the determinants of innovation at territorial level (the Region –R effect) cannot be ignored. However, the application of the available theoretical frameworks should be carefully made, taking into account that research on less developed regions experiments is scarce, with no diversified evidence of evaluation results available.

So, regional innovation policies built around the concept of RIS are very promising but they cannot be shaped in a quite generic. The implementation of RIS in concrete regions needs theoretical and strategic support to avoid risks of high transaction costs in public policies. Besides this, in follower regions, RIS cannot emerge as simple efforts to increase the rationale of coordinating different innovation drivers already in place. RIS should be, on the contrary, a chance of generating innovation-oriented patterns of behaviour, of mobilizing more institutions to regional innovation and principally of placing firms at the core of regional system.

SECTION 2 - SPECIFICITY OF INNOVATION CHALLENGES IN FOLLOWER REGIONS

From a descriptive point of view, it is easy to identify the macro specificities of European follower regions in what concerns innovation. In general terms, in these

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[1] In the sense that some social scientists, like for example Bent Flyvbjberg (2001), use the Aristotelian concept of phronesis developed in The Nicomachean Ethics, rediscovered by authors such as Foucault. In this context, a prudence approach means that virtues dealing with context, practice, experience, common sense, intuition and practical wisdom should also be taken into consideration.

regions R&D activities still have a small expression (R&D expenditure often represents less than 1% of the GDP) and are mainly developed by the public sector. The extreme weakness of R&D activities in the business sector is accompanied by a very low level of patent indicators. Efficiency in R&D activities is apparently low (for instance, the ratio of EPO or USPTO patents / R&D expenditure). However, within this set of regions we can find different performances in what concerns productivity growth, what suggests that the nexus between knowledge creation and growth is, for these regions, a complex one.

As Fagerberg (1987, 1988) has pointed out, productivity growth can be seen as the result of two impulses: innovation and diffusion. For follower countries or regions, the relative contribution of diffusion for productivity growth tends to be greater than in more advanced economies. However, as Fagerberg also refers, based on the experience of successful catching-up economies, follower countries or regions cannot rely only on a combination of physical investment and the use of knowledge created outside. In order to assure a continuous catching-up, they must also develop their own technologic effort.

The idea that diffusion does not occur in an easy way, as a mechanic process of use of imported knowledge in response to new market opportunities, should also be stressed. For follower economies, the capability to use and adapt technology created outside is much more than a question of buying new equipments or codified product engineering. As stressed by many, technical knowledge includes tacit knowledge. If follower countries or regions aim to promote the adoption of new technologies and to be able to quickly respond to technologies evolution, they must develop permanently capabilities that include tacit knowledge. So, in a dynamic perspective, the distinction between innovation and diffusion it’s a relative one because the systemic factors that favour an effective diffusion are partly the same that favours innovation.

In a seminal text dedicated to technological accumulation in developing countries, Bell and Pavitt (1993) have presented the distinction between productive capacity and technological capability. The first one can be improved with the availability of resources that are needed to produce goods and services. In addition, technological capability appeals to skills, knowledge and experience detained by individuals and organizations and these additional resources are largely the result of a learning process. So, not only diffusion is not a mechanical process but also, as referred by Bell and

Pavitt, it would be an error to consider that, in developing countries, technological accumulation will occur as a simple "by-product" of production. These arguments are obviously applicable to European follower regions.

In sum, the core of the evolutionary contributions on the complex relations of interdependence between innovation and diffusion must be permanently taken into account. The NIS and RIS concepts have been largely elaborated from the perspective of the innovation frontier. In follower regions, we must on the contrary build them from the perspective of diffusion but also and to discuss the feasibility of transforming the RIS into a policy tool capable of generating a proactive approach of increasing technological capabilities and fostering innovation. This is a fundamental acquisition of the evolutionary research programme. The strategic approach to diffusion can no longer be understood just as an exogenous process of knowledge transfer, a strictly imitative process. The art of dealing with diffusion in a proactive way, creating innovative trajectories, will be the central role of RIS in follower regions.

Another specificity of follower regions has to do with the pre-existent weakness of R&D activities in the business sector and the apparent bias towards public R&D. However, firms must be at the centre of an innovation system not only because innovation is by definition a commercial or business action but also because innovation is not just the result of a "linear process" from formal R&D to production. As said before, technological accumulation includes a learning process based on the conduction of productive processes. So, innovation policies that present a bias towards public R&D – as they do in follower regions – may have problems of "focus" and a lack of effectiveness. However, building a RIS is a follower region is not just a challenge of re-balancing resources devoted to R&D between institutional sectors. This aimed re-balance must be seen more as a result than a pre-requisite for a successful RIS.

In follower regions, the weakness of R&D in the business sector and the bias towards public R&D activities can be interpreted as a signal of a high degree of disconnection between productive capacity and technological capability, while the connection between these two dimensions is at the centre of RIS in frontier regions. So building a RIS in follower regions is, in large part, a matter of to identify technological trajectories based on links between the two dimensions above referred.

In this process, one set of difficulties can be linked to the technological characteristics of the existing economic activities. Following the taxonomy of Pavitt (1984), if the regional economic structure is based on "supplier dominated" activities, as it is often, technological opportunities created under a demand pull mechanism will be scarce. On the contrary, regional economies with a high expression of "specialized suppliers" activities, based on what Asheim and Gertler (2005) classify synthetic knowledge, will be more able to generate more technological opportunities and links towards R&D activities and to more technology-intensive activities.

The other set of difficulties has to do with the "focus" of public efforts in order to reinforce the regional endowment on technological inputs (formal skills, R&D facilities and so on). Firms and institutions have a limited cognitive capability and so they cannot simultaneously accumulate knowledge in many different fields. This is clearly illustrated by the fact that advanced regions and countries, with a same level of human capital and of R&D effort, present different technological vocations. This need for "focus" clearly applies to follower regions, where technological resources are even more scarce.

At the same time, the reinforcement of the regional endowment on technological inputs in follower regions must rely, at least during a first phase, on public efforts. So, this public "technological push" needs a clear strategic orientation in terms of technological trajectories that are aimed. This aspect puts regional coordination at the centre of a policy aiming to achieve a RIS. Otherwise, under a "bottom-up" impulse originated in public actors such as universities and others, we will risk to have a set of fragmented initiatives and a lack of "focus" in this process. Nevertheless, this aspect shows that coordination costs associated to innovation policy in follower regions can be high.

