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Developing and implementing a smart specialisation strategy at regional level: some open questions*

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ABSTRACT

The smart specialisation strategy (S3) requires the identification in each region of one or more thematic areas where R&D and innovation policy should be focused on to create and sustain a competitive advantage. Not necessarily the chosen areas will belong to the core, general purpose technology that are generally identified as high-tech sectors (ICT, biotech, etc.). For most of the (peripheral) regions the application of the S3 will involve the identification of production domains in which general purpose technology can be applied and adapted. The aim of this paper is to discuss the theoretical underpinning of the S3, focusing the analysis on three concepts: embeddedness, relatedness and connectivity. The analysis is carried out by reviewing the available documents about the definition and implementation of the smart specialisation strategy and the early proposals developed by some European regions. S3 is an important advancement in the design of regional innovation policy. A better clarification of its theoretical basis and implementation problems can improve its effectiveness.

Keywords: smart specialisation; regional innovation policy; low and medium tech-industries.

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1 Introduction[1]

The concept of *smart specialisation* has been highlighted by the European Commission as a central pillar of the Europe 2020 Strategy (European Commission, 2010). The concept emerged within the "Knowledge for Growth" expert group established in 2005 by Commissioner Janez Potočnik to reinvigorate the Lisbon Strategy.[2]According to its proponents, RIS^3 addresses "the issue of specialisation in the R&D and innovation" (Foray et al., 2009, p. 1).

The implementation of the smart specialisation strategy (RIS^3 from now on) requires regions to identify sectors and technological domains in which they are more likely to reach or maintain a competitive advantage, and then focus their investment and innovation policy in those fields. In particular, the application of RIS^3 is crucial for the regions which are not leaders in any of the major scientific or technological domains.

The concept of RIS^3 is based on two fundamental ideas: a) that a region should avoid spreading knowledge investments (high education and vocational training, public and private R&D spending, etc.) across many different fields, but concentrate them in a few sectors or technological domains in which they can have a significant impact (specialisation); b) that those domains are not to be chosen because of their technological or market appeal but because they enhance or complement the research and productive assets already present in the region (smart).

From a theoretical point of view, these ideas rely on two assumptions: a) that achieving a critical mass of resources is essential for obtaining results from R&D investment and productivity in their application; b) that regional specialisation shows a high degree of path dependence and that successful diversification can be achieved only in areas that are closely linked to the existing knowledge base (Asheim et al., 2011; Neffke et al., 2011). To underline the latter aspect, the proposers of the smart specialisation concept have emphasised that its application to regional policy should not imply a top-down approach (i.e. a strategy designed and implemented by regional government) but 'an entrepreneurial process of discovery' (Foray et al., 2009, p. 2) in which regional stakeholders (i.e. firms, research institutions, clusters, associations, etc.) are expected to play a leading role in identifying the areas of

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[1] I thank the participants at the session on Smart Specialisation at the ERSA (European Regional Science Association) Annual Congress, 21-25 August 2012, Bratislava. and specifically Roberta Capello, Koen Frenken, Philip McCann and Raquel Ortega-Argilés for their comments and suggestions. I also thank two anonymous referees for their helpful comments and suggestions.

[2] http://ec.europa.eu/invest-in-research/monitoring/knowledge_en.htm

specialisation. The role of policy-makers is to select the most promising areas among those suggested, rather than imposing a set-piece strategy.

Other concepts useful for characterizing the 'smart' nature of RIS^3 are those of General Purpose Technology (GPTs) and Key Enabling Technologies (KETs). GPTs are mainly represented by information and communication technologies (ICTs). One of the weaknesses of the EU economy is its inability rapidly to adopt and adapt ICTs; this is particularly true in the case of some service sectors (McCann and Ortega-Argiles, 2014, p. 3). KETs are those knowledge intensive domains considered strategic for the development of products and services that contribute to addressing major societal challenges.[3] In the case of KETs, the EU's problem is that it shows a strong position in knowledge creation and patenting but weaknesses in the development of new products and services. In the context of the RIS^3, a distinction is drawn between those (few) leading regions that can achieve a critical mass of R&D investment for the development of GPTs and KETs and follower regions (the majority), which specialize in the application of GPTs and KETs to specific sectorial domains.

