ESPON

KIT
Knowledge, Innovation, Territory

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Executive summary

1. SPATIAL PATTERNS OF KNOWLEDGE AND INNOVATION IN EUROPE

The importance of a territorial analysis of knowledge and innovation

1.1. Knowledge and innovation are recognized to be the strategic assets to build a "smart growth" in Europe. This statement is evident and well known to everybody but the right strategies that can help Europe to move in this direction are not evident at all. The KIT project has the general aim to help – on the basis of sound scientific research – the setting up of strategies on innovation that are consistent with the overall reforms of EU Cohesion Policy. For achieving this aim, the KIT project enters the debate on "smart specialization" strategies in the field of innovation by overcoming the simplistic dichotomy – proposed by the first promoters of such a policy (Foray et al., 2009) – between centre and periphery, between an European research area (the core) and a co-application of scientific general purpose technologies area (the periphery). As the whole KIT project demonstrates, the geography of innovation is much more complex than a simple core-periphery model; the capacity to turn knowledge and innovation into regional growth is different among regions, and the identification of regional specificities in patterns of innovation is essential to build targeted normative strategies efficient for a cohesion policy goal. The normative suggestions that come out from this study can fulfil the gap nowadays existing in implementing the "smart specialization policies" in the field of innovation – as required by the EU in its official document *Regional Policy Contributing to Smart Growth in Europe* (EU, 2010).

What is a knowledge economy?

1.2. The knowledge economy has no unique definition, since it can manifest itself in different forms that sometimes complement and sometimes substitute each-other. A knowledge economy region can be identified as a region specialised either in high-tech sectors, or in scientific functions or is capable to obtain knowledge from other economies through cooperation and networking.

How can a knowledge economy be identified at the spatial level?

1.3. The knowledge economy can be measured at regional level through either the presence of high-tech manufacturing and service sectors, or the presence of scientific activities (human capital and research activities), or the capacity of a region to cooperate – intentionally or unintentionally – with other regions. Three typologies of regions can be empirically identified: technologically-advanced regions; scientific regions and knowledge networking regions. The map of the three types of regions offers a picture of the degree to which the knowledge economy is diffused in Europe, based on the most comprehensive definition of knowledge economy.

Technologically advanced regions in Europe

1.4. Technologically-Advanced Regions (TAR) are those regions with a simultaneous specialization in both medium high-tech manufacturing and knowledge intensive services. The geography of technology in Europe turns out to be highly concentrated, although peripheral regions and regions with capital cities in New Member States (NMS) do play a major role. Over time, no region acquires or loses the status of Technologically-Advanced Regions. The productive fabric of Europe shows therefore a remarkable concentration of technology, either related to the advanced manufacturing or services activities.

Scientific regions in Europe

1.5. Scientific regions are defined as those regions showing at the same time a higher than average scientific activity and a higher than average high-quality human capital.

Scientific regions are concentrated in the centre and in the north of Europe, most of them in Western countries, and especially in Germany and Nordic Countries.

Knowledge networking regions

1.6. *Knowledge networking regions* can be understood as regions that rely on external sources of knowledge and on facilitating interactive learning and interaction in innovation. This knowledge diffusion can take place through two different diffusive patterns: (1) informal interactions and unintentional relations arising from serendipitous encounters between actors who lie in close spatial proximity (henceforth "informal linkages") and (2) formal, intentional relations based on coordinated and well-defined linkages between actors who might, or might not, be in close spatial proximity ("formal linkages"). Hence, we characterize regions in terms of the ways in which they can access external knowledge. To identify knowledge networking regions two synthetic indicators are built, a first one capturing "informal knowledge linkages" and a second one measuring "formal knowledge linkages". This way, knowledge networking regions are those regions that have values for both indicators higher than the average; in other words, regions in a better strategic position to use extra-regional ideas in the production of innovation. Results show that networking regions are concentrated in the centre of Europe as well as in the Scandinavian countries, whereas the Non-interactive regions are mainly those belonging to the New Member Countries and some specific regions in the South European countries (the whole of Portugal and Greece, most Spain except the North-East area, and the South of Italy). More curious is the fact that a higher number of regions belong to the category of Knowledge networking regions (123) with respect to TAR and scientific regions. This results is rather important, telling us that connections to external sources of knowledge, in the form of formal and informal linkages, is a very diffused channel for local knowledge accumulation, even more diffused than the internal production of knowledge.

The knowledge economy in Europe

1.7. The map of the three categories of knowledge economy regions looks rather fragmented, with quite a reasonable number of regions being only networking, and mainly in the central part of Europe. Only three technologically-advanced regions host scientific functions (Dresden, Vestlandet and Bratislava), while most of the technologically-advanced islands are also networking regions. In general, scientific regions are also networking regions, witnessing that knowledge accumulation inside a region also requires networking activity, which allows for the acquisition of knowledge external to the region. Very impressively, a very high number of European regions, mainly in Eastern countries and in the Southern peripheral countries is below the EU average in each respect, witnessing that in most of European regions the knowledge economy is still in its infancy.

How far are European regions from the Lisbon 3% R&D over GDP objective?

1.8. In 2007, R&D spending over GDP, one of the Lisbon objectives for the achievement of a knowledge economy, interestingly shows a strong regional variation, from lower than 0.5% values to more than 6%. A very small number of regions in Europe reaches 3% of R&D expenditures on GDP, witnessing that a smart growth called for by the EU2020 Agenda with the achievement of 3% of the EU's GDP (public and private) invested in R&D/innovation is still an ambitious aim.

Is the spatial concentration of R&D activity a European phenomenon?