In countries where the structure of the NIS is balanced, integrates well the centrality of firms and the level of interaction between players is high, the evidence suggests that the increase of coordination costs determined by the emergence of RIS is minimized. Or, in follower countries and regions, the reform of the NIS and the implementation of RIS will dispute endogenous resources which are necessarily scarce. An adequate identification of the boundaries between NIS and RIS should be placed at the core of the strategy of intervention.

In the following section we will explore the idea that, in follower regions, the creation of the RIS should rely on a mix of dynamics because it can hardly be supported by a simple model in which endogenous R&D activities are the main driver of the process or by a model centred on existing activities and firms. For doing so, we will apply as matrix of analysis a taxonomy built by Asheim and Gertler (2005) that encompasses the links between the regional production structure, the institutional set-up and the different patterns of knowledge production evolving in regions: territorially embedded RIS (TERIS), regional networked innovation systems (RNIS) and regionalized NIS (RENIS). TERIS are systems where firms base their innovation activity mainly on localized learning processes stimulated by proximity, without much direct interaction with knowledge organizations. RNIS correspond, as the authors say, to the ideal type of RIS: a regional cluster of firms surrounded by a regional institutional infrastructure, implying planned policy interventions that led to a more developed role of regionally based organizations such as R&D institutes. In RENIS exogenous actors and relationships play a major role, because industry and support institutions are more integrated in national or international systems. This contribution can be particularly useful in order to call for more diversified models of RIS, especially if we assume that the three above mentioned types can be seen not only as different morphologies but also as components of a more composite process.

SECTION III - FROM CONCEPT TO OPERATIONAL TOOL: BUILDING RIS IN FOLLOWER REGIONS

Follower European regions can be identified through some simple aggregate indicators concerning development and technological levels. However, they can substantially differ in what concerns structural features and structural change needs[2].

Our analysis considers two Portuguese regions and two Spanish regions: Norte, Centro, Galicia and Cantabria. Table 1 presents basic indicators for these regions, together with national values and those concerning Stockholm region (a frontier region that leads the European Innovation Scoreboard ranking). In accordance to their status as follower

[2] A more precise typology of regions would be useful but corresponds to an exercise that is outside the scope of our analysis. For instance, Todtling and Trippl (2005), based on European experiences, consider three kinds of regions: peripheral, old industrial and fragmented metropolitan regions.

regions, Norte, Centro, Cantabria and Galicia present an income per capita in purchasing power parities that is generally below European Union’s average. However, whereas the Spanish regions are converging to the EU levels, the Portuguese regions of Norte and Centro have globally performed worse, not converging or even slightly diverging from EU’s average income in the case of Norte region. Furthermore, Norte with a per capita income of about 13500 Euros is the poorest region of this analysis whereas Cantabria is on the other extreme with an income per capita of approximately 22600 Euros.

Table 1: Development and Technological Indicators

	Years	EU 15	Stockholm	Portugal	Norte	Centro	Spain	Cantabria	Galicia
PIBpcPPS	1995	16958	23500	10984	9262	9212	13436	12500	10965
	2005	25246	38574	16891	13399	14287	23069	22592	18856
PIBpc%EU15	1995	116	161	75	63	63	92	86	75
	2005	113	172	75	60	64	103	101	84
GERD/GDP	1995	1,85	-	0,54	0,37	0,6*	0,79	0,54	0,47
	2006	1,90	4,24	0,85	0,69	0,66	1,21	0,45	0,87
BERD/GDP (% share on GERD)	1995	1,16 (62,7%)	-	0,11 (20,4%)	0,09 (30%)	0,17* (28,3%)	0,38 (48,1%)	0,1 (15%)	0,1 (21,3%)
	2006	1,22 (64,2%)	3,17 (74,8%)	0,35 (41,2%)	0,27 (39,1%)	0,25 (39,1%)	0,67 (55,4%)	0,2 (40%)	0,38 (43,7%)
Pat EPO per million inhabitants	1995	-	3667,3	15,2	10,1	2,9	125,6	61,9	45,6
	2003	-	4196,8**	39,4	51,3	27,8	143,2	81,2	21,2
Pat High Tech EPO per million inhabitants	1995	-	1087,7	0,2	0,3	0,1	13,1	0,003	1,1
	2003	-	513,2	0,5	0,2	0,3	19,0	0,5	14,9**
High Tech manufacturing share on total employment	1995	-	3,28	0,6	0,9	0	0,7	0	0
	2006	-	0,97	0,4	0,6	0	0,5	0	0
Med-high Tech manufacturing share on total employment	1995	-	2,73	2,9	3,6	3,2	4,8	6,7	3,4
	2006	-	2,66	3,5	2,8	3,5	4,0	4,8	4,1
Med Low manufacturing share on total employment	1995	-	0,6	4,4	4,8	6,6	4,7	7,0	3,3
	2006	-	0,7	4,3	4,1	6,9	4,6	4,7	3,4

Low manufacturing share on total employment	1995	-	4,4	14,4	23,7	12,2	9,5	6,6	7,4
	2006	-	3,2	11,7	20,2	9,3	6,8	6,3	9
Total KIS	1995	-	49,9	21,6	19,5	16,1	22,2	18,4	15,8
	2006	-	56,4	23,1	18,5	18,3	27,9	27,4	25,7

Source: Eurostat. *2000 **2002

In what concerns R&D efforts, all four regions present a gross expenditures on R&D (GERD) in percentage of GDP far below the EU15 average of 1,90% in 2006. Norte with an R&D effort of 0,69%, Centro with a similar figure reaching 0,66%, Cantabria with an investment of 0,45% and Galicia with a GERD on GDP amounting to 0,87% are still far from the EU15 average, the Lisbon Strategy's 3% goal and even more distant from the frontier region of Stockholm (Stockholm invests 4,24% of its GDP in R&D). Nevertheless, except for Cantabria, these regions displayed a positive trend from 1995 to 2006. In terms of the sector of performance of R&D, Norte, Centro, Galicia and Cantabria have a BERD share in GERD that is similar across regions, approximately 40%, still far from the 2/3 threshold targeted by EU Lisbon's Agenda but denoting an overall positive evolution.

Both patent activity and patent productivity as measured by the patent/R&D ratio are very low. In 2003, Cantabria, in spite of its lower R&D effort, patent the most, approximately 81 patents per million inhabitants. Norte applied for 51 patents, above Portugal's average of 39, and Centro applied for 28. Surprisingly, Galicia which invested relatively more, is actually the region with lower patent output, with only 21 patents per million of inhabitants. It is, however, worthy of note the positive evolution of these indicators, common to all four regions. For high tech patents, Galicia leads with 15 high tech patents whereas Cantabria only applied an average of 0,5. Norte and Centro present a similar value around 0,2 patents.