A platform for helping regions to develop and implement RIS^3 has been recently created (http://s3platform.jrc.ec.europa.eu). Several European regions have registered on the platform and some of them have presented their RIS^3 proposals at peer review meetings organized by the RIS^3 Platform.[4] Besides the documents in which the RIS^3 is developed and explained, the RIS^3 Platform has recently issued a document explaining the methodology to be followed in the design and implementation of the RIS3 (Foray et al., 2012).[5]

Some of the documents presented by the regions that participated in the above-mentioned meetings are no more than declarations of intent to apply the methodology, rather than being actual plans for its application (see Table 1).[6] This is understandable, given that most regions have only just started the process, which is expected to be completed during 2013. Notwithstanding the preliminary nature of these presentations, their analysis is useful for identifying common problems now emerging in the design of the RIS^3. Some regions identify very broad areas of specialisation (such as ICT, life sciences, etc.) which can hardly serve as effective bases for the selective allocation of funds. Moreover, most of the presentations focus on the implementation of generic innovation policies (such as measures to promote entrepreneurship), rather than on

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[3] A recent EU document has identified the following KETs: Nanotechnologies, Advanced Materials, Micro- and nano-electronics, Photonics, Biotechnology, Advanced Manufacturing (European Commission, 2011).

[4] As of June 2013, eight such meetings had been organized with four regions presenting at each meeting, for a total of 36 regions.

[5] The guide is available on the RIS^3 platform at the following link: http://s3platform.jrc.ec.europa.eu/c/document_library/get_file?uuid=a39fd20b-9fbc-402b-be8c-b51d03450946&groupId=10157

[6] The documents and presentations are available on the website of the RIS^3 platform: http://s3platform.jrc.ec.europa.eu/peer-review

identification of specialisation domains. Though generally mentioned in the presentations, there is little or no analysis of relations between the sectors identified; moreover, only in a few cases is there an attempt to identify complementarities with other EU regions.

These weaknesses are mostly explained by the fact that the presentations are first attempts at applying the methodology. However, I suggest that they may also be the result of some ambiguities present in the RIS^3 concept and in the methodology proposed for its implementation. Specifically, the following questions should be more clearly discussed at theoretical level and more clearly specified in regard to their practical applications.

1. *The scope of the RIS3*: i.e. whether it refers to “specialisation in R&D and innovation” – as in its initial formulation – or to a broader regional development strategy. Initially, RIS3 emphasised the identification of knowledge-based sectors and R&D-based innovation. However, RIS^3 is also implemented by ‘follower’ regions characterized by the presence of low and medium-tech industries in which R&D spending is of no or little importance.
2. *Variety versus specialisation*. A recent body of literature has highlighted the importance of industry variety in promoting innovations. At the same time, the RIS^3 approach requires the concentration of R&D efforts in a few domains, especially in the case of smaller regions. At the implementation level, it is unclear how to define and identify the relations among different domains so that they can be useful in enhancing the region’s innovation capacity. The same questions arise when identifying complementarities among different European regions.
3. *Top down versus bottom-up approach*. The design of a strategy requires the definition of a vision, the setting of specific objectives, and the long-term commitment of resources to achieve them. This process is normally implemented with a top-down approach. It is unclear how this process can be achieved through the suggested ‘entrepreneurial discovery’ approach.

The paper discusses these questions by identifying the theoretical underpinnings of the RIS^3 methodology and the implementation problems most likely to arise. The development and implementation of RIS^3 is an important opportunity for European regions to improve their innovation policy. The aim of this paper is not to question the RIS^3 approach but rather to contribute to its effective application.

The paper is organized as follows. Section 2 discusses the issue of R&D specialisation as opposed to a broader innovation perspective. Section 3 discusses the problems associated with the definition and empirical identification of knowledge relations within the same region and between different regions. Section 4 discusses the implementation problems stemming from the bottom-up approach and proposes a modification of this approach. Section 5 draws the main conclusions.

2 R&D versus innovation and production specialisation

In its original formulation, RIS^3 emphasised the association between research and innovation. Indeed, RIS^3 was conceived as addressing “the issue of specialisation in R&D and innovation” (Foray et al., 2009, p. 1). However, in later formulations it has lost the emphasis on R&D, instead “…embracing a broader concept of innovation, not only investment in research or the manufacturing sector, but also building regional competitiveness through design and creative industries, social and service innovation, new business models and practice-based innovation”(Foray et al., 2012, p. 7).

Consideration of all types of innovation and sectors responds to the aim of extending the RIS^3 approach to all EU regions, also those with few or no research institutions and high-tech clusters. It also recognises the importance of the DUI mode of innovation, i.e. innovation based on learning by doing, using and interacting, as opposed to the STI mode of innovation, i.e. based on science and technology transfer (Jensen et al., 2007). The ‘practice-based innovation’ (or DUI mode) which is typical of low and medium-tech industries is an innovation model that requires little investment in R&D and does not necessitate relations with research centres. It is mainly based on the exchange of information among firms along the production chain. Most of the innovations developed within this model are process rather than product innovations. It is this innovation model that is especially important for the competitiveness of industrial clusters of small firms (such as the Italian industrial districts).