1.9. A comparison with the US and some emerging countries, namely India and China, shows that the concentration of research activities is something that Europe has in common with these countries. In particular, both India (around Delhi and the South) and China (coastal regions) have highly concentrated territorial patterns of scientific efforts, even more concentrated than a 'mature' innovation system like the US one,

witnessing that the achievement of a critical mass is fundamental in scientific activities, especially in relatively less rich countries, with limited funds to be devoted to R&D.

What is an innovation-driven economy and how does it look like in Europe?

1.10. The ability to transform knowledge and inventions into innovation and productivity increases makes an economic system becoming an innovation-driven economy. To measure the penetration of an innovation-driven economy into a regional system, indicators of different types of innovations shall be considered. Innovation, in fact, shows rather differentiated spatial patterns depending on the type of innovation analyzed. Product innovation displays consistent concentration in strong countries, the core of product innovative activity in Europe being carried out in German, Scandinavian, Swiss and British regions, with a few notable exceptions outside these areas. Within countries, capital regions tend to display higher product innovation rates, with some notable exceptions of regions also registering consistent innovation performance despite not hosting the capital city (e.g. Rhône-Alps and Toulouse in France). A completely different spatial trend characterizes process innovation, which displays on average higher values in Southern European countries, namely, Cyprus, Spain, France, Greece, Italy, Malta, and Portugal than in the rest of the Europe, by about two percentage points. Finally, the marketing and organizational innovation spatial trend provides a quite different perspective on innovation. This case captures non-material forms of technological progress – for instance, quality improvements, reductions of environmental damages stemming from firms' production, reductions of energy consumption, creation of new markets, reduced labour costs, reductions of amount of materials required for production, and conformance to regulations. Results show a significant concentration of marketing and organizational innovation in regions in the EU15 countries, with particularly high values in German and Austrian regions. However, the spatial distribution of this soft form of innovation seems much more even across the European space. The relatively even distribution is in particular remarkable when observed within countries, witnessing a similar innovative capability among regions.

Linkages between knowledge economy and innovation driven-economy

1.11. Contrary to general beliefs, data at the regional level show a discrepancy between knowledge and innovation. As expected, the highest difference lies between knowledge economy regions and others. The former definitely show a higher innovation performance, whatever definition is adopted. What is striking in the results is that one would have expected the regions with the highest R&D and scientific activities in general to be the most innovative. Our empirical results show instead that scientific regions, although registering a high innovation rate, are not significantly more innovative than TAR or networking regions. Only a few regions show a pattern of innovation that goes from R&D to innovation. Legitimate questions are raised in front of these results: how do regions innovate without R&D? Which are the innovation modes when R&D, and formal knowledge in general, is not locally available? The next section replies to these questions.

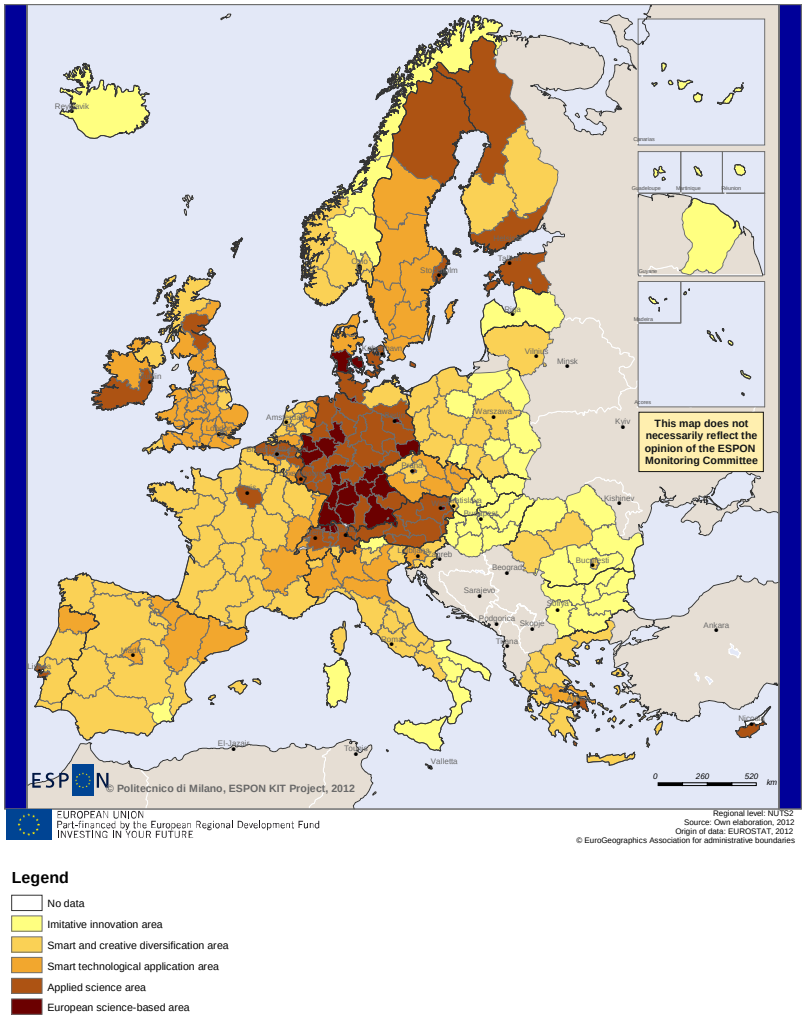
2. TERRITORIAL PATTERNS OF INNOVATION

How do regions innovate without R&D?

2.1. Different modes of performing innovation exist. A region can innovate by exploiting the knowledge that it produces; it can innovate by using knowledge coming from outside the region; it can innovate by imitating innovation that is produced elsewhere. A region adopts one of these modes of innovation according to its context conditions. The empirical results report that five groups of regions can be identified on the basis of their patterns of innovation, namely (map 1):

The **European science-based area** (pattern 1a) is characterised by strong knowledge and innovation producing regions, specialized in general purpose technologies (i.e.,

GPTs), with a high generality and originality of the science-based local knowledge, and a high degree of knowledge coming from regions with a similar knowledge base. R&D endowment is also high in these regions. They are mostly located in Germany, with the addition of Wien, Brussels, and Syddanmark in Denmark.