The composite score of the 2006 Innovation Scoreboard is standardized to a (0,1) interval where 1 is given to the top performer region in each criteria. In a ranking that analyzed 203 NUT 2 regions, the 2006 European Innovation Scoreboard ranked Stockholm has the best performing region in EU scoring 0,90. In what concerns our four follower regions, their poor performance was expectable given their R&D efforts. In particular, Galicia, which invests the most in R&D, obtains the higher score of 0,34 which places it in the 142nd place. Centro comes next, placed on 153rd of the ranking with a core of 0,31. Despite Cantabria's lower R&D effort, it scores 0,27 which is higher than Norte with 0,22. Respectively, these regions fall into the 163rd and 186th position.

Structural features and regional assets

The previous paragraphs described the investment in knowledge production and proxied innovation output. The results showed an increasing, though still very low, level of R&D investment along with a sector performance execution pattern mostly centre on Universities and Government laboratories. Both the low participation of firms on R&D and the regions innovative output are linked to their economic structure.

Norte region is a well studied example of a path-dependent trajectory of industrialisation, evolving from a productive structure clearly marked by the predominance of "supplier-dominated" sectors (using the taxonomy proposed by Bell and Pavitt). Data reveals that although the weight of high and medium high tech industries is similar to the other regions, Norte presents a predominant specialization on low tech industries accounting in 2006 for 20% of total employment. The vast majority of traditional sectors that led the historical process of industrialisation in Portugal (textiles, apparel, shoes, furniture and other wood industries and light mechanical industries) are export-oriented and strongly represented in the region, representing the most vulnerable part of the specialisation profile of the Portuguese exports considering the threats and the opportunities generated by the last impulse of globalisation. These sectors are moving towards a dual structure, in which an increasing number of firms are leading a significant number of upgrading processes within the global value chains. At the same time, punctual examples of "specialised suppliers" are emerging in sectors such as scientific instruments, equipments, information systems, software and moulds.

The Centre region shares some structural characteristics of the North region, principally regarding the presence of supplier-dominated sectors (food industries, textiles and apparel and shoes albeit less represented than in the North, ceramics, metallic furniture). Nevertheless, the economy of Centro, as for Galicia or Cantabria, does not present a high share of low technology activities. The region is usually presented in the literature as a fine illustration of concentration of clusters, structured as localised learning and entrepreneurship creation processes and creative local productive systems. Some of these clusters are evolving towards more diversified patterns of specialisation

(automation and robotics, moulds, components for the automobile industry, software industries, and telecommunications).

Despite the peripheral geographic location and debilities of transport infrastructures, Galicia possesses large natural energy resources, fisheries reserves and a significant tourism potential, much focuses around a natural resource, the sea. Based on this shipbuilding remains a very important activity with a strong entrepreneurial basis (namely Astano and Empreza Nacional Bazan shipyards in Vigo and Ferrol) and the same can be said about fisheries and fish industries (in which Pescanova is a European leader). Agriculture still carries a considerable weight (Eurostat Portrait of Regions, 2004), in particular, stock raising and milk production activities. Galicia also has an important cluster in automotive industries with the presence of a OEM (PSA group automotive plant in Vigo) and several component producers. Outside its industrial tradition, Galicia has developed more recently a strong cluster centered on fashion design and has been successful in the creation of fashion global brands and global distribution (where Zara is a well-known case study).

With a strong industrial background, Cantabria has specialized in metal products, food products, beverages and tobacco, ferrous and non-ferrous minerals and metals and chemicals. Some of these activities are nowadays fragmented industries, due to the severe change in competitiveness conditions occurred in heavy metal and chemical activities. A different situation occurs in the automotive cluster, which gathers approximately 130 small medium enterprises and is structured around some large Tier 1 suppliers like Nissan, Bosch, Bravo, Daimler-Benz or Bridgestone-Firestone. Like Galicia, stock raising and agriculture are still important economic activities in Cantabria, associated to food processing industry where Nestle is the biggest player (OCDE 2008).

In what concerns the regional network of knowledge infrastructure the Norte is served by three representative universities: two of them are well placed in the national ranking (Porto and Minho) and the other (UTAD) is mainly regional, integrated in a low density and inner area (Trás-os-Montes and Douro Valley). The two main universities have a solid education capacity in all of the main technological domains (namely health

sciences, biology, mechanical engineering, materials and ICT). In consequence, Norte has today a good supply of qualified technicians and researchers and faces a light tendency of brain drain. Around the universities, there are a few relevant technological institutes devoted to applied research and development and to technology transfer and services. These non profit interfaces between the university and public and private firms operates in areas such as biomedical, immunology and cancer, human tissues engineering, biomaterials, automation, energy and information systems. However, their sustainability and dimension are still weak. There is still a group of Polytechnic Schools mainly concentrated in the high-density coastal areas. The region also hosts some important technological centres managed in a highly participated way by the firms (shoes, textiles and apparel, cork, light mechanical industries). Nevertheless, the links between Universities and firms are still thin.

The institutional framework in Centro is very similar to the North region case. A similar universe of universities dominates the research and high education activities: two at the coastal area, Coimbra (the oldest) and Aveiro (a dynamic newer university) and one at the interior (Beira Interior) and a network of Polytechnic Schools, some of them articulated with the Universities, completes the framework. Technologic Centres are also represented (textiles and apparel, glass, moulds and ceramics) and the dissemination of interfaces University-industry followed the pattern of the North experience.

In Galicia, the network of R&D institutions, namely Universities, technological centres and technology transfer infrastructures is concentrated along the western coast of Galicia. Based on 3 Universities (Santiago de Compostela, Vigo and A Coruña), R&D institutions are specially relevant on 3 domains: biology, with a special focus on marine and fishing technologies and agriculture, automotive engineering and design. In the field of biological sciences technological infrastructures are devoted to research on sea biology, oceanography, agriculture and food technologies. Some examples are the technological centers CETMAR[3], ANFACO-CEGOPESCA[4] and CSIC[5]. The

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[3] *Centro Tecnológico del Mar.*
[4] *Centro Tecnológico Nacional de Conservación de Productos de Pesca*.

automotive cluster of Galicia finds in the region important technological resources, in particular, the technological centre CTAG[6]. In design, the technological centre CIS[7] stands out as a major innovation support institution on this domain. However, a low density of links between industry and Universities characterizes a system where the divorce between firms and Universities is still the rule and not the exception (Faina et al.,).