It is impossible to deny the importance of the DUI mode of innovation for the competitiveness of most EU regions (Asheim, 2012). However, some issues should be considered. Recent empirical evidence has shown that firms combining the two modes are more likely to innovate new products or services than are those relying primarily on one mode or the other (Jensen et al., 2007). Also in the case of small and medium-sized enterprises (SMEs), Parrilli and Elola (2011) demonstrate that innovation output is more sensitive to STI drivers than to DUI drivers, although there is wide variation in the importance of the two modes at sectorial level (Aslesen and Freel, 2012; Fitjar and Rodríguez-Pose, 2012). Besides the debate on the relative merits of the DUI and STI models for the innovation performance of firms, it is important to underline that the RIS^3 originates from the need for a more effective link between new knowledge production (research) and its applications in the development of new services and products.

The emphasis on ‘research-based’ innovations does not mean abandoning the DUI mode and substituting it with the STI mode: the main aim of the RIS3 should be that of combining the two(Jensen et al., 2007). This aim concerns one of the main problems of the EU when compared with the USA and Asian countries; i.e. its relative strength in basic and applied research as opposed to its ability to transfer research results into new products and services. This is due to the lower level of R&D investment in the private sector and the weak links between research centres and firms (European Commission, 2011).

A risk associated with shifting the balance from research to innovation is that it will be more difficult to select the domains in which to concentrate public resources. All sectors are able to incorporate innovations by relying on the DUI mode or applying knowledge developed in other domains. This poses a challenge for the ‘selection’ process: all sectors have the potential to innovate but not all of them to develop useful links with research institutions at local level.[7] Promoting innovation in existing sectors is a aim different from identifying specific domains in which a research-based model of innovation can be successfully implemented at regional level. The instruments with which to achieve these two aims are also very different.

A possible solution of this problem would be that of identifying the technological domains on which traditional sectors are more dependent for innovation and promoting their development within the region, in the hope that the proximity of suppliers and acquirers of new technology will produce benefits for both. However, this strategy has several implementation problems. The first is how to identify the knowledge links most productive in developing new technology and promoting innovations.[8] The second problem is that the knowledge domains from which a production sector can profit when acquiring new knowledge are quite diverse. In the case of the footwear industry, for example, the domains could be R&D on new synthetic materials, or process automation to save labour input, the application of ICT in marketing and distribution, and so on. It is likely that firms in the same sector will stress different aspects of innovation, depending on their competitive strategy, so that it is difficult to select the most promising domains.

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[7] Traditional sectors depend for most of their process and product innovations on technology produced in other sectors. For this reason, in innovation model terms, they are referred to as ‘supplier dominated’ (Pavitt, 1984).

[8] This question will be discussed in more general terms in the next section.

A shift of emphasis from R&D to innovation poses two further questions within the RIS3 approach.

One of the main reasons for the selection of specific domains (i.e. specialisation) is the need to achieve a critical mass of resources when investing in R&D. It is unclear whether this is also the case when the focus is on promoting innovation. This is not to deny the importance of promoting innovation as such in the private and public sectors of a region; but its is not at this that the design and implementation of the RIS^3 should be addressed.

The second question is whether in the case of R&D there is a rationale for public intervention, based on the idea that firms will under-invest in the production of new knowledge because of appropriability problems and spillovers (Hall and Lerner, 2005). In the case of innovations, firms have more direct incentives to adopt them. Recent studies have emphasised that a public intervention to promote innovation may be justified both on the basis of the above-mentioned market failures in R&D investment and also in order to address 'system failures', most of all the barriers to effective collaboration between firms and research centres also to promote a more demand-led approach to research (Dodgson et al., 2011; Metcalfe, 2005).[9] The latter argument reinforces the rationale of the RIS^3, given that its aim is to promote, not research as such, but effective relations between research institutions and firms. The literature on the Triple Helix emphasises the role of policy-makers in promoting and shaping university/industry relations at local level to foster existing industry clusters or to develop new ones (Etzkowitz and Leydesdorff, 2000). The RIS^3 approach recognises that this can be effectively pursued by concentrating private and public resources in a few specific domains.

The refocusing of RIS^3 from research to innovation also stems from policy-maker concerns, because specialization is a more costly policy action and one more exposed to public failures. It often pays, in political terms, to include as many subjects as possible when allocating public funds and to be as generic as possible about the targets and objectives. This is exactly what the RIS^3 strategy is trying to avoid, and it is an additional reason for not shifting the emphasis from research-based innovation and specialisation.