Map 1. Territorial patterns of innovation in Europe

The **applied science area** (pattern 1b) is made of strong knowledge producing regions characterized by applied science, with a high degree of knowledge coming from regions with a similar knowledge base. R&D activity is high also in this cluster of regions. This type of regions is mostly agglomerated and located in central and northern Europe, namely in Austria, Belgium, Luxembourg, France (i.e. Paris), Germany, Ireland (i.e. Dublin) Denmark, Finland and Sweden with some notable exceptions at East such as Praha, Cyprus and Estonia and at South such as Lisboa and Attiki.

The **smart technological application area** (pattern 2a) shows a high product innovation rate, a limited degree of local applied science, and a high creativity which allows to translate external basic and applied science knowledge into innovation. R&D endowment is similar to the Applied science area. This group of regions includes mostly agglomerated regions in EU15, such as the northern part of Spain and Madrid, Northern Italy, the French Alpine regions, the Netherlands, Czech Republic, Sweden and the UK.

A smart and creative diversification area (Pattern 2b), characterized by a low degree of local applied knowledge, some internal innovation capacity, high degree of local competences, which suggest that the not negligible innovation activities carried out in the area mainly rely upon tacit knowledge embedded into human capital. Moreover, regions in this area are strongly endowed with characteristics such as

creativity and attractiveness that help to absorb knowledge and to adapt it to local innovation needs. These regions are mainly located in Mediterranean countries (i.e. most of Spanish regions, Central Italy, Greece, Portugal), in agglomerated regions in Slovakia and Poland, a few regions in northern Europe, namely in Finland and the UK.

The **imitative innovation area** (pattern 3) has a low knowledge and innovation intensity, but a relatively high entrepreneurship, creativity, attractiveness and innovation potentials. Most of these regions are in EU12 such as all regions in Bulgaria and Hungary, Latvia, Malta, several regions in Poland, Romania, and Slovakia, but also in Southern Italy.

Policy consequences of such a variety of territorial patterns of innovation

2.2. The variety of innovation patterns explains the failure of a "one size fits all" policy to innovation, like the thematically/regionally neutral and generic R&D incentives; the latter do not suit the widespread development of a knowledge economy. On the contrary, innovation patterns specific of each area have to be identified, and their efficiency in generating growth identified. On this information, ad-hoc, targeted innovation policies can be drawn. To move in this direction, the measurement of efficiency and effectiveness of each pattern of innovation on growth is necessary, and this is what follows.

3. EFFICIENCY OF EUROPEAN REGIONS IN KNOWLEDGE CREATION

What is the impact of R&D expenditures and human capital on local knowledge production?

3.1. The way regions exploit R&D and human capital to generate new local knowledge strongly differs among regions. Both R&D and human capital are less effective in the regions with the lowest knowledge endowment, witnessing that a certain degree of knowledge is required to generate new knowledge. This is true up to a certain threshold, when increasing returns turn into decreasing returns.

The importance of the right mix of R&D and human capital

3.2. The geographical distribution of the regional capacity to exploit the right mix between human capital and R&D confirms the presence of a dualistic – centre vs. periphery – pattern in knowledge inputs exploitation. This calls for specific policies, which should target the latter group of regions, in order to support them - not with additional resources - but with the provision of organizational and structural assistance that should enable them to exploit all the potential of their relatively abundant inputs in delivering higher levels of knowledge output, which in turn is expected to ensure better long run economic performance.

4. THE IMPORTANCE OF EXTERNAL KNOWLEDGE FOR INTERNAL KNOWLEDGE CREATION

How does knowledge diffuse over space?

4.1. Knowledge diffuses within the region by means of structured and defined channels, such as networks and labour mobility of human capital, that turn to be very important for the capacity of a region to generate its own knowledge.

The capacity of regions to use external knowledge to generate new knowledge

4.2. The capacity of regions to exploit external knowledge to produce new knowledge strongly differs among European regions. Empirical results tell that in order to benefit from external formal knowledge, a region needs to have a certain amount of internal knowledge. A normative intervention for supporting inventors' mobility is worth for strong scientific regions.

5. THE ROLE OF R&D AND HUMAN CAPITAL ON REGIONAL PERFORMANCE

R&D requires a certain critical mass

5.1. R&D is more efficiently used in those regions that considerably invest in R&D, such as those in the "European science-based area". On the contrary, regions characterized by lower levels of R&D spending, have little benefit from further investments in R&D to improve their economic performance being their elasticity of GDP to R&D below the European average. This result warns about the simplistic translation at regional level of the suggestions given by the Lisbon Agenda, and reinforced by the Europe2020 Agenda; the achievement of 3% of R&D to GDP can be a good strategy for regions that have already a certain level of R&D activities. Instead, a Lisbon Agenda for regions with a low level of R&D endowment seems to produce rather limited effects on GDP growth.

Human capital has a higher impact on GDP than R&D

5.2. When efficiency of human capital to regional production is measured, interesting results emerge, namely: i) human capital has a higher impact on regional production than R&D; ii) the highest impacts are registered where human capital is present in a very limited way, demonstrating that human capital is a more important pre-condition for growth in weak regions than R&D. Moreover, human capital shows strong decreasing returns: in regions where it is present in high quantities, its effects on growth are limited.

An efficient combination of both R&D and human capital is important for regional performance

5.3. The achievement of an efficient combination and use of knowledge inputs is important for a high production performance, but it is a very difficult task, much more than the achievement of an efficient combination and use of traditional production factors (labour and capital). Those regions that are able to achieve an efficient combination of knowledge inputs are a few in Europe. Innovation policies should be oriented towards the reinforcement of the efficient combination of knowledge production factors, rather than on the reinforcement of single separate knowledge inputs.

