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Defining European ICT Poles of Excellence: Literature Review

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The same report has also been published as an ESRI Working paper under the title ICT Diffusion, Innovation Systems, Globalisation and Regional Economic Dynamics: Theory and Empirical Evidence. ESRI Working Paper 233 (2008). It is available at: http://www.esri.ie/publications/search_for_a_working_pape/search_results/view/index.xml?id=2540.

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1. An introduction to the research question

The Commission Communication entitled "A Strategy for ICT R&D and Innovation in Europe: Raising the Game"[1] proposes reinforcing Europe's industrial and technology leadership in ICT. Building on Europe's assets, in particular its many ICT industrial clusters, the strategy seeks to step up the effort in ICT Research and Development and Innovation (R&D&I). Moreover, the Communication anticipates a landscape where by 2020, "(...) *Europe has nurtured an additional five ICT poles of world-class excellence* (...)". This strategy has been firmly confirmed in the later Digital Agenda for Europe.[2]

Location as an assumption

The policy context of the present study, reflected in this quote, is rooted in a strong location-focused assumption, motivated by a tradition of cluster-based policies and also by the debates around the role of European regions in Innovation policies,[3] and the resulting rethinking of regional policies and regional funding of (ICT-related) innovation, (ICT) technology transfer and more generally technology-driven economic growth.

Since the EU-level ICT R&D&I policy (the 2009 Communication), location has been considered of priority interest for both regional and national policy makers. The challenge for policy has been to foster a business environment with spatially-anchored resources and capabilities, which would be perceived by national and international businesses as attractive complements and/or substitutes to those available in other regions or countries of the world.

The focus on ICT R&D&I is determined by the fact that the Digital Economy is seen as one of the possible responses to the current crisis (EC 2010). At the same time, ICT is seen as providing essential infrastructures and tools for knowledge creation, sharing and diffusion, boosting the innovation capacity of other sectors and contributing to overall productivity growth. This importance of ICT is still reflected in R&D budgets worldwide, where they typically represent close to 25% of the total R&D investment (Turlea, Nepelski et al. 2010).

Late 2011 policy developments further encapsulated this view in a draft legislative package that frames EU cohesion policy for the period 2014-2020. In particular, the draft regulation on Regional funds,[4] which lays down common provisions on the funds, proposes a specific ex-ante conditionality of "the existence within the national or regional innovation strategy for smart specialisation of an explicit chapter for digital growth"[5] and more broadly "the existence of a national or regional research and innovation strategy for smart specialisation in line with the National Reform Programme, to leverage private research and

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1 Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0116:FIN:EN:PDF

2 Available at: http://ec.europa.eu/information_society/digital-agenda/index_en.htm

3 See for example at: http://ec.europa.eu/enterprise/policies/innovation/policy/regional-innovation/index_en.htm.
Also, an example to show that the debate is a long-lasting one: http://www.eua.be/eua/jsp/en/upload/PLIII4_Getsiou.1161612680851.pdf

4 COM(2011) 615 final. Regulation laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund covered by the Common Strategic Framework and laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and repealing Regulation (EC) No 1083/2006 {SEC(2011) 1141 final} {SEC(2011) 1142 final}.

5 Annex IV of the mentioned draft regulation.

innovation expenditure, which complies with the features of efficient national or regional research and innovation systems".

As said above, this study is rooted in a "location-focused assumption". Of course such assumption about the existence of "agglomeration economies" is strongly corroborated by scientific theoretical and empirical literature: economic activities tend to agglomerate, and even more so, apparently, those related to ICT. Hence, location and the agglomeration of an ICT-related activity in a geographical space, stand as a legitimate and central topic of this study.

Still, the identification of the most important Poles is often based, in the political or specialised media discourse, on anecdotal rather than sound evidence and clear criteria. When informally questioning experts about European ICT Poles of Excellence, the examples of Dresden, Cambridge or Grenoble are often cited as outstanding candidates, the equivalents of Silicon Valley or MIT in the US. And of course, this is legitimate and correct. Similarly, the specialised press will praise places like Stockholm[6] or Dublin.[7] But, as a matter of fact, few attempts have been made to capture in objective terms those characteristics that would help us to identify ICT Poles of Excellence, and even fewer have focused on ICT R&D and Innovation. Praising statements are often related to one-shot observations of well-branded start-ups. To our knowledge, only a few studies have been more systematic in the last decade, and none of them have addressed the issue in a comprehensive manner. We will describe them in some details in the present report.

Change as an assumption

Together with location, a second assumption underlies some of the research questions of this study: that of change. The 2009 Communication clearly refers to the emergence of "*an additional five ICT poles of world-class excellence*" by 2020. It assumes that the geography of economy will change in as little as a decade. It takes up the hypothesis that ICT themselves, together with globalisation, specialisation, service economies and other major trends will participate in the rapid redistribution of economic activities across the world, and in particular Europe. This is probably true at world level, considering the rise of Asian countries or, more broadly, those of the BRICS.[8] It might be less true regarding Europe as in an integrated market, and a partially integrated currency zone, competitive advantages may be less easy to displace. This has been indirectly observed in the ICT industry itself since the European Enlargement of 2004,[9] but it also stems from the path dependency that characterises agglomeration economies: these successful places usually keep and nurture further agglomeration and success in the long-term.

Research objectives

Taking into account the two above-mentioned initial assumptions – location and change- , the study attempts to identify ICT R&D&I-related agglomeration economies that would meet world-level excellence, and to identify weak signals that would indicate the dynamics

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[6] See for example: Cheshire Tom, 2011. Europe's hottest start-up capitals. In: Wired, Volume 2011, Issue 9. This article is described in a later section of this report.

[7] Example presented at IPTS expert workshop on Poles of Excellence of November 2010. See at: http://is.jrc.ec.europa.eu/pages/ISG/documents/AgendaEIPEWS_004.pdf

[8] BRICS: Brazil, Russia, India, China, South Africa. For ICT industry developments in BRICS, see: http://is.jrc.ec.europa.eu/pages/ISG/PREDICT/BRIC.html

[9] More on this topic in the "Annual report on R&D in ICT in Europe", in particular the 2009 and 2010 editions. Available at: http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html

of a changing ICT-related economic geography in Europe. Both of those identification processes are based on quantitative data, built on a set of relevant criteria leading to measurable indicators.