Generic innovation policy is more likely to sustain existing sectors than to target promising diversification in more knowledge-intensive activities. By shifting to supporting innovation in established sectors, RIS^3 is more likely to suffer "local capture": that is, when the policy agenda is taken over by local actors, whose interest does not coincide with the general interest of tapping into the unused innovation potential (Barca, 2009, p. 131). This shift may also

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[9] I thank one of the referees for pointing this out.

encourage the 'policy imitation' of a standard set of innovation policy tools adopted in successful regions, thus evading the 'place-based' approach which is one of the main novelties of RIS[3].

McCann and Ortega-Argilés (2014) provide a justification for the RIS3 within the place-based approach to innovation policy. They also analyse how the RIS3 logic can be applied to peripheral regions which lack a large research infrastructure and a diversified production context. The place-based approach emphasises the need to take account of the specific features of regions in policy design and implementation. In the case of innovation policy, it also stresses the need to concentrate funding by selecting, for each region, the limited number of areas where innovation can usefully be enhanced (Barca, 2009).

A place-based approach could generate a different mix of broader innovation policy as opposed to support for R&D investment. Regions that lack a strong research infrastructure could shift to a more general innovation policy targeting those sectors more likely to benefit from the acquisition and application of new knowledge from GPTs or KETs. Regions that choose this pattern should be asked to analyse potential connections with other EU regions with complementary research infrastructures. However, in these cases too, the emphasis on specialization and R&D should remain, because it has been demonstrated that the 'absorptive capacity' of new knowledge depends on the firm's own investment in R&D (Cohen and Levinthal, 1990; Nieto and Quevedo, 2005; Nooteboom et al., 2007).

As a result, we would expect a different emphasis between R&D and innovation according to the level of the region's innovative performance.[10] This relation does not emerge from the regional presentations: even regions classified as 'modest' in the most recent EU regional innovation scoreboard (European Commission, 2012) indicate a large number of specializing domains, some in high-tech sectors where the region is unlikely to have any chance of investing adequate resources.

The latter issue highlights a generally absent application of the 'critical mass' principle. Only a few presentations quantify the existing infrastructure for the proposed specialization sectors: number of researchers, public and private investment in R&D, employees in the production sectors; etc. The question of the number of domains and of the 'critical mass' of resources that can justify their selection is aggravated by ambiguity in the 'nature' of such specialization, i.e. whether it is an industry sector (such as agriculture, tourism, automotive

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[10] This question is posed here in simple, dichotomous terms. The elaboration of an innovative strategy at regional level requires much deeper analysis of the region's innovative characteristics, as highlighted by (Camagni et al., 2014). See also Camagni and Capello (2013).

industry, etc.) or a technological domain (such as nanotechnology, biotechnology, etc.). Moreover, even in the case of technological domains, in most cases these are very broadly defined (i.e. ICT, biotechnology, etc.), and only in a few regions (Saxony, Wales) is there an attempt to identify specific technological domains (see Table 1). This is also due to the difficulty of classifying technological domains compared with the classification of economic activities. One possibility could be the use of the international patent classification (IPC). Asking regions to specify the NACE codes for the sectors of specialization and the IPC codes for the technological domains would have several advantages. First, it would give a more immediate idea of the 'scope' of the proposed specialization domains, according to the number of digits used to identify the domain. Second, it would facilitate the identification of similarities and complementarities in the specialization patterns of the regions. The latter aspect is of critical importance when identifying the potential relations among specialization domains within the same region and across different regions.[11] In the design of the RIS3, regions should be asked to clarify better whether the strategy targets industry sectors or technological domains. In the former case (industry sectors), regions should be asked to specify which technological domains are more likely to contribute to innovation in the proposed industry sectors and whether these technological domains will be developed within the same region or through connections with other regions. In the latter case (technological domains), regions should be asked to analyse which industry sectors are more likely to benefit from the new knowledge produced in the technological domains identified, and whether these sectors will be developed within the same region on in other regions.

3 Identifying infra-regional and inter-regional links

The emphasis on the intra-regional links among sectors is theoretically justified by the recent literature on the importance of 'related variety' in fostering innovation, especially radical product innovation as opposed to incremental innovation in existing production (Asheim et al., 2011; Frenken et al., 2007).

The concept of 'related variety' relies on the observation that the 'cross-fertilization' of ideas between different technological domains is better than specialisation when the aim is to promote innovation and diversification rather than efficiency in existing production. The literature on related variety has demonstrated that a diverse production base can be preferable

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[11] Attempts have also been made to map the relations between technological domains and production sectors using IPC and NACE (Patel and Pavitt, 1997).

to specialisation, especially when the aim to foster radical (product) innovation rather than efficiency. McCann and Ortega-Argilés (2014) emphasise the importance of relatedness at regional level within the logic of the RIS^3 approach. However, adoption of the concept of 'related variety' within the RIS^3 raises several questions at theoretical and practical level[12].