In what accounts the institutional framework, Cantabria has one single university (University of Cantabria) that constitutes a main building block for knowledge production in the region. Cantabria's University is relatively large considering the region's size. An Academic Hospital and some other Office for technology transfer are also worthy of note. Cantabria's research and technological institutions convey a specialization across three basic scientific domains, namely, biomedicine, ICTs and engineering. In the biomedical field, the IFIMAV[8] is the leading research institute. The regional capabilities on this area are being extended with University of Cantabria's Institute of Biology and Cellular Research. In spite of the absence of a relevant ICT business sector, Cantabria possesses research facilities on ICT from which the School of Industrial Engineering and Telecommunication (SIET) and the Institute of Physics (IFCA) stand out. IFCA and SIET also enhance regional technological research offer in the engineering domain in which the Institute of Hydraulics (INHAM), the Schools of Civil Engineering and Mining and the Component Technological Centre are other relevant expertise centers, the latter closely linked to the automotive cluster.

In sum, all the four regions face a double challenge of fostering innovation in existing activities but, at the same time, of structural change. Structural change needs are probably more severe in Norte and in Cantabria. In the first case this is due to the high share that low tech industries still have in employment and to the fact that a large part of these industries, although structured in local / regional clusters, face a "lock in" problem

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[5] Includes the *Instituto de Investigaciones Agrobiológicas*, the *Instituto de Investigacións Mariñas* and the *Misión Biológica de Galicia*.
[6] *Centro Tecnológico de la Automoción de Galicia.*
[7] *Galicia Tecnoloxía e Deseño.*
[8] Instituto de Formación e Investigación Marqués de Valdecilla.

and have a weak capacity to generate new technological opportunities. In Cantabria case structural change needs are expressed by the large employment destruction that occurred in traditional heavy industries, during the last three decades. In this period, growth and a relative prosperity where insured largely by non-tradable activities (construction and real state) and by tourism but new and more technology intensive activities in the tradable sector are confined to the automotive cluster (however without the presence of OEMs facilities inside the region). Centro region presents a more diversified set of activities and some of them have experienced a relevant technological up-grading. For instance, the mould cluster (a typical synthetic knowledge activity) has evolved from a simple manufacturing activity to an engineering activity. Galicia is combining a capacity to be among world leaders in some specific activities (fishing industries and fashion / distribution) with a strong position in activities like automotive that generates good technological opportunities.

The commitment of all these regions to knowledge is now effective and based on public initiatives. This “public push” is generating a good regional supply of human capital and is at the basis of some interesting recent dynamics. Illustrating this strong commitment, all the four regions are implementing projects of scientific and technological parks: AvePark and Uptec in Norte; Biocant in Centro; Parque Tecnológico de Vigo and Tecnopolo de Ourense in Galicia; Pctcan in Cantabria. In Norte and Centro Regions clusters of ICT activities are already relevant, namely in software production. Their formation was mainly induced by local start-ups co-generated by University institutions but, more recently, top world firms are locating facilities around (for instance, R&D centres of Microsoft in Braga and of Nokia / Siemens in Aveiro). Also there are a few examples of external location decisions concerning R&D activities pursued by public or non-profit entities. Norte region, in particular, is showing a strong attractiveness in that field: Fraunhoffer Institute is currently beginning its operation (R&D and technological brokerage in ICT) in University of Porto campus; the European Centre for Tissues Engineering, an FP project, will gather in AvePark 300 R&D European technicians; a joint initiative of Spain and Portugal national governments has located in Braga the Iberian

Nanotechnologies Laboratory, that will gather in place around 300 R&D Iberian technicians.

In Table 2 we summarize the information quoted above, considering the main assets that can concur to a RIS. The mention of these assets is organized following the RIS type for which each asset mainly operates and we believe that the table is self demonstrative. Then, we will discuss strategic goals and innovation strategies central to a RIS implementation.

Table 2: Regional Assets and Recent Dynamics concurring for RIS types

		NORTE	CENTRO	CANTABRIA	GALICIA
Territorially embedded RIS operators	Regional Clusters in activities with low capacity of creation of new technological opportunities (supplier dominated sectors)	Strong expression of textiles, clothing, footwear, furniture and other low tech activities.	Relevant local clusters of ceramics and construction materials, glass / cristalery products and metallic furniture.		
	Regional Clusters in activities with capacity of creation of new technological opportunities (specialized suppliers sectors / synthetic knowledge / analytical knowledge)	Emergence of technical and functional textiles cluster. Small equipments and automotive components cluster.	Moulds cluster, evolving to engineering activities.	Automotive cluster with presence of FDI / tier 1 facilities and large number of local suppliers.	Fishing and food industries, with regional world leader firms. Automotive cluster with OEM facilities.
	Non R&D professional and technical institutions supporting training, technological and other services	Sectoral technological centres located in the Region (textiles, footwear, cork, mechanics and materials)	Sectoral technological centres located in the Region (glass, ceramics, moulds)	Technological centres for automotive components and fc logistics	Sectoral technological Centres located in the Region (sea activities, fisheries and food, automation, design)

Table 2: Regional Assets and Recent Dynamics concurring for RIS types (cont.)

		NORTE	CENTRO	CANTABRIA	GALICIA
Regional Networked Innovation Systems operators	Emergent Regional Clusters knowledge based / R&D in the business sector (science based sectors / analytical knowledge)	Emergence of an health cluster (pharmaceuticals, bio and composite materials, small health devices)			Blue or sea biotechnologies
	Knowledge Intensive Business Services	ICT clusters based on regional start-ups and linked to Universities of Minho and Porto	ICT cluster based on regional start-ups, linked to Universities of Coimbra and Aveiro	Logistic activities	Fashion activities ICT Cluster
	R&D institutions (Universities and other non-profit R&D units)	R&D institutions providing a supply of human capital and of knowledge in all the main scientific domains Relevant critical masses of scientific resources in biosciences, life sciences, biotechnology, human tissue engineering, nanotechnologies	R&D institutions providing a supply of human capital and of knowledge in all the main scientific domains Critical masses of scientific resources in telecommunications, new materials, information systems and in health activities	R&D institutions providing a supply of human capital and of knowledge with focus in health sciences, ICT and Physics	R&D institutions providing a supply of human capital and of knowledge in all the main scientific domains

	Regional interface / brokerage institutions (science and technologic parks, technology transfer bureau, …)	AvePark and UPTEC are two Technological Parks under construction, linked respectively to Minho and Porto Universities Solid examples of interfaces University-industry receptive to firm-based organisational models of functioning	Biocant, a specific industrial park for bio-firms already in place Emergent regional structure of inter-faces University-industry and one example of a solid incubator of technological-based firms	PCTCAN, Santander science and technological park under construction	Tecnopolo de Ourense gathering all 3 public universities and other entities. Parque Tecnologico de Vigo, with presence of firms of the automotive cluster and logistics.