In short, the European ICT Poles of Excellence (EIPE) study pursues the following main objectives:

- Define what European ICT Poles (EIPE) of world-class Excellence are, their salient characteristics and the corresponding quantitative indicators.
- Develop a quantitative methodology for the identification and analysis of *existing* European ICT Poles of Excellence.
- Develop a quantitative methodology for the identification and monitoring of *emerging* European ICT Poles of Excellence.

This report pursues the first objective.

To do so, it roots the definition of EIPE in a large body of scientific literature, both conceptual and empirical, that has described, analysed and mapped for almost a century[10] the spatial concentration of economic activities, and more recently knowledge-intensive and ICT-related activities, at local and global level.

This scientific literature helps us rooting the identification of EIPE on firm ground. Interestingly enough, no systematic effort has been made so far to focus, as we will here, on the building of a *quantitative* tool to characterise sector-specific innovation-related agglomeration of economic activities. Similarly, no serious attempt has been made to determine an approach to excellence in this context.

In summary, the study seeks to establish a sound quantitative methodology for identifying and monitoring the existence and progress of current and emergent *European ICT Poles of world-class Excellence* (EIPE).

This research objective is no trivial undertaking, for the following reasons:

- It is known that *the agglomeration* of economic activities are not bound to specific spatial spread or administrative limitations. In that sense, they will escape systematic statistical collection.
- In addition, when speaking of agglomeration characteristics, contemporary scientific literature insists on observing *networking patterns* beyond the mere geographical concentration in one location. Methodologically speaking, this will call for introducing and adapting network analysis techniques into the measurement toolbox.
- The reference to *emergent* Poles calls for an understanding, not only of the characteristics of current Poles, but also of the pre-conditions that would today allow for agglomeration and excellence in the future.
- The *ICT sector*-specific focus calls for a clear categorisation, but more importantly, for access to dedicated statistical data.
- The introduction of the *innovation* concept raises all the traditional questions about its definition and measurement.
- The benchmarking of *excellence* introduces a notion of distinctive performance, the criteria for which have yet to be decided. These criteria must allow us to distinguish the best pole among other poles, poles among the many European ICT clusters.

[10] Starting in the 30s, in particular with Marshal and Weber in the conceptualisation of industrial districts.

This brief overview already indicates that this study is a totally unique exercise. We will see that it leads us to observe the characteristics of contemporary ICT R&D innovation and production activities and their respective patterns of agglomeration, internationalisation and strategic global positioning.

EIPE Working Papers Series

The EIPE study is developed around several tasks,[11] whose results are presented in a series of IPTS working papers.[12] This Working Paper synthesises the conclusions of the conceptual and empirical literature review that was carried out both at the beginning of the study and pursued during the study.[13] It summarises the most prominent concepts discussed in the relevant literature, the methods that were developed and leads to a definition of the European ICT Poles of Excellence that will guide later work.

The EIPE Working Paper 1 is structured as follows: after this introduction, Chapter 2 takes into account:

- the theoretical literature related to agglomeration economies,
- the theoretical literature on the role of ICT in regional dynamics,
- the empirical efforts to map business and inventive activities in Europe or the US, in ICT and in non-ICT industries,
- finally, an inventory of attempts, by public authorities and the media, to label businesses, regions or activities as "excellent" or "innovative".

In Chapter 3, the report introduces the definition of European ICT Poles of Excellence (EIPE) that will serve for elaborating the methodological and statistical observation tool, which will be developed in the EIPE Working Paper 2.

[11] These successive tasks are schematically represented in Annex 1

[12] Forthcoming. Available, when authorised for publication, at: http://is.jrc.ec.europa.eu/pages/ISG/EIPE.html

[13] The current version is dated June 2012. It is intended by IPTS to update it on a periodic basis, as to take in account further advances in the literature or adapt to any relevant refinement of the concepts. Its latest version is the one that will be presented on the IPTS publications website at: http://is.jrc.ec.europa.eu/pages/ISG/EIPE.html.

2. A brief review of the literature

To work out a conceptual definition of European ICT Poles of Excellence, there is an obvious need to summarise and benefit from the existing literature that would reflect upon (i) spatially agglomerated economic activities, (ii) the role of ICT in regional dynamics, as well as from (iii) the empirical exercises or (iv) the labelling initiatives[14] that would have attempted to reach similar goals.

In all cases, the aim is to clarify what can be borrowed as valid for the EIPE conceptual definition and empirical methodology, while putting aside aspects that appear to be less valid for the exercise due alternatively to historical changes to the overall economic context, to the specificities of the ICT sector or to the geographical scope of the study. Otherwise expressed, the effort has aimed at extracting from existing theoretical and empirical knowledge what could serve the definition of EIPE and their statistical method of identification. Simultaneously, it aimed at contrasting the present exercise and its object, ICT Poles of Excellence, from earlier objects of observations such as (mainly) industrial clusters and regional economics. The review of literature confirms those studies offer many lessons to take but are not identical in aims, methods and results.

It needs to be clear from the outset that we are not concerned here with providing an in-depth analysis of the very broad literature related to all strands and debates about economic agglomerations or regional development, but we rather intend to provide a sufficient overview of selected sources as to lead to a refined and operational concept of Poles of excellence and extract some guidance for the methodological framework for identifying them.

This chapter is structured around four main sections: the first one is dedicated to a brief review of the scientific literature around agglomeration economies (Section 2.1) and the second around the role of ICT in regional dynamics (Section 2.2). The next section reviews what the authors have identified as existing major empirical exercises identifying spatially agglomerated economic activities successively presenting business activities and innovative activities (Section 2.3). Finally, Section 2.4 lists several labelling initiatives.

2.1 Theoretical approaches to agglomeration economies

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The idea of spatially agglomerated economic activities is not new in the industrial economic literature. This section is organised around the main strands of academic literature that has been analysing, from close to a century, the phenomena of agglomeration of economic activities, its characteristics and its factors of emergence.

Three successive and partly overlapping concepts are discussed below: those of industrial districts, clusters and business networks. They reflect the chronological development of the

[14] The authors have separated those two categories – Empirical studies and Labelling initiatives -, even if this had to be done in a slightly arbitrary way. They have regrouped those exercises whose scientific or statistical basis are evident and presented in a more or less transparent way, and called those "Empirical". Other initiatives, often of governments or the international press, are labelling specific locations as Poles, Clusters, etc. often with much less "method". Such labelling exercises might be seen as challengeable. They still offer a range of useful lessons for our purposes. For that reason, the authors have considered also those cases in this report.

literature, while also acknowledging the changing context and patterns of economic activities, in particular in advanced economies.