At a theoretical level, the related variety approach could clash with the 'critical mass principle', which is the main justification for the specialisation strategy. This problem is particularly important in the case of small regions that may have difficulties in promoting several technological domains (or industry sectors) at the same time. In fact, the related variety approach is based on consideration of 'Jacobian' agglomeration advantages, which are mostly observed in rich (and large) urban contexts (Jacobs, 1969). A possible solution could be that of focusing on those domains between which there are potential knowledge links. This in turn raises two practical questions.

The first question concerns the size of the local system. Jacobian agglomeration economies are observed in large urban areas where diversity is associated with the critical mass in each specialisation. The size of the region (in terms of population and firms) is critical for deciding whether a strategy of related variety in R&D can be implemented. The presentations of the regions do not consider the supposed positive relation between the size of the region and the number of technological domains (or industry sectors); relatively small regions have identified high numbers of specialization domains, sometimes much higher than those of larger regions. It is difficult to define an ideal ratio between the size of the region and the number of domains (or sectors) in which the region can usefully specialize. However, regions proposing more than a few domains should be asked to provide information on the resources available for each domain and an analysis of the knowledge relations that may help in achieving scale and scope economies in private and public investment. This in turn raises the question of how to define and empirically detect knowledge relations between different sectors.

There are two ways to define and empirically detect the degree of relatedness among industry sectors (or technological domains). The first is to detect them indirectly on the basis of observed (revealed) associations among different productions: if within the same geographical area it is more likely that the same associations will be observed among sectors, we can deduce that there are advantages in their spatial proximity. These advantages may depend on the presence of vertical relations (input-output exchanges) or on the existence of

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[12] On this point see also the discussion by Boschma (2014).

overlapping areas in the knowledge base used by those sectors (Hidalgo et al., 2007; Boschma and Iammarino, 2009; Capello, 2009).

The second way to define and detect the degree of relatedness among sectors is to identify an ‘a priori’ criterion of relatedness. In the case of vertical relations, this criterion could consist in the coefficients of the input-output tables that measure the importance of input-output exchanges among sectors (Cainelli and Iacobucci, 2012). The implementation of the RIS[3] requires focusing on knowledge relations, rather than on input-output exchanges. The former are more difficult to define and detect empirically. The empirical tool most commonly used to measure knowledge proximity is the association of IPC (International Patent Classification) codes observed in patents (Ponds et al., 2007). One of the main problems in application of this technique is that not all industries and firms rely on patents when producing and applying new knowledge. Moreover, in all sectors, the distribution of patents by firms is highly concentrated, with a few large companies owning most of the patents.

Given the above-mentioned problems, it is necessary to find other ways to define and measure potential relatedness in terms of knowledge exchanges among sectors.

A possible solution is to rely on the increasing adoption of the open innovation model, which requires firms to develop collaborative relations with other firms and research institutions when implementing their R&D strategy. One way to detect such relations could be to analyse the collaborations developed by firms when participating in EU, national and regional programmes that promote research and innovation. Attempts have been made to build comprehensive databases of R&D collaborations at regional level.[13] Implementation of these databases will enable researchers to detect not only the most likely associations between firms and research institutions in R&D projects but also the industries and firms most active at regional level in R&D investment.

The literature on industry-to-industry and industry-to-research collaborations is rapidly expanding (D’Este and Iammarino, 2010), and so is the literature on labour mobility across firms and on the relations between the skills of such workers and the knowledge base of the firms in which they are employed (Boschma et al., 2009).

Despite the large and growing literature on these aspects, we still lack commonly agreed indicators for technological relatedness between industry sectors and technological domains; and, most of all, we lack comprehensive and comparable data on which such indicators could

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[13] One of these examples is theinnovation portal developed by the Marche Region, which is publicly accessible at the following link: www.marcheinnovazione.it

be constructed. The difficulty of analysing and measuring the degree of relatedness between sectors and technological domains is evidenced by the fact that it is analysed in only four out of the 36 regional presentations. In all the others, the question is only mentioned (but not analysed) or not mentioned at all. Moreover, even in the presentations that attempt to analyse the relatedness among different domains, the analysis is based on qualitative considerations, with no attempt made to quantify the intensity of such relations.

Even more problematic is the assessment of cross-sectorial links with other EU regions (Foray et al., 2012, p. 6); these relations are labelled 'connectivity'. In the original formulation, inter-regional links were supposed to develop between 'core' regions at the frontier of GPTs or KETs and peripheral regions, which would specialize in application of these technologies to specific production domains (McCann and Ortega-Argilés, 2013). These links envisage the creation of 'vertical relations' between producers and users of new knowledge, rather than horizontal relations of the type implied by related variety. In fact, the benefits of cross-fertilization between sectors, which is at the basis of the concept of related variety, is closely dependent on spatial proximity (Boschma, 2005). However, excessive reliance on proximate partners for learning and innovation may increase the risk of a region being locked-in in established industries (Hassink, 2005). From a normative point of view, it would be beneficial to foster network relations with partners outside the region (Broekel and Meder, 2008). Moreover, some authors argue that the role of geographical proximity in knowledge exchange and innovation is unclear, and that other dimensions of proximity (i.e. institutional, social, etc.) may be more relevant.There is evidence that, at least in some sectors, innovation is achieved through links that extend far beyond regional boundaries (Belussi et al., 2010).