Table 2: Regional Assets and Recent Dynamics concurring for RIS types (cont.)

		NORTE	CENTRO	CANTABRIA	GALICIA
Regionalized external innovation Systems operators	External business investments in high-tech or R&D activities	Several recent investments in ICT (software, components or devices), made by Quimonda, Microsoft, etc.	Nokia / Siemens R&D centre in Aveiro		
	External non-business facilities in R&D activities	Fraunhoffer Institute Iberian Nanotechnologies Laboratory European Centre on Tissues Engineering			

Potential innovation trajectories and feasibility of implementing RIS

Following the conclusions of the precedent sections, the implementation of a RIS in the four regions studied must be associated not only to a more effective innovation dynamics but also to structural change needs. On the other hand, RIS implementation must insure an adequate combination between innovation and diffusion. Our assessment on the feasibility of implementing RIS takes in account the evaluation of regional assets and is based on additional questions concerning:

- The innovation trajectories that can be considered with a certain probability of success;
- The drivers of change that will support the implementation;
- The critical paths of institutional and organisational change.

Innovation trajectories

The group of four regions presents a contrasted pattern of productive specialization generating very different conditions for demand-pull innovation. Norte is a particular case of a persistent high share of low tech activities, generating a limited set of opportunities for knowledge accumulation. However, in all the four regions there are relevant clusters on tradable goods that can play a role under a demand pull perspective: small equipments and automotive components in Norte, moulds in Centro, automotive clusters in Cantabria and Galicia are good examples of this. These clusters present well established networks of firms and they integrate specialized technological agencies. They operate in activities based on what Asheim calls synthetic knowledge, i.e., capabilities partially based on tacit knowledge and associated to the use and integration of several technologies. An innovation trajectory based on these activities should now explore more effective links to R&D institutions. The “public push” in recent years has significantly increase R&D capabilities in scientific domains such as materials, hydraulics, automation, ICT. So, links to the mastering of some core technologies following a demand pull perspective are possible, conducting to new hi-tech business opportunities and to a better focus of public R&D.

The above mentioned innovation trajectories are in line with the analysis of successful experiences of acquisition of advanced technological capabilities in developing

countries. S. Teitel (2006) mentions the existence of quasi-innovation systems in the sense that the circumstantial convergence of prerequisites may explain the success of the punctual experiences of acquisition of advanced technological capabilities in selected sectors. In this case, the implementation of RIS needs the ability of exploiting the so-called circumstantial convergence of prerequisites, amplifying them in a coherent way through links to the public R&D sector.

However, innovation trajectories based on the precedent are not sufficient in order to respond to structural change needs and to the economic valorisation of technological inputs that are being created under the "public push" investments. So, all the four regions should incorporate more strategic oriented innovation trajectories, induced by public intervention and following a "science push" rather than a "demand pull" perspective. Again, Norte region seems to be a particular case, because of the relevance of its universities and public R&D assets. The recent creation of the "Portuguese Health Cluster", based in Porto, and gathering approximately 100 organizations (Universities, hospitals, pharmaceutical firms, and medical devices and materials producers configures a good example. Cantabria also aims to build a health cluster, based on its excellence of research and assets in scientific domains linked to the health sector.

Constructing an innovation trajectory largely based on public R&D assets implies a great emphasis on technological entrepreneurship promotion and puts at the centre of innovation policy the organizational capabilities to do so in an effective way. Attracting foreign business players will also be relevant. An adequate public support (namely through services and devices demand by the public health sector) is also necessary. In sum, these kinds of innovation trajectories must be quite "public driven" during its first stages.

Apparently, Galicia configures a case where links between the business sector and the R&D public infrastructure can be easier. Not only R&D activities seems to be more focused in domains such as biotechnology and marine technologies but also food and fisheries industries have a strong economic basis, with the presence of some top world firms.

Drivers of change

Our experience on recent dynamics in the four regions suggests that a first driver of change relies on efforts to accumulate resources in general purpose technologies. Dynamics generated around ICT in Norte and Centro regions are quite demonstrative on that. After a period of sustained investment in higher education and R&D, technological resources in ICT are generating the following dynamics:

- Clusters of ICT activities (mainly KIBS) around the Universities of Minho, Braga and Coimbra, including many fast growing start ups;
- Strong articulation with public sectors (health, education and administrations sectors), that places Portugal as a successful case of e-government;
- Wide spread of applications in the tradable goods sectors;
- Good attractiveness for FDI, illustrated by recent location decisions of some top world leaders.

So, the focus on general purpose technologies seems to be an adequate leverage for innovation trajectories in follower regions. This is because the process combines the emergence of new clusters with the incremental innovation processes in a wide range of sectors. Resources formation in general purpose technologies illustrates a process where innovation and diffusion are clearly combined and so this will suit very well to follower regions specificities and challenges (in the same sense see Bresnahain and Trajtenberg, 1995). Regional endowments in general purpose technologies are showing to be also a powerful attractor for hi-tech FDI. The formula, in Cooke's sense, combines internal and external knowledge: "A strong, regionalised innovation system is one with systemic linkages between external as well internal sources of knowledge production (universities, research institutions and other intermediary organisations and institutions providing government and private innovation services) and firms, both large and small" (Cooke, 2006).

Besides ICT, nanotechnologies will be in the centre of a new generation of general purpose technologies (Youtie and alii, 2008). The location in Norte region of one of the main European research centres (Iberian Nanotechnologies Laboratory) will be a major asset on this perspective.

Another driver of change has to do with entrepreneurship. Because follower regions must face structural change challenges and a relevant part of its entrepreneurial resources suffers from “lock in” effects (Portuguese experience shows that financial resources accumulated in traditional tradable goods activities tend to be applied in non tradable goods sectors such as financial and utilities sectors), innovation trajectories based on “science push” mechanisms must incorporate the promotion of technological entrepreneurship. Even in frontier regions, technological entrepreneurship was largely induced by public initiatives, namely universities incubators (see for instance Löfsten and Lindelöf, 2002). So, arguments in favour of public initiatives in that field will also apply to follower regions, where the hi-tech business sector is weaker.