6. THE ROLE OF INNOVATION ON REGIONAL PERFORMANCE

Is R&D useful for innovation?

6.1. R&D is more useful for generating innovation in those regions where a critical mass of R&D efforts and investments is already concentrated. Moreover, regions differ considerably in their sources of knowledge for their innovative activities. Some regions strongly link their innovative performance to their large science and formal knowledge base, others are more likely to rely upon diverse sources of knowledge, possibly embedded in technical and managerial capabilities (like in the "Smart and creative diversification area").

Is knowledge embedded in human capital useful for innovation?

6.2. The effect of knowledge embodied in human capital (measured as the share of population holding a tertiary degree) is comparable to that of R&D. On average, the impact of human capital on innovation capacity is positive; however, this average effect hides a greater variety of behaviours across regions. Knowledge embodied in human capital is more efficiently used in regions endowed with a larger share of graduates, such as those in the "European science-based area", in the "Smart technological application area" and in the "Applied science area". Regions highly endowed of human capital should keep this record in order to maintain their innovative performance. Normative choices that limit such investments risk to put under stress the innovative profile of the regional economies in the medium to long run.

Has innovation a labour-saving nature?

6.3. In general innovation (either only product or only process innovation) is a labour saving process. However, this result differs among regions. In particular:

- regions specialized in production functions suffer less from job losses, since new jobs are created in these regions for the production of the new goods;
- regions with large metropolitan settings (Megas) experience amplified labour-displaying effects of process innovation. Cities show in fact higher density of service activities, the latter having a higher propensity to introducing process innovations.

Does innovation increase productivity of traditional production factors (labour and capital)?

6.4. Interestingly, the efficiency level of European regions (measured in terms of total factor productivity level) is not only linked to the strength of the local formal knowledge base. As expected, the "European science-based area" reports the highest productivity level; however, the efficiency ranking does not strictly reflect the knowledge ranking, either in the form of R&D expenditures or in the form of number of patent applications. Innovation looks, on average, crucial to achieve higher efficiency levels. These benefits are likely to be unevenly reaped by the different groups of regions. In particular, only regions in the "European science-based area" seem able to benefit from innovation increases, whereas in the other regions innovation does not seem to bear a considerable impact on efficiency increases. This result suggests that formal knowledge is not the only and chief driver leading to higher efficiency performances. Rather, a tight relationship between knowledge and efficiency level seems to be at place only in those groups of regions in which the local knowledge base is already quite developed and rich.

Does innovation increase regional growth rates?

6.5. Both knowledge and innovation play a crucial role in explaining growth patterns in European regions, thus supporting the efforts to enlarge and strengthen the European knowledge base proposed in the Lisbon Agenda and EU2020 strategy. However, our findings also suggest some caution in the interpretation of this result. The impact of innovation on GDP growth is, at the European average, 3.5 times greater than that of R&D. Importantly, the growth benefits stemming from innovation are spatially more distributed than those stemming from formal knowledge. In fact, the differences in the reaction of GDP growth rate to innovation across the five patterns of innovation are not as noticeable as those in the impact of R&D on GDP growth rate. Whereas this partly reflects a more spatially distributed nature of innovation in comparison with knowledge, this also suggests that the different groups of regions are similarly efficient in translating innovation benefits into higher GDP growth rate.

The use of innovation to achieve higher efficiency levels

6.6. The role of innovation on regional productivity is uneven and does not only depend upon the strength of the local formal knowledge (as developed through R&D activities and patents). Formal knowledge is crucial but not exhaustive. In fact, higher than average efficiency levels can be achieved also by taking advantage of local informal, tacit and embodied knowledge creatively and successfully translated into commercially viable innovations.

7. CASE STUDY EVIDENCE

Is it a matter of industrial or territorial features in defining the different patterns of innovation?

7.1. A first lesson from the case study analysis is the larger importance that territorial, rather than industrial, features have in shaping territorial patterns of innovation. This is particularly evident since case studies in the same industry in different regions yield radically different innovation patterns, according to the territorial specificities of the regions analyzed.

Changing from one innovation pattern to another

7.2. Whilst, most industry-regions case studies show stable situations in the patterns of innovation, few cases have been identified providing evidence of a switch of patterns. In particular, the Bratislava automotive case study registers a shift from an imitative to an adoptive territorial pattern of innovation. In this case thanks to the local availability of entrepreneurial skills, local actors may reverse engineer the knowledge embedded in products traded with multinational corporations (i.e., MNCs). An opposite case of change from an endogenous to an adoptive pattern of innovation characterizes the ICTs in Lombardy, where local firms, once fully capable of bringing new products to the market by exploiting local GPTs, and innovative capacity, must now look for scientific knowledge that is sourced from outside the region in order to innovate. The causes of this shift of innovation pattern has been identified in the insufficient innovation investments and poor governance of the ICTs sector in Lombardy, which nowadays registers attempts to launch new policies, in particular with regard to interesting and promising experiences concerning the production of vouchers for cooperative behaviour in innovation activities by the regional board.

The crucial role of the local labour force

7.3. The positive effects of clustering provide firms with local supplies of a suitable, well qualified and, in many respects, experienced workforce. In research intensive regions such as Oxford, Cambridge and Tuscany, there is a well established research culture, which pervades the locality and is manifested in acquaintance with the requirements of research active firms. A similar cultural identity is found where there is an history of innovation within firms in manufacturing, as in Piedmont. Frequent and meaningful interaction between firms, the local universities, and local or regional government also supports the positive effects of clustering and agglomeration effects.