2.1.1 Industrial districts

Main definitions

The two main theoretical frameworks that generated an extensive amount of research on the spatial distribution of economic activity are those of industrial districts and local production systems (Marshall 1922, Weber 1929).

The concept of industrial district was introduced by Marshall (Marshall 1922) who defined it as a concentration of specialized industries in particular localities where business relationships are instituted in a local environment and affected to a certain extent by the existence of socio-cultural aspects.

Another seminal contribution to the conception of industrial geographical aggregation is rooted in Alfred Weber's "Theory of the Location of Industries" (Weber 1929). Weber introduced *the least cost approach*, which intends to explain the location of (manufacturing) firms as determined by the interaction of two groups of factors: so-called regional factors (i.e. geographically determined), such as transportation and labour costs, and non-regional factors (i.e. determined by the interaction of firms' location decisions).

Factors of emergence

A. Weber in particular considers *the relevance of cheap labour location as explanatory factor for agglomeration.* In all industrial districts, and especially in high-tech sectors, phenomena such as information spillovers, transaction costs reductions, existence of a pool of specialised service firms and spin-offs have a crucial influence in determining the location of industry.

Additionally, high-tech firms do require skilled workers. If one considers the quality-adjusted price of labour (by computing both education and training expenses as part of the labour costs) the search for particular locations which are endowed with a richer pool of already trained workers does correspond to the least cost approach.[15]

Authors such as Palander (1935), Hoover (1937 and 1948), Isard (1949 and 1956), Moses (1958), Bechman (1990) further contributed to the Weber's least cost approach and developed a partial equilibrium analysis model. Focusing on the *supply side* of the economy, they defined the minimisation of costs to be the driving force of location decisions. They also determined that the concept of perfectly competitive general equilibrium could not be meaningfully applied to spatial economics (Maggioni 2002) as a spatial perfectly competitive general equilibrium framework would imply the following assumptions: transport costs equal to zero, capital and labour ever-present or perfectly mobile, and production technology uniform throughout space.[16]

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[15] Still, these pools of skilled labour are often produced by already existing group of similar firms. In this context, it is thus rather difficult to distinguish labour orientation from the willingness to experience agglomeration economies.

[16] Interestingly enough, we can speculate that if applied to ICT R&D, these assumptions become more realistic: transport costs tend to zero for digital goods and are minimized for other high-tech goods in the digital economy; high-skilled labour is exceedingly mobile; production technology of innovation is globalized. Hence, we can expect a wide dispersion of this type of activity and its location in places which ere, until recently, not on the map of the intensive R&D&I activity, e.g. Asia (Nepelski, De Prato et al. 2011).

A number of complementary perspectives on location dynamics arose (see, for example, Maggioni, 2002) turning their attention to *the demand side* of location decisions. These studies consider two types of innovative firms: those that produce very specific consumer products whose relevant market extends to the whole world, and those that produce some intermediate goods used as input for other firms, which are usually larger and spatially concentrated. Their observation is that an industrial customer (demand side) would prefer to do business with geographically aggregated firms rather than with geographically dispersed ones.

More authors took into a closer consideration the *demand side* and developed theories that are alternatively called "market area" or "locational interdependence" approaches (Fetter 1924, Hotelling 1929, Lösch, Eaton and Lipsey 1976). Based on two main assumptions that buyers are dispersed in a wide area and that costs are constant, these theories suggest that the producers seek the location that ensure them the greatest sales value. In doing so they would follow the scope of maximizing their revenues through serving the largest possible market.

Contrary to the least cost approach, pioneered by Weber and further developed by various authors that treat the firm's optimization strategy as the minimization of costs, the demand side approach looks at the maximization of revenues, subject to the decisions and actions of competitors.

A group of scholars (such as Fujita 1990, Rivera-Batiz 1988, Kanemoto 1990, Papageorgiou 1979, Saxenian 1994) assume *price interaction* or *comparative advantage* to be the fundamental cause of spatial agglomeration of economic activities. Based on this assumption, they develop empirical evidence showing that the availability of specialised local produced services in one of the major causes of industrial agglomeration.

A closely related approach, *economic geography*, was put forward by Krugman (1991, 1992, 1993, 1994, 1998) and further developed by Baldwin (1997), Ottaviano and Puga (1997) and Venables (1995, 1996). Their approaches answer two main questions of geographic concentration of industrial production, i.e. the existence of agglomeration phenomena and the determinants of firm's location, in terms of the interaction of increasing returns, transportation costs and factor mobility. The existence of the geographic concentration of industrial activity is seen as a result of three forces, the first two being centripetal and the third being centrifugal: firms locate close to the largest possible market, workers want to have access to the wide variety of goods, and firms care of serving peripheral markets.

A class of models that seem to fit better the case of high-tech firms is the one based on the *non-price interaction* (Fujita, 1985, Henderson, 1977, Kanemoto, 1980) based on information exchange and knowledge spillovers. It assumes that firms in the same area receive the same amount of external economies regardless of their positioning and active behaviours: firms engage in a communication activity and agglomeration economies are arising from flows of communications among firms exchanging information.

Characterisation of the phenomena

Regarding industrial districts, numerous cases have been observed over the world, but the organisation model of the industrial district has been studied as a special feature of the Italian socio-economic development, in the textile, fashion and furniture industries.

Italian scholars provided invaluable contributions to the concept of 'industrial district'. While the presence of conscious cooperation was not considered necessary in the Marshall's view

of industrial districts, it has been attributed a role in consolidating and improving the effectiveness of the structure by many scholars addressing the formulation of the notion in the '70s and '80s (as in (Becattini 1978; Beccattini 1990).

Building upon the concept of Marshall and Weber, (Becattini 1978) pointed out the importance of relationships such as those associated with society, history and culture in the analysis of localised production processes. This observation opened a wide reflection on the way in which *external economies* would increase productivity and innovation potential and eventually the related *local economies* as a whole. When analysing the determinants and consequences of the appearance of geographic agglomeration, literature is pointing out, for example, that industrial districts represented an evolution from the fordistic paradigm **(**Rullani, 2002) where growth of firms was based on *accumulation*, to a next paradigm of growth based on *propagation*. This kind of growth follows lines external to the firms themselves, and industrial district become mediators in this new paradigm of growth among an increasingly high number of smaller firms, creating an environment which is seen as much better responding to a more complex economic system lead by innovations.