In the framework developed in the previous section, one would expect inter-regional links to differ according to the region's innovation score and to the different balance between research and innovation policy. Regions emphasising innovation policy exploit relations with research centres developing GPTs or KETs functional to innovation in the chosen domains. Regions emphasising support for R&D should privilege regions where complementary research capabilities can be found in sectors where new knowledge can be applied. At present, none of the regional presentations analyse actual and potential connections with other regions.

Besides the theoretical justifications for such collaborations, there is again the practical question of how to detect the actual and potential links with the highest potential in terms of possible knowledge exchanges. On a practical basis, regions could be asked to map the collaborations that research centres and firms in the region have developed within the EU framework programmes; this could be the basis on which to assess the actual intensity of such collaborations and whether their patterns are congruent with the proposed RIS3.

4 Bottom-up versus top-down approach

The proponents of the RIS3 approach stress that it should be the result of a bottom-up process involving all the main private and public stakeholders, and that it should rely on the 'entrepreneurial discovery' of firms. This is not only to ensure consensus in the implementation of the strategy but also to single out the most promising domains where public investments will be concentrated.

The suggestion is "…to let 'entrepreneurs' discover the future domains of specialisation through a relatively complex entrepreneurial process of discovery" (Foray et al., 2012, p. 11).It is also clarified that "… entrepreneurs must be understood in a broad sense (firms, higher education institutions, public research institutes, independent inventors and innovators) and include whoever is in the best position to discover the domains (for R&D and innovation) in which a region is likely to excel given its existing capabilities and productive assets" (Foray et al., 2012, p. 12).

In my opinion, this is the most controversial question for implementation of the RIS^3. It is true that entrepreneurs (or researchers) are in a better position than policy-makers to identify research and innovation opportunities; however, it is also clear that the knowledge of entrepreneurs and researchers is limited to their area of expertise. When entrepreneurs or researchers are asked to single out the more promising domains in terms of R&D investment and innovation, they invariably indicate the domain in which they are involved. Identification of the most promising domains through a bottom-up process of entrepreneurial discovery will inevitably result in the proliferation of promising domains, depending on the number of different stakeholders involved in the process.

The bottom-up approach seems to conflict with the idea of identifying a regional 'strategy', which is one of the most promising novelties of the RIS^3. A process of strategy design is best described as a top-down approach. Even when some of the stakeholders (such as leading research centres or firms) are asked to contribute, the top-down approach is evident from two aspects: a) the choice of the stakeholders to be involved in the process; b) the final choice of the specialization domains.

The importance attributed to the bottom-up approach by the proponents of the RIS^3 is justified by the aim of preventing policy-makers from developing RIS^3 without consideration of the actual weaknesses and strengths of their region. However, this aim is better achieved, not by shifting to a bottom-up approach, but by requesting regions to justify their choices on the basis of quantitative and qualitative data on the technological domains and industry sectors that they have identified.

A bottom-up approach in this phase is more likely to result in a widening of the specialization domains, rather than in their more effective identification (Boschma, 2014). To avoid a selection process that merely goes along with the requests of regional stakeholders, the identification and selection of promising domains must be based on indicators that demonstrate the effective strength of regional actors in R&D and innovation: number of researchers in university departments; number of people involved in R&D; number of R&D projects; number of patents; etc. The strength of the technological domains should be assessed on the basis not only of their absolute quantitative relevance (critical mass property) but also of their quality in light of a national and international comparison.

Quantitative and qualitative evaluation is easier for public research structures, such as universities, because data on the number of researchers by scientific domain are readily available. Moreover, the quality of their research can be assessed by referring to publication metrics. Data and information about the research infrastructure and output can be supplemented with other information about technology transfer activity: collaborations with firms, presence of ILO, number of spin-offs, etc.

The assessment of the R&D capability of firms is more difficult. Data on the number of people employed and on R&D investment are normally available only at an aggregate level, not for individual firms. Moreover, the degree of aggregation is too high for any meaningful analysis of specific technological domains to be conducted. In the case of firms, it is also more difficult to assess the output of their R&D activity, which is supposed to consist primarily in product and process innovation. The easiest indicator is the number of patents; however, as explained in the previous section, this is a very partial and distorted measure when traditional sectors and small firms predominate. Also in this case, implementation of a database of R&D projects developed by firms and supported by regional, national and EU funds will provide a useful tool with which to verify whether there is a critical mass of R&D activity by regional firms in the technological domains that have been chosen.