Still associated with entrepreneurship, the clustering of external initiatives could be a major scope for RIS implementation in follower regions. Frontier regions have built RIS in a international context in which locations of R&D activities largely relied on endogenous initiatives. Since the 90s, foreign direct investment flows in R&D have increased significantly and changed their scope. This tendency has been highlighted by several authors (e.g. Serapio and Dalton, 1999, Meyer-Krahmer and Reger, 1999, Kuemmerle, 1999, Gerybadze and Reger, 1999 and Hedge and Hicks, 2008). Multinationals global R&D investments are still mostly focused on developed countries (Meyer-Krahmer and Reger, 1999) though the cost advantage and high quality competences have attracted R&D flows to pockets of knowledge such as the Indian ICT cluster in Bangalore (Kumar, 1996). In spite of the focus of multinationals FDI R&D in the US, EU and Japan (Meyer-Krahmer and Reger, 1999), the acknowledgement of excellence research centers in follower regions pose to these regions new relevant opportunities. Thus FDI R&D is going from a market penetration strategy to a technology oriented strategy (Florida, 1997).

Among the motives for FDI R&D’s current trends, literature has put forward two main strategies: home base exploiting and home base augmenting. The first explanation implies that firms seek mostly to explore their own advantages in other markets. Hence, the R&D activities there conducted are of a supportive type (Kuemmerle, 1999, Le Bas and Sierra, 2002). The second explanation lays on multinationals trying to enhance their competitive advantages building blocks by tapping to centers of excellence with

important competences. This strategy aims to extend the company's knowledge base and leads to the establishment of R&D facilities, following a model of a global network that only maintains at home a coordination privilege (Meyer-Krahmer and Reger, 1999, Kuemmerle, 1999, Le Bas and Sierra, 2002). So, an increasing awareness of the systemic and learning features of innovation goes together with a tendency to effectively gain access to world wide knowledge reservoirs. Empirical evidence seems to provide support to this view and the trend of an increased importance of the home-base augmenting strategy (e.g. Kuemmerle, 1999, Gerybadze and Reger, 1999, Le Bas and Sierra, 2002 and Hedge and Hicks, 2008).

These results provide important insights in terms of regional innovation policy and though literature is mostly focused on technological frontier or advanced follower regions, important insights can be derived for follower regions such as Norte, Centro, Galicia or Cantabria. On one hand, this tendency constitutes an opportunity for regions to develop policies following an outside-inside perspective in attracting and clustering external R&D initiatives and speeding up capability building and catching up. On the other hand, FDI R&D has highlighted the importance of the Science Push perspective in policy terms, though it also indicates that specialization and scale are precursors of excellence and multinationals are increasingly selective.

In a more moderate way, even public or non-profit R&D institutions are beginning to exploit the advantages of outward locations, following the same principle of home base augmenting and exploiting opportunities generated by high skilled human capital reservoirs in follower countries and regions.

So, clustering of external initiatives will be a very important component and, in a certain sense, a specific feature of RIS implementation in follower regions. Recent dynamics in Norte region illustrates well the relevance of this innovation driver.

The last driver worth of mention has to do with brokerage institutions and activities. After a solid expansion of the expenditure on R&D public organizations, the four regions in analysis are implementing a new set of technological infrastructures clearly defined as brokerage institutions. In particular, science and technological parks such as AvePark and Uptec in Norte, Biocant in Centro, PCTCan in Cantabria and Tecnopolo

de Ourense in Galicia are in their early stages but they are showing a good capability to attract firms and other organizations. As noted by Felsestein (1994) and Asheim and Coenen (2005), science and technological parks promote systemic industry-university cooperation and technological transfer. In follower regions, science parks can play a major role in the emergence of new technology intensive clusters, as analysed by Bakouros and alii (2002). Druille and Garnsey (2000) also emphasise the role of science parks in Cambridge and Grenoble as attractors of high-tech and R&D external investments, even if these investments are located outside the park.

Institutional and organisational change

The above considerations make clear that in less developed regions the implementation of RIS is very sensitive to the policy decision process and to policy environment. So, the feasibility assessment of the creation of RIS cannot be dissociated and it is strongly interdependent with institutional and organisational change. For all the regions studied, the implementation of a RIS can be seen as a radical innovation in the governance model of regional policies.

Financial public support to innovation is a consensual matter. The basic foundations for innovation policy rely on the idea that innovative activities and specially R&D activities are a source of technology spillovers. Arrow (1962) argued that a positive spillover results from any new technological knowledge, due to the existence of indivisibilities, non-appropriabilities and uncertainties. Since then, several authors (Romer, 1990, 1993; Jones, 1995) have discussed the knowledge attributes of non-rivalry and dynamic feedback. As a consequence, the social return of innovative actions turns on to be higher than the private return.

Governments at national level have traditionally used direct funding of basic and applied research and indirect methods such as the patent system and research tax credits to help mitigate market failures and the resulting underinvestment problem. However, conventional instruments for innovation policy had little to do with the Regional Innovation Systems (RIS) perspective. Here, the focus is clearly put on network-based support and on strengthening the region’s institutional infrastructure. In addition to a

market failure approach, regional innovation policies must follow a coordination approach.

Innovation policies in follower regions often fail short in the promotion of interactions between public and business sectors, but these interactions are at the centre of the systemic nature of RIS. As analysed by us in what concerns Portuguese experience (QCA III) and Cantabria experience (OCDE, 2008), this lack of articulation reflects both the weakness of internal R&D skills in the business sector and the model of financing public and non-profit R&D organisations. In frontier regions links between Science and Industry can be seen as a matter of increasing the “fitness” of a system that has already consolidated elements. Differently, the promotion of this links in follower regions must go together with the sustainable expansion of the public R&D sector and with the development of internal capabilities in firms. However, policy instruments both for public and business sectors have mainly rely on financial subventions to business projects and to public organizations.

A new set of policy instruments is needed. For the business sector, instruments such as public subventions to wage expenses of young researchers and technicians employed by firms have proved to be efficient in other experiences. Small teams of R&D personnel will be effective in internal R&D development but also – and in many case we should say mainly – they will play a crucial role in creating a demand for technological services and hence to create linkages with science and technological institutions.

Because the RIS perspective emphasises innovation as a highly localised process favoured by interactions, policy instruments should be based on the idea of public-private partnership (PPP) involving several local actors. For instance, the support to R&D consortia projects with mandatory participation of the business sector is of major importance and crucial to increase connectivity between firms and other institutions. Not only this will promote R&D in firms but also it will be helpful in order to lead R&D activities in other institutions to be more focused on firm’s needs. This kind of instruments were only recently applied in Portuguese experience but they are proving to be very effective. On the contrary, in Cantabria R&D+I Plan for 2006-2010 we did not found the same kind of instruments, at least in an explicit way.

Also, programmes aiming to promote technological start-ups are almost always based on institutional networks involving public agencies, universities, technology centres, research institutes, entrepreneurial associations and other non-profit institutions. On this, international experience shows that national multisectoral programmes tend to be less effective than regional targeted programmes.