The role of finance

7.4. The availability of sources of finance is among the most important of the more general elements that support knowledge and innovation creation. Venture capital is of great importance to support entrepreneurial activity among micro and small firms, and the most obvious example of this is the biotech sector in Oxfordshire, where research active firms require support for extended periods of time before they are able to enter phases of revenue generation. In addition good levels of general education as well as the provision of high standards at technical and advanced university level institutions are regarded as necessary throughout the case study examples.

Stable relationships between different actors of the local economy

7.5. Interestingly, supportive conditions for knowledge creation and innovation come about over an extended period of time and cannot be achieved quickly. Stable relationships between different actors of the local economy, investments support, and governance frameworks allow networks to build up that enable both specific industrial, as well as infrastructural development that may benefit a wide spread of sectors. In some of the case study areas (e.g., Piedmont), networking is relatively informal, but in other areas networking organizations dedicated to particular industrial concerns have developed along with those that deal with wider industrial conditions in the region. Dedicated networking structures provide the means whereby firms, both on an industrial or more general basis, may represent their views or define their needs to various levels of government. These structures are well developed and operate on quite an extensive

and formal basis in the biotech and ICT sectors in the UK. However, in other regions this kind of lobbying tends to be more general, for example, in Kosice where networks tend to operate much more on an individual and informal basis.

Quality of the governance

7.5. Local government and other agencies participate to different degrees in the promotion and support of sectors located in their regions. Where involvement is strong the focus has been on establishing the perception of a region as hosts to sectors with particular strengths. The local government authority in west Wales is an example of strong public sector support focussed on developing a perception (and the reality) of expertise and culture within the food sector, and a similar approach is adopted by state bodies in promoting the products of the wine sector in Arezzo. The media sectors in Cardiff are also recognised and designated as important areas for future growth by the local and regional governments. Such local policy support is manifested in concrete actions, for example, by supplying advisory and other support officers, in facilitating land planning systems to allow for industrial development, and in encouraging clustering effects. Support in developing business networks, both locally and with external regions is seen as important in all the case studies. In Slovakia's wood processing sector this is seen as particularly important to improve levels of local collaboration and co-operation, and in Slovakia in general there is an expressed need to develop better systemic or generic support measures rather than to focus on one-off and specific projects.

8. POLICY IMPLICATIONS

A one-size-fit all strategy is not an efficient policy choice

8.1. The general aim of increasing European competitiveness through knowledge and innovation is a strategic and rightly formulated goal. However, the vast empirical analysis - both qualitative and quantitative – developed in this project has highlighted under many respects the inappropriateness of the "one-size-fits-all" policy which could be derived from a fast and superficial reading of the Lisbon and Europe 2020 Agendas. When a regional perspective is adopted, in fact, an aggregate policy goal of 3% of the EU's GDP (public and private) to be invested in R&D/innovation shows its fragility in supporting the increase of the innovation capacity of each region in Europe, since: (i) a critical mass of R&D spending has to be achieved in the region, and this is not the case in most regions in Europe; (ii) R&D spending on its own does not guarantee high efficiency level in the production of new knowledge; it is instead the efficient combination of different knowledge inputs that guarantees high efficiency levels in knowledge production; (iii) R&D spending and knowledge production in general spill over to neighbouring regions; however, regions receiving knowledge require a certain level of receptivity to exploit it.

What can be done in the near future?

8.2. The pathways towards innovation and modernization are differentiated among regions according to local specificities. In fact, territorial innovation patterns exist, that differ one another in terms of the different modes of combining knowledge and innovation, due to different territorial (context) conditions that support the creation / diffusion of knowledge and innovation. In front of this differentiated situation, ad-hoc, thematically/regionally focused innovation policies have to be built; what we call smart innovation policies.

Innovation policies consistent with the EU cohesion policies: smart innovation policies

8.3. Smart innovation policies may be defined as those policies able to increase the innovation capability of an area by boosting effectiveness of accumulated knowledge and fostering territorial applications and diversification, on the basis of local specificities and the characteristics of already established innovation patterns in each region. The

logical pathway towards 'smart innovation' policies is drawn in Figure 1. The Reform of the EU Regional Development Funds can be assumed – and in fact was explicitly intended – as a "key means of turning priorities of Innovation Union Flagship Initiative into practical action on the ground" (EC, 2010b, p. 2). Along similar lines, this contribution, with its detection of five, conceptually differentiated innovation patterns, may pave the way towards a renewed, spatially sound inclusion of the smart specialization strategy in R&D policies into an appropriate regional innovation policy framework.