Once the promising domains of specialization have been identified, the bottom-up process of ‘entrepreneurial discovery’ can be used more effectively to identify the specific areas and projects to be supported. As previously observed, one of the weaknesses of the RIS^3 already proposed by EU regions is that the specialisation domains are identified in very broad terms:

for example biotechnology, life science, energy saving, etc. (see Table 1). The bottom-up approach should help in singling out the specific projects that will be carried out within the chosen domains.

5 Conclusions

This paper has discussed some of the issues that arise when considering the theoretical underpinnings and the practical implementation of the RIS^3. It has also proposed ways to address such issues. The starting point of the analysis has been recognition that the RIS^3 is an important advance in the design of regional innovation policy. The aim of the paper has been to contribute to a more effective definition and application of the RIS^3.

The first issue discussed is that the RIS^3 approach has progressively shifted from a strategy for R&D-based innovation to a broader concept of innovation that gives space to the DUI approach (i.e. practice-based innovation) as well. This poses several problems at theoretical and practical level. On the theoretical side, the shift to a broader concept of innovation may reduce the emphasis on specialisation, because innovation policy can be addressed to almost all sectors. Moreover, while there are justifications for public intervention in supporting investment in R&D, the extent to which public resources should be invested in promoting innovation is debatable. On the practical level, the shift to innovation will enhance the ability of the sectors already strong in a region to appropriate most of the public resources. One way to overcome this problem is to allow a variable mix between research and innovation policy according to the region's innovative capability. The analysis of the strategies so far proposed by the regions has also highlighted the scant importance given to the 'critical mass' principle when identifying the sectors or domains of specialization. This problem could be overcome by requesting regions to quantify the innovation infrastructure for each of the domains chosen.

The second issue raised by the paper is the relation between specialisation and variety at regional level. Also in this case, there are theoretical and implementation problems. Specialisation and resource concentration is a way to obtain scale economies in R&D investment; at the same time, the recent literature has emphasised the role of variety at local level when the aim is to promote radical innovations. This entails that when the specialisation domains are selected, special emphasis should be given to assessing whether and to what extent these domains are able to promote knowledge exchanges and cross-fertilization of new ideas. Moreover, regions are also asked to analyse the potential links with other regions; these latter links may be vertical between producers and users of new knowledge, or horizontal between complementary technological domains. Detection of the actual and potential linkages within and across regions raises several challenges at practical level, because we lack a commonly agreed set of indicators with which to define and empirically detect these linkages. The paper has stressed the importance of developing datasets on firm-to-firm and firm-to-research relations at regional and intra-regional level.

The third issue has concerned the balance between the top-down and bottom-up approaches in the design and implementation of the RIS^3. The proponents of the RIS^3 emphasise the bottom-up approach and advocate a process of entrepreneurial discovery in which firms and research institutions should play a key role in identifying the promising domains. The paper has questioned this idea by emphasising that the identification of a 'vision' and the design of a 'strategy' at regional level must necessarily rely, at least at the beginning, on a top-down approach. A bottom-up process can be used in a second phase, once the strategy has been defined and the specialization domains have been identified. The involvement of firms and researchers could help in singling out the specific projects that could be carried out within the chosen domains.

Overall, the paper has underlined the importance of maintaining the focus on R&D-based innovation and on specialization, thus avoiding the risk of ambiguity between RIS^3 and the much broader innovation and development policy. Moreover, the application of RIS^3 to regions with weak research infrastructures may require a different mix between research and innovation policy.

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Table 1 – Synthesis of the RIS^3 presentations