Of course, technological PPP can be also present in national innovation policies, as related by Stiglitz and Wallsten (1999, 2000). However, the above mentioned relevance of proximity in the innovation process suggests that effectiveness of technological PPP will often be greater at local level or under local or regional management.

This led us to a final question concerning critical paths of the organizational and institutional dimension of RIS: coordination costs can be very high if the boundaries and articulation between regional and national systems of innovation are not clearly defined.

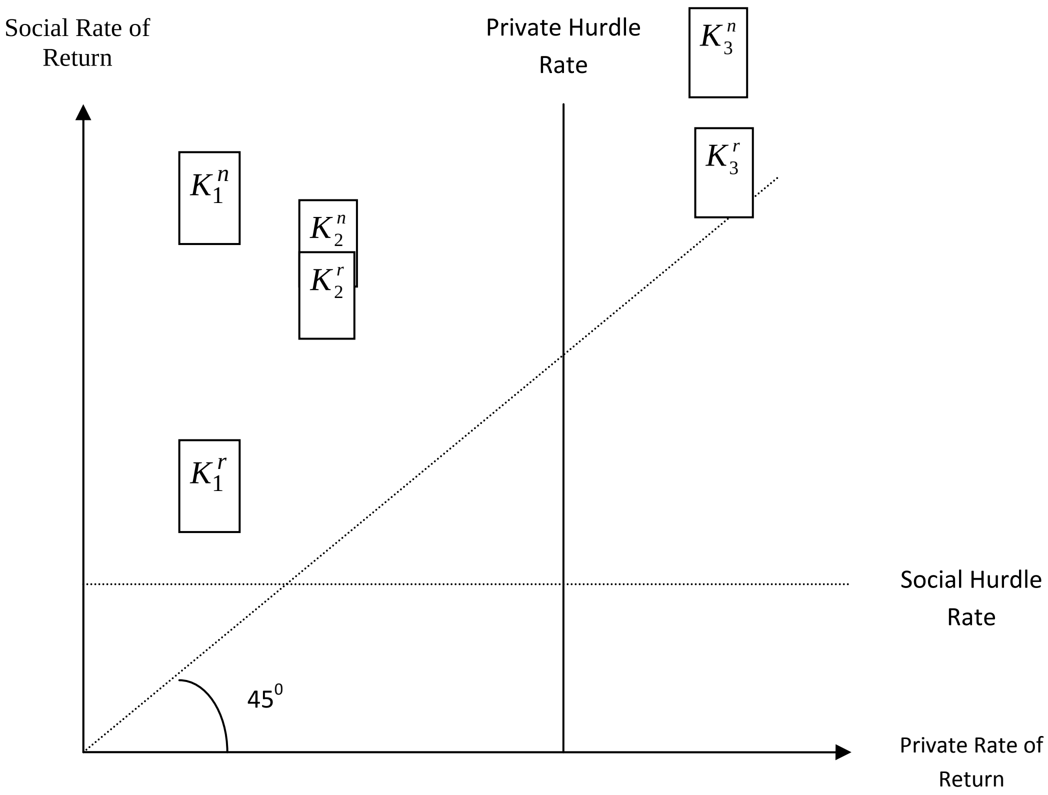
Norte and Centro are follower regions within a follower country and, in fact, they are "planning regions" under the statutory power of national government. We find in this one major weakness for RIS implementation. On one hand, the NIS framework is itself unachieved. On the other hand, as Cooke (2001) refers, "region" is a key component of a RIS, considering it as a meso-level political unit set between the national or federal and local levels of government that must have at least some statutory powers to intervene and support economic development.

On the contrary, Cantabria and Galicia are political regions with a high degree of autonomy and competences in a large set of fields of economic and development policies. So, in those cases, the problem is restricted to the definition of a pattern of cooperation with the NIS.

In a theoretical way, the boundaries between NIS and RIS can be defined taking in account differences between national and regional social rates of return of the innovative actions. Figure 1 can help us to precise better this complex problem of social evaluation. In innovative actions, we can consider that only social benefits can exceed private benefits but there will be no negative externalities. So, innovative or knowledge based investments will appear, in Figure 1, always above the 45 degrees line. If social benefits at national level (superscript n) clearly exceed social benefits at regional level

(superscript r), this will imply that national policies will be more adequate. On the contrary, when social national benefits match with the regional ones, then regional policy should prevail.

Figure 1: Private and Social Evaluation of Projects



For instance, K_1 can illustrate a basic R&D project for which private return is very low (under the hurdle rate) and, at the same time, social benefits will spread all over the country or even outside, as it is often the case. So, basic research should be a matter of national policy. An opposite case is represented by K_2 and, in this case, regional policy will be the adequate level (K_2 can illustrate, for instance, a project of a Science Park). However, unclear cases like K_3 will always exist. K_3 illustrates a profitable private investment worthy of public support in order to avoid an underinvestment level. However national benefits slightly exceed regional benefits, as it is often the case.

Subjectivity in the assessment of social benefits is certainly high and so national and regional perspectives will often be in disagreement. So, political status of the region will remain a crucial aspect.

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The next table may be interpreted as a preliminary grid of analysis for assessing the feasibility of implementing RIS in the selected regions. It will hopefully evolve towards a more consistent model of strategic assessment of not only the feasibility of the decision itself but also of the architecture, composition and systemic nature of the concrete RIS.

Table 3: Preliminary Grid for Assessing the Feasibility of Implementing RIS

<table>
<tr><th></th><th></th><th>NORTE</th><th>CENTRO</th><th>CANTABRIA</th><th>GALICIA</th></tr>
<tr><td rowspan="4">Rationale and strategic goals</td><td>Catching up with more advanced regions</td><td colspan="4">In line with the Lisbon Agenda, all the four regions must pursuit a sustained increase in their technological own effort with expression in technological level indicators. In particular, the expansion of business R&D and patenting are critical goals.</td></tr>
<tr><td>Fostering innovation</td><td colspan="4">Innovation promotion in all sectors (tradable and non-tradable activities). However, the low level of average technological indicators reflects in a great extent regional economic structures still including low-tech activities.</td></tr>
<tr><td>Structural change needs</td><td>Norte is an extreme case of an European region with a great prevalence of low-tech activities but, at the same time, a sustained expansion of the public R&D system is creating good conditions for the emergence of knowledge-intensive activities.</td><td>Centro also needs to pursuit structural change objectives, although in a less “dualistic” context than the observed in Norte.</td><td>Cantabria has observed a process of deindustrialization with the collapse of former activities central to its specialisation profile but, with exception of the automotive cluster, Cantabria experiences some difficulties in launching new activities of tradable goods.</td><td>In comparative terms, Galicia seems to be the region where structural change needs are less sticking. However, strong clusters in fisheries industry or automotive industry should generate a path towards the mastering of core technologies and the emergence of knowledge-intensive activities.</td></tr>
<tr><td>Implementing RIS</td><td colspan="4">Implementation of a Regional Innovation System will be a radical innovation in order to manage successfully a new cycle of policies oriented towards innovation and competitiveness goals.</td></tr>
<tr><td>Innovatio trajectorie</td><td>“demand pull” trajectories based on existing clusters</td><td colspan="4">In all the four regions there are relevant clusters with a strong entrepreneurial basis and technological sectoral support infrastructures (technologic centres), namely synthetic knowledge activities (Asheim) or specialized suppliers (Pavitt). This allows potential trajectories towards the mastering of core technologies and the emergence of knowledge-intensive activities.</td></tr>
</table>