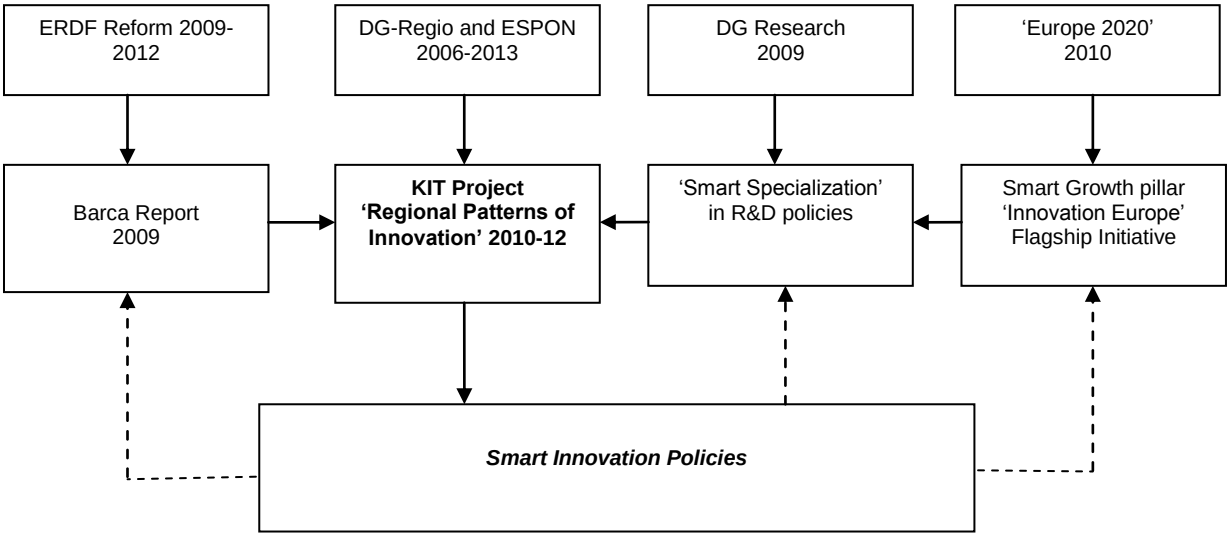


Figure 1. Logical pathway and contributions to Smart Innovation Policies

The two key concepts of "embeddedness" and "connectedness" - put forward in the recent debate on smart specialization – are a starting point: policies have to be embedded in the local context, in local assets ("embeddedness"), and have to guarantee the achievement of external knowledge through strong and virtuous linkages with the external world ("connectedness"). Smart innovation policies go a step forward, since they adapt the two concepts of "embeddedness" and "connectedness" to the specificities of each pattern of innovation, without incurring in the unrealistic situation of having one policy action for each European region, or in the paradox of rejecting innovation policies, like R&D funding and specialization, just because they are traditional tools. Smart innovation policies look for ad-hoc interventions - appropriate for each single territorial innovation pattern - with the aim to reinforce regional innovation process, to enhance the virtuous aspects that characterize each pattern, and to reinforce each pattern's efficiency (Table 1).

Policy goals and actions to increase local knowledge

8.4. Regional innovation policies for each pattern should differ first of all in terms of policy goals.

A - The maximum return to R&D investments is the right policy goal for regions belonging to the "European science-based" and the "Applied science" patterns, characterised by a sufficient critical mass of R&D endowment already present in the area. Regions characterised by these two innovation patterns can in fact exploit the indivisibilities associated to research activity and take advantage from additional R&D funding. Given their different research specialization, the two patterns can reinforce their efficiency when innovation policies are devoted to the reinforcement of the regional research specificities: in the "European science-based area" the maximum return of R&D spending is obtained through policy actions devoted to R&D spending in GPTs, and a strong specialization is fundamental in these regions to achieve a critical mass of research. Applied scientific fields of research should instead absorb much of the

R&D funds in the "Applied science area", diversifying their efforts in related sectors of specialization. This leads us to claim that the disagreement on specialization in favour of specialised diversification, highlighted in the recent debate, is applicable to some - but not all - regions. Support in this sense can be provided by national governments, satisfying a critical mass through the financing of national projects. European funds can in this case be of valid support, and the European Research Area be further expanded. The right policy levels to support and achieve this normative goal are the European and national one, complemented by European funds. European and national research funds should in fact be devoted for the development of national excellences, of unique research centres able to achieve a critical mass of researchers in general purpose technologies, when a specialization of this kind exists in the country.

B - R&D support is not the most natural policy goal for the "Smart technological application" and the "Smart and creative diversification" patterns; in these areas the relatively low R&D endowment does not guarantee the presence of a critical mass of R&D in order to exploit economies of scale in knowledge production. The returns to R&D of such kind of policy are modest in these areas. The innovation policy aim in these patterns can be found in the maximum return to co-inventing application (the typical Schumpeterian profits), which deeply depends on the ability of regions to change rapidly in response to external stimuli (such as the emergence of a new technology). To achieve such a goal, supports to creative application, shifting capacity from old to new uses, deepening or improving productivity in existing uses, are the right policy tools for maximising the return to co-inventing application. Policy actions for the achievement of such goals can take into account incentives to technological projects that foresee new and creative use of existing scientific knowledge for the "Smart technological application area".

This support can effectively be given by local governments, able to understand local excellence and interpret right needs. On the other hand, support devoted to the identification of international best practice, and to entrepreneurial creativity are more in favour of an innovation pattern like the one of the "Smart and creative diversification area". The relevant policy level changes in this case to a regional one, which is much more suitable to identify local specializations and expertise on which to insist.

C - Finally, in the "Imitative innovation" pattern the aim has to be devoted to the achievement of the maximum return to imitation, through a creative adaptation of already existing innovation, via adoption processes driven by creative ideas on the way already existing innovation can be adopted to reply to local needs. The maximum return to imitation is supported by incentives to local firms for the development of creative projects with multinational corporations (MNCs). A local policy can be the right policy level, not only by developing MNCs attraction policies, but also indirectly by investing in the specific local assets on which the area can excel. In this case, the relevant policy level are both the national and local ones. In these areas, policies on intangible assets, like the quality of institutions, of the education system, and of human capital in general (not measured in this study but nevertheless important in defining the propensity of adopting and exploiting innovation), are strategic policy actions, that can be developed at both national and local level. The policies on intangible assets like education and training and quality of institution, or even the development of an innovation-prone society, through the development of a digital society and therefore of social innovation, should be interpreted as horizontal intervention policies, from which regions belonging to each pattern may get advantage, as rightly pointed out by the Seventh Progress Report (EU, 2011). However, our analysis warns about general education and training policies since: i) also human capital suffers from decreasing returns, and therefore it generates advantages on GDP growth at decreasing rates; ii) the most efficient regions register a *mix* of human capital and formal knowledge. In policy terms, these elements suggest: i) that education and training policies are the highest returns where human capital is present in a limited way; ii) that education and training policies should be developed following the knowledge domain in which the region hopes to excel.