The presence of a local community of people, sharing a relatively homogeneous system of values and views in a district is seen as another characteristic. The analysis claims that a population where agents show some specialisations and complementarities, and the presence of some intangible factor in human resources (which recalls what Marshall labelled "industrial atmosphere") provide a better acknowledgement for district workers inside the district itself resulting in concentrating them in the area.

Along the same line of thoughts, industrial districts are expected to show a singular combination of competition and cooperation among the firms belonging to the same agglomeration, affecting to a large extent the transaction costs of accessing the market, the mobility in the labour market, the diffusion of innovation, and flow of knowledge.

The exposition of the firms to the social and cultural values of the local population and the interaction with this environment is argued to have significant impact on the effectiveness of the district itself (Cainelli, 2002). In this interpretation, the (even small) firm in the district environment can manage to play an active role, behaving as agent of change and promoter of new competitive strategies.

Fundamental aspects in the *ecology* growing out of such agglomerations of firms are the *absorptive* capacity of themselves towards innovations, good multiplication capacity, and also exploration capacities in order to support and take part in the process of ideas development and innovation creation.

Final observations

As already hinted above, this brief review of the Industrial Districts literature offers some useful insights to root an initial theoretical and methodological background for the European ICT Poles of Excellence. Still, it appears from these readings that this strand of literature, for historical reasons, might be slightly outdated due to the transformation of the overall context of production and research since its foundation. Also, while the literature acknowledges the empirical existence of agglomeration processes, at an early stage it rather focuses on their factors of emergence rather than on identifying the resulting characteristics.

Certainly, this focus on factors of agglomeration stands as a useful input. The literature identifies and debates a variety of factors, organised usually around 2 or 3 main categories:

- Some authors oppose two type of factors: so-called regional factors (i.e. geographically determined), such as transportation and labour costs, and non-regional factors (i.e. determined by the interaction of firms' location decisions), such as agglomeration forces.
- Others propose to categorise under more classical terms such as *supply side* factors driving to a minimisation of costs strategy (i.e. spatial distribution of relevant inputs and output; cheaper labour, other firms locations) and *demand side* factors rather driving to maximization of revenues (i.e. serving the largest possible market; do business with geographically aggregated firms; greatest sales value).

Within such overall framework, the theory developed by some early authors shows serious limitation in considering the representation of inter-firm relations to be purely competitive, while inter-firms relations often rely heavily on the semi-formal and formal relations between agents. This view will be further developed in the second and third strand of literature, described below.

When considering our EIPE case, the main limitation of this strand of literature is actually that it represents the inter-firm relations only as competitive and leaves aside other strategic interactions, like technical and research collaboration, complementarities and knowledge spillovers, as well as those interactions that go beyond the limits of the location itself. All those are relevant and needing to be taken in account to analyse R&D and innovation-related activities. We will see this in more recent approaches.

We can conclude that the analysis of industrial districts as a complex economic and social form of organisation which contains within itself the essential factors of its own formation and development, can only be used with caution if applied to the mapping of the ICT R&D location patterns: it needs to show how location patterns are not justified only by comparative advantage (such as least cost or revenue maximisation factors) and tend to results in a more complex structure, certain aspects of which are better reflected in the concepts of clusters and of networks which we analyse in the further sections.

Box 1: A synthesis of the industrial districts concept and main characteristics.

Definition

(...) spatial agglomeration of similar and/or related firms. The concept relates to a sub-regional area with a specialised industrial production. The institutional set-up and collective action of agents within the system have a crucial impact on the competitive advantages of the industrial district.

Actors

Competitive firms of one branch and/or active in the same technological field.

Spatial extension

Local to regional.

Geographic orientation

Closed internal / regional networking.

Relationships and cooperation form between actors

Informal relationships mainly in the vertical direction.

Key authors

Marshall, 1922; Weber, 1929, Maggioni.

2.1.2 Clusters

Main definitions

The concept of "clusters" represents a more recent strand of literature as it started to gain popularity following the seminal work of Porter (1990), which introduced the term into the economic and business literature. Porter defined a *cluster* as a vertical (producers and suppliers) and horizontal (particularly research and development qualification, technology infrastructure, support agencies) concentration of interdependent firms within a single sector or within similar economic sectors in a restricted geographical area. Dieter Rehfeld (1993) further developed the concept of *production clusters:* he focuses on the spatial concentration of different components of a value-added chain but also emphasises the interfaces between internal and external economic interconnections in a region.

Characterisation of the phenomena

The characterisation of the *cluster* phenomena encompasses several approaches,[17] which can be roughly grouped as follows. One approach broadly relies on the notion of *economic linkages* among agents in understanding clusters' nature and strengths. This approach includes applied regional cluster analyses (Feser & Bergman, 2000), strategic and competitive analyses (Carrie, 2000) and empirical classification models (Gordon & McCann, 2000; Porter, 1998).

A second approach studies the nature and diversity of the *institutional organization* of clusters (e.g., Carrie 2000). Third, *geographical proximity* and its attendant economic advantages are the aspects investigated by Gordon and McCann (2000).

Although the foregoing approaches are a valuable contribution to the theory of clusters, they often neglect the role of knowledge-based elements in the underlying frameworks and classificatory models they use to describe clusters. Knowledge-based elements do receive certain attention within *qualitative and case-based research studies* (Meyer-Stamer, 1998; Rabellotti, 1999). However, the idea that knowledge-based elements are a key determinant of a cluster's strength forms the basis of a rather separate approach, developed by the founder of the cluster theory himself, in his later work.

Specifically, Porter studied the concept of clusters as a factor in *competitive advantage* (Porter 1990). Within this approach, the strength of a cluster depends on a series of interacting factors that can be grouped under several categories: firm strategy, structure and rivalry; firm conditions; related and supporting industries; factor conditions related to climate, labour supply, government fiscal and incentive policies, etc. Despite being a departure from the purely economic approaches in understanding clusters, Porter's more recent theory still relies to a significant extent on the notion of economic linkages in characterizing a cluster's competitive dynamics.

Morosini (2004) takes a step further, departing from the approaches purely relying on economies of scale by emphasizing that knowledge interactions within the cluster are not random but rather deliberate, socially constructed and vital for the cluster's competitive survival. He defines an industrial cluster as a *socioeconomic entity* characterized by a social community of people and a population of economic agents localized in close mutual proximity within a specific geographic region. Within an industrial cluster, significant parts of both the social community and the economic agents work together in economically

[17] For an in-depth overview of different approaches used to study clusters see Morosini, 2004.

linked activities, sharing and nurturing a common stock of product, technology and organizational knowledge in order to generate superior products and services in the marketplace.