		Technical and functional textiles cluster; small equipments and automotive components cluster.	Moulds cluster, evolving to engineering activities.	Automotive cluster	Fishing and food industries, with regional world leader firms; automotive cluster with OEM facilities.
	Public sector "science push" trajectories	All the four regions are expanding in a relevant way their Human Capital endowment and R&D public activities. New business activities largely based on local start ups but with an eventual presence of FDI are emerging or foreseen.			
		ICT cluster; health cluster.	ICT and telecommunications; biotechnologies.	Health cluster.	Biotechnologies (namely marine); ICT

Table 3: Preliminary Grid for Assessing the Feasibility of Implementing RIS (cont.)

		NORTE	CENTRO	CANTABRIA	GALICIA
Drivers of change	General purpose technologies	Regional endowments on skills associated to general purpose technologies can produce a strong leverage effect in follower regions, because they are central to the combination of innovation and diffusion. ICT are playing this role, namely in Norte, Centro and Galicia. Nanotechnologies will become a new GPT. The Nanotechnologies Iberian Institute, in Norte, is a major asset on this perspective.			
	Technological entrepreneurship	All the regions possess a first generation of incubators and this will be enlarged with new ones created inside the scientific parks. However, effectiveness of these incubators is still weak.			
	Clustering external initiatives	Attracting external R&D and high-tech activities, lead by profit or non-profit entities seems to a competitive advantage of follower European regions, in a relatively new cycle of R&D globalisation.			
		Two research institutions classified as European Centres of Excellence have been	NOKIA I&D centre for the telecommunications in Aveiro strongly associated to the		CESGA (supercomputing research centre) with participation of Intel and HP

		recently located in the region: European Institute of Human Tissu Engineering (300 researchers) and the Iberian Institute for Nanotechnologies (300 researchers); Fraunhoffer Institute; Business locations (Qimonda, Microsoft, Indra, etc.)	University.		
	Promoting interactions	In all the four regions there is a new generation of technological infrastructure projects, besides R&D public centres and the pre existing sectoral technological centres. Science and technological parks are the main projects in that field.			
		AvePark (Un. Minho and others) and UPTEC (Un. Porto and others)	Biocant (Un. Coimbra and othters) focused on bio-pharmaceutical products.	PCTCan (regional agencies, Un. Cantabria and others)	Tecnopolo Ourense (Universities and others)

Table 3: Preliminary Grid for Assessing the Feasibility of Implementing RIS (cont.)

		NORTE	CENTRO	CANTABRIA	GALICIA
Institutional and	Needs of policy instruments reform	The major aspect has to do with the weak level of connectivities between the business sector and public entities. This is observed in all the four regions. To overcome this problem, a new set if policy instruments is needed, under a general concept of private-public partnership. Instruments shaped for the integration of engineers, masters and PhDs in firms should be significantly enhanced. Specific instruments for projects developed in Industry – University consortia are also central to RIS implementation.			

	Articulation with NIS	The implementation of RIS increases coordination costs. The definition of boundaries between national and regional systems is still vague because, in practice, it is not easy to assess a comparison between regional and national social benefits. In follower regions and follower countries these problems are amplified because managing Innovation Systems is also a learning-by-doing process. This is a challenge for governments but also for other organizations. For instance, Universities like those in the four regions studied are national universities that pursuit internationalisation objectives; the top-ranked scientific teams are strongly attracted by the new opportunities generated by the internationalisation of the national scientific system led by the Government. So, Universities must be able to combine regional strategies and partnerships with national and international ones.	
		Because Portuguese regions are “planning regions” with no political statutory power, the risks of crowding-out effects with NIS are high. For instance, the strategy of attracting FDI in knowledge-intensive activities and services is led by national agencies, with practically no receptiveness to regional innovation strategies.	The status of regional autonomy reduces significantly the risks of crowding-out effects produced by the interaction with NIS.

CONCLUSIONS

The central question addressed in this paper is the feasibility of implementation of a RIS in a follower region. The precise definition of what is a follower region was out of our scope. We have considered as case studys four European regions (Norte e Centro in Portugal; Galicia and Cantabria in Spain) that are clearly far from the development and technological levels of frontier regions. All the four regions need not only to foster innovation and increase productivity at the aggregate level but also to insure a process of structural change.

For these regions, the implementation of RIS can be seen as a radical innovation on innovation policy. The systemic nature of a RIS can improve effectiveness of policy and, in doing so, will accelerate a catching-up process. However, RIS concept is still vague and is being structured mainly on the framework of developed regions experiences. So, using the RIS concept as a policy tool for fostering innovation and structural change in follower regions is a new challenge.

We used taxonomies of RIS proposed by authors like Asheim or Cooke as an instrument for evaluating regional assets that can support and be enhanced by RIS implementation. The applied analysis to our four concrete cases confirmed the explanatory power of the taxonomies, namely if we accept the idea that these taxonomies can also be taken as components of a more composite process of RIS implementation.

The methodology for assessing the feasibility of RIS implementation, besides considering strategic goals and regional assets of concrete regions, has considerer three sets of components: potential innovation trajectories, drivers of change and institutional and organizational change. We have tried to demonstrate that this methodology can be operative in a coherent way. In particular, for our follower regions we have consider the relevance of four drives of change: the leverage effect induced by general purpose technologies, the need for effective promotion of technological entrepreneurship, the accelerator role played by a competitive position that follower regions present in order to attract and cluster external initiatives and, finally, the need for a new set of organizations placed at the centre of connectivities or interactions promotion.

This methodology must be taken as a first proposal and we believe that it can be enriched by a deeper analysis of recent dynamics that are underway on the four studied regions as well as by its application to a larger set of regions.

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