Table 1. Smart innovation policies by territorial patterns of innovation

	Territorial patterns of innovation				
Policy aspects	**European science-based area (Pattern 1a)**	**Applied science area (Pattern 1b)**	**Smart technological application area (Pattern 2a)**	**Smart and creative diversification area (Pattern 2b)**	**Imitative innovation area (Pattern 3)**
Policy goals	Maximum return to R&D investments		Maximum return to applications and co-operation in applications		Maximum return to imitation
Policy actions for local knowledge generation (Embeddedness)	Support to R&D in:		Support to creative application, shifting capacity from old to new uses, improving productivity in existing uses, through:		Fast diffusion of existing innovation Enhancing receptivity of existing innovation
	New basic fields General Purpose Technologies	Specialized technological fields Variety in applications	Incentives to technological development and upgrading Variety creation	Identification of international best practices Support to search in product/market diversification Support to entrepreneurial creativity	Support to local firms for complementary projects with MNCs Support to local firms for specialized subcontracting
Policy actions for exploitation of knowledge spillovers (Connectedness)	Incentives to inventors attraction and mobility Support of research cooperation in:		Incentives for creative applications through:		Incentives for MNCs attraction
	GPT and trans-territorial projects (ERA)	specific technologies and trans-territorial projects (ERA), in related sectors/domains Encouraging of labour mobility among related sectors/domains	Co-operative research activities among related sectors Co-operative search for new technological solutions	Participation of local actors to specialized international fairs Attraction of "star" researchers even for short periods Work experience in best practice Knowledge creation firms of the same domains	Bargaining on innovative 'local content' procurement by MNCs
Relevant policy level	National level (also with EU funds)	National level (also with EU funds)	Local level (also with EU funds)	Local level (with also EU funds)	National and local levels (with also EU funds)
Policy style	Reach a critical mass in R&D activities through concentration of public support Priority to triangular projects by Universities-Research Centres-Enterprises Peer assessment of R&D research programmes Support to knowledge and technological transfer mechanisms to related sectors Thematical/ regional orientation of R&D funding:		Ex-ante careful assessment of innovation and differentiation strategies and projects Continuity in public support, subject to in-itinere and ex-post assessment of outcomes Support to bottom-up identification of industrial vocations, by raising awareness on local capabilities and potentials ('strategic industrial planning') Thematical/regional orientation of innovation funding, in order to:		Favour local spill-overs of managerial and technological knowledge from MNCs Support to co-operation projects between MNCs and local firms
	in general purpose technologies	in specific fields of research and technological specialization of the area	strengthen present formal and tacit knowledge through co-operation with strong external partners in the specialization sectors	enhance local technological receptivity, creativity and product differentiation capability in specializ. sectors	Support to technological transfer and diffusion
Beneficiaries	University, research centers, large local firms		Local firms	Local entrepreneurs	Local firms

Policy tools and actions for achieving external knowledge and innovation

8.5. Beyond the previous policy recommendations aimed at fostering the creation of local knowledge, often policy interventions can be suggested for knowledge acquisition from

outside the region, what has been called connectedness. As has been the case for embeddedness, also in the case of connectedness its implementation varies according to the specificities of the different patterns of innovation".

A - In the two patterns where external science-based knowledge is merged with local knowledge, the policy tools to attract external knowledge are incentives to inventors attraction, and support of research cooperation in GPT and trans-territorial projects, for what concerns the "European science-based area", and in related sectors belonging to specific fields of technological specialization for the "Applied science area". This suggestion is in line with the creation of the European Research Area (ERA) put forward by the European Commission, an area composed of all research and development activities, programmes and policies in Europe which involve a transnational perspective. The "Applied science area" could also be favoured by the encouragement of regional and inter-regional labour mobility between related sectors, which makes skills and experience moving around across sectors and regions. The right policy level for such policies are the European and national ones.

B - Policy tools for knowledge acquisition in the "Smart technological application area" and in the "Smart and creative diversification area" are incentives for creative applications. For such a purpose, cooperative research activities in related sectors in those regions where a little applied science base exists are an efficient policy tool for the "Smart technological application area". Participation of local actors to specialized international fairs, the attraction of "stars" even for short periods of time, or a work experience in best practice knowledge creation firms of related sectors are right incentives to stimulate innovation in the "Smart and creative diversification" area whose innovation capacity lies in the brightness of their entrepreneurs to find outside the area the right applied science on which to innovate and move towards a specialized diversification in related sectors. The right policy level for such policies are the national and local ones.

C - The traditional incentives to attract MNCs remain the most efficient tool to attract new knowledge in areas with very limited – formal or informal, scientific or technical – knowledge together with general local policies to highlight the local assets on which the region excels, or can hope to excel.

Policy style

8.6 The policies suggested require renewed styles in their design-to-delivery phases in order to enhance efficiency and effectiveness. As in more general regional development policies, a strong attention should be devoted to the following elements:

- Transparency, which means clear justification of the spatial allocation of funds in the different measures, from spatial concentration in some cases (reaching a critical mass in R&D, particularly in Innovation Patterns 1 and 2) to spatial pervasiveness in others (tapping local creativity, diversification and adoption capabilities: Patterns 3 to 5);
- Control on local strategies followed, in order to avoid rent seeking attitudes by local élites (in politics, in the economy, but also in the high education and research fields). This means favouring active co-operation among main local actors: universities, research centres and firms. The internal strategies of the single actors in the research and innovation fields, perfectly lecit, may not be the best ones for the entire regional community, or the most appropriate in terms of risk assumption by the public sphere; therefore, programmes and projects presented jointly by all three main actors should be solicited and given high priority (especially in Patterns 1 and 2);
- Peer ex-ante assessment of main R&D and innovation projects presented to public support;
- Knowledge transfer, knowledge diffusion through inter-sectoral and inter-regional co-operation and general knowledge dissemination should be favoured, in order to boost productivity of the publicly supported R&D;