Currently, despite the fact that there is no widely accepted single definition of the term cluster, almost all definitions introduce to common characteristics: they share the ideas of proximity, networking and specialisation, and a central assumption that a cluster is more than the sum of its parts. The relationships between the firms of a cluster are characterised both by cooperation and interdependence on the one hand, and by innovation-related competition on the other hand. Furthermore, it is assumed that spatial proximity produces positive externalities for the involved firms such as a supply of labour with an appropriate qualifications profile or specific infrastructural provision.

Therefore, clusters differ from simple geographic agglomerations of economic agents in terms of the level of embeddedness and integration of the social network. This implies that even those relations that are normally considered to be purely generated and regulated by the market depend on norms, institutions and sets of assumptions shared among the group of actors, and are not simply the outcome of the economic decisions (Gordon and McCann, 2000).

Factors of emergence

As summarized by (Kozovska 2010), there are three main factors for firms to cluster (i.e. three types of geographical agglomeration externalities) which were first analysed by Marshall and later rediscovered (Arrow 1962; Romer 1986). As a result, they have been defined as the Marshall–Arrow–Romer (MAR) externalities:

1. *Input externalities*: concentration of producers in a given industry generates incentives for input suppliers to locate close by. As a consequence, producers can share specialised services, save on transportation costs or purchase inputs more efficiently.
2. *Labour market externalities*: industrial clusters favour the creation of pools of specialised workers, who acquire cluster-specific skills valuable to the firms. Clusters could also improve the functioning of labour market through a better matching between employers and employees.
3. *Knowledge externalities*: industrial clusters facilitate the exchange of information and knowledge and seem to be a form of organisation particularly favourable to technological and knowledge spillovers.

The above model applies to the agglomeration of one given industry in a region. A second model looks at inter-industry spillovers as most important factor of agglomeration and knowledge creation. Karlsson et al. (2010) state after Jacobs (1969) that the agglomeration of firms in urban regions fosters innovation due to the *diversity* of knowledge sources located in such regions. Thus, the *variety of industries* within an urban region can be a powerful engine of growth for that region, and the exchange of complementary knowledge across diverse firms and economic agents leads to increasing returns to new knowledge.

Given the relative importance of the two specialisation mechanisms, *different regions may exhibit different growth experiences given their historically given economic structure*.

Performance criteria

A number of additional studies are of a particular interest in the view of our research objectives as they focus on estimating cluster performance (Meyer-Stamer, 1998; Porter, 1998; Pyke et al., 1990; Rabellotti, 1995; Schmitz, 2000; Simmie & Sennett, 1999).

Although the empirical findings remain somewhat disjointed, they mostly suggest that a cluster's long-term economic survival and success hinges on the way in which its agents manage to organize mutual cooperation while at the same time fostering greater competition (Swann & Prevezer, 1996).

The economic performance of industrial clusters hinges primarily on the degree of knowledge integration between member firms and on their global competitive scope. Firms in industrial clusters, which present a high degree of knowledge integration and compete globally, innovate more, present stronger growth patterns, adapt to changing environmental conditions more rapidly and have a more sustainable economic performance than firms in less integrated clusters, which tend to compete within strictly local geographic boundaries.

Final observations

This brief review of the clusters literature offers again useful insights to construct a theoretical and methodological background for the European ICT Poles of Excellence.

In particular, it invites for an important insight into the cooperation and competition mix, and in particular into the primary source of clusters competitiveness, knowledge integration, considered by many authors to be the main element for understanding agglomeration dynamics and EIPE location patterns.

It also offers a further set of characteristics to observe such as proximity, networking and specialisation; the relationships between the firms of a cluster (i.e. cooperation and interdependence; innovation-related competition); the presence of positive externalities (i.e. supply of labour with an appropriate qualifications or that of a specific infrastructure).

The literature introduces also to the notion of cluster performance and the conditions thereof (degree of knowledge integration between member firms; global competitive reach).

It is nevertheless true that many of those approaches still rely on the notions of localization economies of scale and might fail describing or explaining some aspects that could stay specific to ICT Poles of Excellence. This will be made even more evident when considering, in Section 2.3, the outputs of observatories strongly rooted in cluster theories.

Box 2: Synthesis of the industrial districts concept together with its main characteristics[18]

Definition: geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated organisations in a particular field linked by commonalities and complementarities. There is competition as well as cooperation.

Actors

Mainly firms of one branch/technology active in different markets.

Spatial extension

Regional to national.

Geographic orientation

From closed internal to inter-regional or national networking.

Relationships and cooperation form between actors

Regional interactions with inter-regional relationships.

Authors

Meyer-Stamer, 1998; Porter, 1990, 1998; Pyke et al., 1990; Rabellotti, 1995; Schmitz, 2000; Simmie & Sennett, 1999; Swann & Prevezer, 1996; Morosini, 2004.

2.1.3 Techno-economic networks

Main definitions

The two previously discussed concepts of spatially bounded business activity focused primarily on the localised dimension of these activities. Networks and networking come as a third and most recent strand of literature. These later concepts take on board the lessons and observations of earlier theoretical and empirical views about agglomeration, but intend to go beyond their limitations and encompass the impacts of contemporary changes in economic activity.

The basic point of departure in discussing techno-economic networks is the observation that firms operate in the context of internationally interconnected business relationships, forming a set of connections that go beyond specific locations. In knowledge intensive activities such as R&D, global networks are emerging as a result of multinational enterprises' (MNEs) decisions concerning the location of their economic and R&D activities and the interactions between them (Breschi and Malerba 2005; Sachwald 2008; Lahiri 2010; Nieto and Rodriguez 2011). From a strategic viewpoint, these global networks are becoming the firms' potential sources of efficiency and effectiveness and affect the nature and outcome of their actions (Håkansson and Snehota 1995; Wilkinson and Young 2002).

A techno-economic network is defined as a coordinated set of heterogeneous actors, who participate collectively in the conception, development, production and distribution or diffusion of procedures for producing (already existing or new) goods and services, some of which give rise to market transactions (Callon 1992). In certain cases, the actors behave predictably, and the technology and its products evolve along lines that are relatively easy to characterise; in other cases, the network actors develop complicated strategies leading

[18] This synthesis is adapted from (Koschatzky and Lo 2007).

to a number of innovations, and these provoke unexpected rearrangements: they can separate into smaller networks, or they can join other networks.