Region	Country	Population (thousands)	Regional Innovation Scoreboard 2011	Proposed areas of specialisation
Algarve	Portugal	451	Moderate-high	Agrifood; ICT and Creative Activities; Renewable Energies; Health and Life Sciences;
Alsace	France	1,815	Follower-medium	Green Economy; Health & Wellness; Humanities and social issues;
Aragon	Spain	1,346	Follower-low	Health &Biotecnology; Tourism & Trade; Culture & Heritage; Territory & Quality of Life; Agrifood;
Attica	Greece	3,812	Follower-medium	Not identified
Azores	Portugal	247	Modest-high	Blue biotech; renewable energy; marine ecology and biodiversity; geosciences; fisheries and aquaculture; tourism;
Balears	Spain	1,113	Modest-medium	ICT; Environmental and sea technologies; Life science; Biohealth and biotechnology; Creative industries;
Basque	Spain	2,163	Follower-high	Ageing Society; Digital world; Transport and mobility; Renewable energies; Biosciences; Nanosciences; Advanced Manufacturing;
Bratislava	Slovakia	602	Moderate-high	Not identified
Canary Islands	Spain	2,127	Modest-medium	Astrophysics and astronomy; Marine environment; Biotech; Renewable energies; water; Sustainable tourism;
Centre	France	2,530	Leader-low	Not identified
Cornwall	United Kingdom	535	Follower-medium	Smart grid development; marine energy; floating wind and bio fuels; creative; biomedical; health and well being; digital economy;
Emilia Romagna	Italy	4,354	Follower-high	Agrifood; Construction; Mechatronics; Health Industry; Creativity & Culture;
Friesland	Netherland	630	Moderate-low	Watertechnology; Life sciences; Sustainable energy; Agriculture; Tourism;
Kuyavia and Pomerania	Poland	2,098	Modest-medium	Food processing and packaging; Medical services and health tourism; Automotive industry; transport and automation; tools, molds and plastic products; Information processing, multimedia, programming, ICT services
Languedoc-Roussillon	France	2,600	Follower-high	Digital growth; key technologies to support traditional and emerging sectors
Lapland	Finland	195	Leader-medium	Not identified
Lubelskie	Poland	2,175	Modest-low	agriculture; bio resources processing; food production; Health and wellness services; bioenergy;
Marche	Italy	1,541	Moderate-high	Home automation; mechatronics; green manufacturing; health and well being

Continue

Table 1 (continued)

Region	Country	Population (thousands)	Regional Innovation Scoreboard 2011	Proposed areas of specialisation
Nord Pas de Calais	France	4,000	Moderate-high	Railway transport; Health-Nutrition-Food; Commerce of the future; Automotive; Buildings and eco-construction; Mechanical engineering; Advanced materials (green chemistry, textiles, composites); Energy and power electronics; Waste treatment, sediments, polluted sites and soils; Images and digital creation; E-health
Northern Ireland	United Kingdom	1,800	Moderate-medium	Advanced Manufacturing; Advanced Materials; Sustainable Production & Consumption; Life & Health Sciences; ICT; Electronics & Photonics
Ostrobotnia	Finland	175	Leader-medium	Not identified
Piemonte	Italy	4,440	Follower-high	Aerospace; agrifood; cleantech; smart communities; Mechatronics; life sciences; textiles; mobility;
Pomorskie	Poland	2,201	Modest-high	ICT; logistics; pharmaceutical & cosmetics industry; off-shore industry; energy; biotechnology; creative industries; automotive industry;
Puglia	Italy	4,090	Moderate-medium	Aerospace; Agri industry; Cultural heritage; Biotechnology and life science; Energy and Environment; Logistics; Mechanics and Mechatronics; New materials and nanotechnology; ICT;
Reunion	France	840	Modest-high	Biotech; Life science; Fishing and aquaculture; Energy; ICT; Tourism; Environment;
Rhone-Alpes	France	6,218	Leader-low	Not identified
Satakunta	Finland	227	Leader-medium	Not identified
Saxony	Germany	4,050	Leader-low	Microelectronics (3D-integration, smart systems-integration); Nanotechnology (nanoelectronic, ultrathin multifunctional films and surfaces, nanomaterials and particles, nanobiotechnology, nanofabrication); Photonics (organic electronics); Advanced materials and advanced manufacturing technologies (lightweight, composite materials, resource efficient production, smart materials); Biotechnology (regenerative medicine, bioengineering)
Sicily	Italy	5,043	Moderate-low	Not identified
Skane	Sweden	1,251	Leader-high	Sustainable cities; Personal health;
South Moravian	Czech Republic	1,196	Moderate-low	IT / es-security; Mechanical engineering; Electrotechnics /scientific intruments; life sciences;
Swietokrzyskie	Poland	1,270	Modest-low	Energy efficiency; conferences and fairs; health and spas; metal foundry;
Tuscany	Italy	3,750	Moderate-high	ICT; life science; cultural heritage; energy effciency; renewable energy; robotics; nanotechnology; home automation; photonic science; aerospace; virtual reality; bio-medicine; infomobility; pharmaceutical;
Vest	Romania	1,920	Modest-low	Not identified
Wales	United Kingdom	3,063	Follower-low	Life Sciences and Health (Patient data records, Wound healing, e-health); Low carbon energy and environment (Smart living, eco innovation, low carbon energy); Advanced engineering and materials (Photonics, MRO aerospace); ICT (High performance computing, Broadband infrastructure, Trust and Security);
Wallonia	Belgium	3,500	Follower-high	Life Sciences and health; Agri-Food Industry; Aeronautics and space Industry; Mechanical Engineering; Transport & Logistics;