- Favour continuity over time in public support decisions – a crucial precondition for local learning processes – at the condition of fair and effective intermediate and ex-post assessment of outcomes;
- Build a formalized, but flexible, organizational model for supporting the identification of regional specializations, in R&D and production, and for strengthening the search process of new thematic application fields and diversification areas, inside and outside the present technological and production domains: a local, participatory model that could be labelled as 'strategic industrial planning';
- Favour creativity and entrepreneurial spirit in all regional conditions. This means, on the one hand, to detect and support present local skills, traditions, social values, positive attitudes towards the environment and local culture, solidarity and cultural diversity (especially in Pattern 3 and 4); on the other hand, to create an innovation-friendly business environment, reduce barriers or resistance to change, enhance receptivity to external stimuli and opportunities, discover new local potentials through the engagement of insufficiently utilised local resources (in Patterns 3 - 4 and especially 5).

Beneficiaries

8.7. Beneficiaries of these policy recommendations differ among patterns; university, research centres and large R&D laboratories of private firms are the natural beneficiaries of the "European science-based" area and of the "Applied science area". Local firms are the natural recipients of "Smart technological application area" policies; entrepreneurs and small firms are the natural recipients of policies devoted to the "Smart and creative diversification area". Local firms are thought to be the right subjects for the "Imitative innovation area" policies.

Moving from one pattern to another: smart evolutionary innovation policies

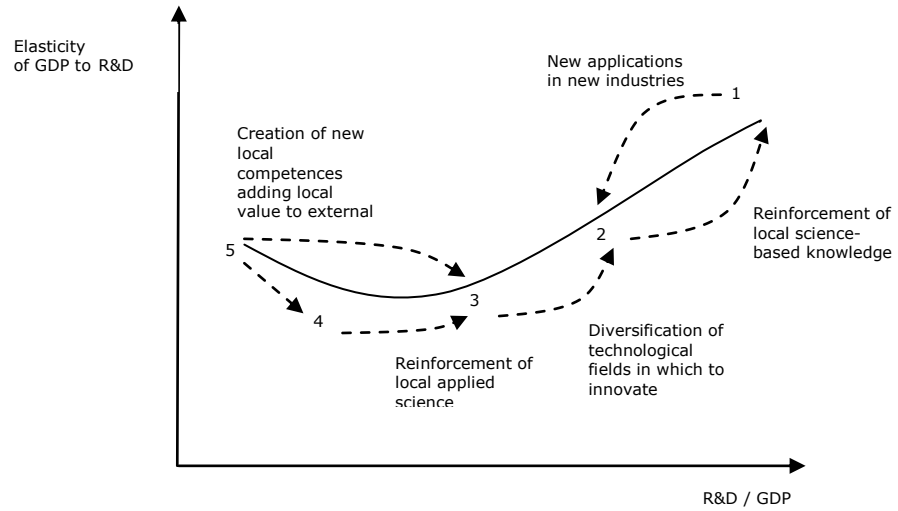
8.8. The previous policy suggestions are meant to increase the efficiency of each pattern. However, within each pattern, regions exist that are more advanced than others, and that potentially could move to a different pattern. For these regions, evolutionary policies can be foreseen, devoted to the achievement of more efficient innovation patterns. The application of the evolutionary policies requires the identification of the most efficient regions within each pattern. These regions have to show a strong efficiency with respect to other regions in the same pattern, and especially should demonstrate an already clear policy oriented towards the increase of returns to knowledge and innovation. In this way, evolutionary policies would find a fertile ground on which to produce their virtuous effects (Figure 2).

Moving away from the Imitative innovation area

8.9. The most efficient regions in the "Imitative innovation area" could be pushed towards either a "Smart and creative diversification area" or a "Smart technological application area" through the support in the creation of new local competences adding local value to external competences. The case study of the automotive industry in Bratislava is a right example in this respect. Following the creation of local suppliers with specific competences, the innovation pattern moved away from an imitative pattern; in fact, innovation processes increasingly derive from the knowledge that local subsidiaries have cumulated through strong interaction with the parent company. The innovative pattern in this area is increasingly becoming a "Smart technological application pattern".

Moving away from the smart and creative diversification area

8.10. The most efficient regions in the "Smart and creative diversification area" can be supported in order to move towards a "Smart technological application area" through the reinforcement of local applied science; in this way higher efficiency levels can be achieved.



Legend: 1 = European science-based area; 2 = Applied science area; 3 = Smart technological application area; 4 = Smart and creative diversification area; 5 = imitative innovation area

Figure 2. Evolutionary trajectories and policies by patterns of innovation

Moving away from the European science-based area and from the applied science area

8.11. The 'European science-based area' could be stimulated to avoid some evidence on decreasing returns of R&D activities in terms of knowledge creation, by diversifying research into new application fields in new industries, merging aspects of the 'Applied science area'.

Moving away from the smart technological application area

8.12. Finally, some regions belonging to the latter area could strengthen their science base in GPT fields, if already present with some critical mass, moving towards the first Pattern, namely the 'European science-based' one.

Policies have to support clearly defined innovation trajectories

8.13. Whereas in some cases innovation is the result of unforeseeable events, of totally unexpected creative disruptions of existing innovation trajectories, it is also reasonable to claim that regional innovation policies based on public funds can only support clearly defined innovation trajectories, holding the lowest likely risks and the highest expected returns.

A right policy mix

8.14. The complementary actions of static and evolutionary smart innovation policies - targeted on each innovation pattern - would certainly be the right policy mix to implement the "smart specialization policies" in the field of innovation - called for by the EU in its official document Regional Policy Contributing to Smart Growth in Europe (EU, 2010) - and to achieve a "smart growth" in the years to come.

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