An important implication of the networking process for MNEs as well as for locations of R&D activity is that being connected globally is increasingly recognized as a crucial determinant of the position of both individual firms and locations in a global hierarchy (Cantwell and Janne 1999; Enright 2009; Meyer, Mudambi et al. 2011; De Prato and Nepelski 2012).

Characterisation of the phenomena

Techno-economic networks are characterised as a new form of economic actor that creates collective knowledge and skills through basic technological research (Laredo and Mustar 1996). The research carried out in techno-economic networks is 'basic' because a large majority of the research teams, and not just the academics, place a great deal of emphasis on outputs normally regarded as 'academic', such as PhD theses and publications in refereed journals. It is 'technological' because a majority of the teams, and not just those from industry, take part on the assumption that a new commercial product or process will eventually result from their work.

Applied to ICT R&D, network relations implicate a special mode of organizing knowledge transfer, which has little or no underlying contractual relationship and is based on bilateral information trading on an informal or semi-formal cooperative basis (von Hippel 1987; Schrader 1991). The knowledge transfer occurs through interactions between scientists, researchers or engineers at trade fairs, conferences or during informal meetings, is based on trust and reciprocity, and needs time to develop. Compared to formalized research cooperation, this type of cooperation might provide additional benefits of integration while avoiding some of the costs of the formalised one (Teece 1996). This observation is pertinent also to the ICT sector, where the knowledge base is complex and expanding, and learning takes place in networks of interacting firms instead of within individual firms.

It is generally argued that techno-economic networks are organised around three 'poles': the scientific, the technical, and the market poles (Callon 1992; OECD 1992; Hull, Walsh et al. 1999; Graf 2006). In more precise terms, these three main poles can be defined as follows (Graf 2006):

- The scientific pole includes universities and public and private independent research centres, which produce empirical knowledge.
- The technical pole consists of labs in firms, cooperative research centres and pilot plants, which design, develop, and transfer artefacts for specific purposes (e.g. models, prototypes, pilot projects, patents, tests, standards).
- The market pole is comprises firms (customers, suppliers, competitors), professionals and practitioners who market the innovations.

This model can be extended by a fourth pole, consisting of government agencies and other public authorities (De Laat 1996). However, this pole is sometimes viewed as a component of the institutional framework rather than as a separate pole, on the grounds that government agencies and public authorities shape the environment rather than play an active part in the innovative process (Graf 2006).

According to (De Bresson and Amesse 1991), techno-economic networks of innovative firms are identified in 5 different configurations: supplier – user networks, networks of pioneers and adopters, regional inter-industrial networks, international strategic alliances,

and professional inter-organizational networks. In all of the above-listed cases the interaction for the diffusion of knowledge and information takes place between people forming interpersonal networks (Zucker 1986; Zander and Kogut 1995; Olav 2003).

In contrast to clusters and other economic agglomerations, which function on the principle of market exchange, innovative (techno-economic) networks operate largely through informal contacts where the reciprocity is less strict. This means that there is no direct payment for every bit of information, although there are punishments for free-riders such as exclusion from information channels (Graf 2006). From the perspective of an industrial or innovative network, interdependence and co-evolution are important characteristics, and the competitive aspect of strategy is less important (Gadde, Huemer et al. 2003). In various ways, firms and individuals are embedded in networks where economic factors and social dimensions are both crucial. Moreover, according to Graf many actors are not always led by profit-seeking motives, since they work for governmental or private non-profit organizations such as universities or public research institutes, as well as for public administrations (Graf 2006).

Performance criteria

Differently from industrial districts and clusters, the performance of a techno-economic network is determined by the interaction of its actors with each other. These functions can be grouped into two categories: those directly concerned with the innovation process and those that support the innovation process indirectly (Graf 2006). The first group of functions includes two tasks: identifying problems and creating new knowledge, which are fulfilled through R&D, search and experimentation, learning by doing, learning by using and imitation. The second group of functions is performed by the network poles and by the institutional framework that facilitate the exchange of information and knowledge within the system by supplying incentives for the companies to engage into networks, supplying resources, guiding the direction of research, recognizing the potential for growth, stimulating/creating markets, reducing social uncertainty, counteracting the resistance to change (Johnson 2001; Graf 2006).

Final observations

Networks and networking as third and most recent stand of literature offer us some ultimate essential aspects to incorporate in our understanding of ICT Poles of excellence.

Taking into account the globalisation of economic activities and accounting for the heterogeneity of locations, the current project will need to incorporate network analysis in its toolbox, acknowledging the status of location or actors within networks, interdependency within systems, and the crucial determinant of the position and role of both individual firms and locations in the global hierarchy.

Also innovation is centre stage in the analysis of techno-economic networks, marked by the presence of technical and market poles complementary to a scientific one (R&D). This innovative function is expected to accentuate further the patterns of informal cooperation and interdependent relations, rather than purely competitive.

Second, informal cooperation seems especially pertinent to the ICT sector, where the knowledge base is complex and expanding, and learning takes place in networks of interacting firms instead of within individual firms.

Finally, while we do not follow the approach considering cognitive proximity as a performance criterion of research networks to be taken into account together with other forms of proximity (geographical, organisational, institutional), we still consider this

criterion to be appropriate to be taken on board in understanding the aspects that foster the successful exchange of knowledge.

Box 3: Synthesis of the industrial districts concept together with its main characteristics.

Definition:

A coordinated set of heterogeneous actors, who participate collectively in the conception, development, production, etc. of goods /services.

Actors:

Cross-branch and/or cross-technology mixture of companies active at different levels of value-added chains.

Spatial extension

National to international.

Geographic orientation

Relatively low internal coherence with strong integration into national and international division of labour.

Relationships and cooperation form between actors

High level of both formal and informal interactions at national and international level.

2.1.4 Insights from the literature on agglomeration economies

Our brief literature review reveals a series of fundamental observations to take on board for the conceptual and methodological elaboration of ICT Poles of Excellence.

First, the literature points at one common evidence: that of the geographical agglomeration of economic activities. This is a historical trend in Europe, observable probably at least since the emergence of processes of urbanisation: economic activities, for reasons that might vary with time, tend to concentrate in restricted geographical areas. Both the factors that explain the agglomeration, as well as the selection of the areas or their definition in spatial terms remain debatable for experts.

Second, those three strands of literature – industrial districts, clusters and networks - show that we assist to a double-sided evolution, that of the object under observation, simultaneously to that of the concepts and methods to observe it.

Economic activities are not currently organised as they were at the beginning of the XXth century. What observers were studying when speaking of industrial districts is not equivalent to the object analysed by network analysts. This evolution of the organisation of economic production in our advanced economies, and the role of knowledge within that organisation, is probably an obvious observation for whoever has been studying industrial production during the latest two decades: the ICT have profoundly affected the organisation of the whole supply-side[19] of any sector, accompanying in particular the globalisation processes and reinforcing them. Briefly speaking, the earlier definitions and characterisations of districts, of clusters or even of networks can only partly satisfy the requirements needed to define and observe contemporary EIPE.

Also, the objects and methods of analysis have obviously evolved. We have seen how the atomistic approach to the firm-level motives for agglomerating – driving the district approach - has progressively expanded to inter-firm relations, horizontal and vertical, formal and informal while opening up also the analysis beyond the geographical scope of

[19] And, of course, of the demand-side. But at this point, this is of little relevance to our report.

the "agglomeration" to finally encompass the global reach in terms of knowledge integration and of market. The traditional paradigm that investigates atomistic actors competing for profits is not seen as appropriate in the contemporary context anymore and has been supplemented. This evolution went along with a shift from homogeneous units of observation (i.e. firms of same sector) to heterogeneous actors, from competition factors to cooperation, from the local to the global,

Box 4 presents synthetic definitions of industrial districts, clusters and networks. Each of these definitions includes a set of main features characteristic to a relevant concept. This presentation allows for filtering out the elements common across the concepts in order to be included in the definition of EIPE.

Box 4: Definition of concepts of concentration of economic and R&D&I activity

Industrial district: (...) spatial agglomeration of similar and/or related firms. The concept relates to a sub-regional area with a specialised industrial production. The institutional set-up and collective action of agents within the system have a crucial impact on the competitive advantages of the industrial district.

Cluster: geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated organisations in a particular field linked by commonalities and complementarities. There is competition as well as cooperation.

Network: a coordinated set of heterogeneous actors, who participate collectively in the conception, development, production, etc. of goods /services.

All the above elements lead to the following six main observations:

Agglomeration will be marked by a group of firms that are active in the same or related industries, located geographically close to each other. Two important benefits of being clustered stem from access to market, nearby suppliers, direct observation of competitors but also other features such as the ability to exploit collective knowledge within network-based effects.

Second, it is **a matter of actors and of heterogeneity**. Beyond the individual firm, the actors belong to a variety of categories that can fall under such taxonomy as that of scientific, technical, market and governmental actors, even if the latter is seen mainly in its role of component of the institutional framework, shaping the environment rather than playing an active part in the innovative processes.[20]

There is no doubt that such playground corresponds to similar observations and analysis offered by the literature on Innovation systems.[21] Such literature can help us deepen our observations and interpretations.

Third, a focus on the **knowledge function**, and in particular on R&D&I functions, is essential together with a similar focus on the market functions, as two main features of contemporary agglomeration. The agglomeration phenomenon relies partly on an adequate balance of those two functions, and their interrelation.

Innovation, resulting from knowledge integration and market processes. Some authors introduce the rather blunt expression of "co-participation in innovation" as a way of coining this interdependence and its goal: linking knowledge and market, and benefiting of this

[20] In such case, public research institutions need to be categorised within the scientific category.

[21] Coined by Lundvall (1985). See also: National Innovation Systems (OECD, 1997) available at: http://www.oecd.org/dataoecd/35/56/2101733.pdf

interface. Innovation is expected to accentuate the patterns of interdependent relations, from competitive to cooperative, between firms.

Consequently, analysing EIPE will encompass to observe knowledge-intensive inputs and inventive outputs, but also their innovative, knowledge-intensive, market impacts.

Fourth, the **international reach** is the relevant background for the analysis. No serious analysis of contemporary agglomeration processes, its actors or impacts as well as its performance assessment can be developed currently without setting the agglomeration process within a context of international reach. Such context encompasses the existence of global partners or competitors (often multinationals), foreign markets (trade), international relocation of activities (inward and outward), international investments (VC, inward or outward FDI), etc.

Fifth, the knowledge and market functions need to be seen within a **broad system of networking processes**. Those can be formal and informal, face-to-face and mediated, developed at global and local level. The outputs of those networks are knowledge integration and market reach. But more essentially, those networks and their externalities need to be seen as participating to an ecosystem, where each part, each actor and location, occupies a status and fulfils roles that are more or less essential to the whole system, more or less substitutable, and more or less specialised. Such holistic view, interpreting the economy as a system of systems and each of its elements as interacting with all others is a major step forward in the theoretical approach to current agglomeration economies.

Network-based effects are mainly associated with local social interactions in cluster theory. But currently, they should not be restricted to the relationships present within the same location. Once the notion of networking is extended geographically to other clusters, locations or actors, it becomes possible to observe networks that go beyond individual regions and span across nations. This way the globally dispersed R&D&I and economic activities emerge as a system of inter-lined relations and roles, with various intensity and quality of relationships between individual locations.

Analysing the position of individual locations in a network, there are clearly differences in the characteristics between the locations, which indicate that along the pattern of labour division goes also an uneven distribution of ownership and control of economic, and R&D&I activities.

Finally, the performance of the agglomeration situates it **within a global hierarchy of locations**, within what is a life-cycle: in a system of systems, any part is probably substitutable to ensure the resilience of the system. Hence, excellence stays a relative assessment as it is strongly determined by time, relative position and aspects to which a dedicated focus would attribute importance. In the EIPE case, the strong bent towards ICT technologies and their industry will play an important role.

We see now that in a response to the global contemporary economic and technological trends, ICT Poles of Excellence outgrow the conventional understanding of industrial districts or clusters. Poles struggle to assemble heterogeneous actors that integrate the knowledge and production functions, expand beyond the local geographical boundaries and intend together to position themselves in a global hierarchy of locations.

Beyond those six general features, EIPE might still show some additional specific characteristics. Most evident is the characterisation of Poles of Excellence as of Information and Communication Technologies, referring to both its industry (supply-side) as to its

features as innovation-enabling technology for the demand side. This will be further explored in the next section on ICT and Regional dynamics.

2.2 Theoretical approaches to ICT and regional dynamics[22]

Authors: C Karlsson, G Maier, M Trippl, I Siedschlag, R Owen, and G Murphy

Information and Communication Technologies (ICT) undoubtedly constitute one of the key innovations of the last century. ICT represent a new technological paradigm that belongs to the family of General Purpose Technologies (GPT). A GPT has the potential to be pervasively adopted and adapted to a many sectors of the economy in ways that drastically change operations and products and the relationships between different sectors. The characteristics of GPTs have been described by Bresnahan & Trajtenberg (1995, p.84): "*Most GPTs play the role of 'enabling technologies', opening up new opportunities rather than offering complete, final solutions*." GPTs also involve 'innovational complementarities', i.e. "*the productivity of R&D in a downstream sector increases as a consequence of innovation in the GPT technology*". Thus, GPT have two major characteristics: generality of application; and, innovational complementarities. However, other characteristics of GPT are also important (Lipsey, Becar & Carlaw, 1998): (i) wide scope for improvement initially, (ii) many varied uses, (iii) applicability across large parts of the economy, and (iv) strong complementarities with other technologies.

Some innovations are incremental and some are drastic. ICT are an example of a drastic innovation, which qualifies as a general purpose technology (GPT), since they have the potential for (i) pervasive use in a wide range of sectors in ways that radically change their modes of operation and the character of their output, (ii) setting the stage for series of incremental innovations, and (iii) producing discontinuities in the observed pattern of resource allocation and the evolution of output. The fact that ICT is a GPT has many implications: i) its adoption entails experimentation, which may lead to innovation by adopting firms, which in turn shows up as total factor productivity growth, ii) as well as innovating themselves, firms can learn from the (successful or unsuccessful) innovation efforts of others, so there are spill over effects (Bresnahan & Trajtenberg, 1995), and iii) successful implementation of an ICT project requires reorganisation of the firm around the new technology (Helpman & Trajtenberg, 1998, Yang & Brynjolffson, 2001; Brynjolfsson, Hitt & Yang, 2002).

ICTs are composed of a wide range of product and service technologies including computer hardware, software and services and a host of telecommunications functions that include wire or wire line, and wireless, satellite products and services. The rapid diffusion of ICT has produced important changes in how and where goods and services are produced, the nature

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[22] This Section 2.2 is a chapter of a much broader literature review authored by acknowledged academics in regional issues and published by IPTS in 2010. The full report (102 pages) "ICT and Regional Economic Dynamics: A Literature Review", authored by Karlsson C., Maier G., Trippl M., Siedschlag I., Owen R. and Murphy G. The extract we quote here is built upon some introductory paragraphs of the Executive Summary followed by the integral Chapter 4 on "Regional Dynamics and Economic Transformations during the Deployment phase of ICT". It is available at: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=3579. The Report has also been published as an ESRI Working paper under the title ICT Diffusion, Innovation Systems, Globalisation and Regional Economic Dynamics: Theory and Empirical Evidence. ESRI Working Paper 233 (2008). It is available at: http://www.esri.ie/publications/search_for_a_working_pape/search_results/view/index.xml?id=2540.

of goods and services produced, and the means by which goods and services are brought to the market and distributed to consumers. This implies that ICT has had an impact on the industrial structure of regions and on the geographical location of different industries not only within the EU but worldwide. ICT has also influenced the relationship between customers and suppliers and the way many markets for intermediate and final goods and services are organised.

However, there are substantial differences among countries and regions, also among the developed economies, as regards their role in the development of ICT and their ability and propensity to adopt ICT applications in various activities and sectors (Johansson, Karlsson & Stough, 2006). This implies, among other things, that there is a substantial variation in the impact of the use of ICT on efficiency, productivity, and economic growth in different countries and regions.

During recent decades, production and innovation systems have going through radical but simultaneous and interwoven transformations due to new competitive strategies, globalisation, the emergence of the knowledge society and the ICT revolution. This has created quite new conditions for the business community as well as for the political community. However, the geographical impacts of these developments in general and of the ICT revolution in particular have been disputed. Some argue that we are heading for a world where businesses operate without considerations of supra-regional, national, and regional boundaries, where multinational companies act without any distinct home base and where ICT including the use of e-commerce and the Internet exclude time and space as important parameters. Others claim that geographical proximity increase in importance to businesses in order to be able to create inter-firm networks based on trust, reciprocity, and interactive learning. As we will try to show below, both stories are true to a certain extent and both processes are running simultaneously and in intense interaction with each other.

In most advanced economies, an ever increasing share of economic inputs and outputs is in the form of ICT and knowledge (Bristow, 2003). As a result, the traditional determinants of *industrial location* – access to raw materials, transportation networks, low costs, a large pool of general labour – are becoming less important for location within these economies. Instead, *locational choice is increasingly becoming governed by access to particular skills, technology, and knowledge, as well as entrepreneurial talent and venture capital.* Of particular importance is the provision of ICT skills, ICT technology, ICT knowledge, ICT services, ICT entrepreneurial talent, and ICT competent venture capital (Johansson, 2006).

Although, there is now a substantial body of literature on the spatial consequences of the increased use of ICT in the economy, much of it is inconclusive (Johansson, Karlsson & Stough, 2006). One reason might be that the context is rapidly changing not least due to the success of the Internet and e-commerce. Even if much interest have been devoted to the issue of how investments in ICT capital and the use of ICT induce *spatial transformations*, much less interest have been devoted to how these transformations affect regional economic growth. This is interesting per se since several economists have suggested an important link between national economic growth and the concentration of people and firms in large urban regions (Karlsson & Johansson, 2006). The high concentration of people and firms in large urban regions creates an environment in which knowledge moves quickly from person to person and from firm to firm. This implies that large, dense locations encourage *knowledge diffusion* and exchange, thus facilitating the spread of new knowledge that underlies the creation and imitation of new products and new ways to produce products (Carlino, 2001).

The New Economic Geography (NEG) theory, which has developed since the early 1990s, provides theoretical tools to understand the *factors driving spatial transformations and the effects of these transformations on regional economic growth*. It starts with the presumption that *functional regions* and not countries are the natural units for economic analysis. The reason is that economic activities are not evenly distributed across space and show clear tendencies to agglomerate. The NEG theory explains why economic activities concentrate in certain regions and not in others (Krugman, 1991; Fujita, Krugman & Venables, 1999; Johansson, Karlsson & Stough, 2002, Eds.)

The increased use of ICT enables major *reductions in geographical transaction costs* by reducing spatial information frictions (Flamm, 1999; Sichel, 1997). Examining the interrelationships between three variables – increasing returns due to scale economies, demand for final products and geographical transaction costs – in a world with monopolistic competition makes it possible to draw some general analytical conclusions concerning the effects of ICT-induced reductions of geographical transaction costs. When geographical transaction costs are reduced, producers in large regions, i.e. regions with large home markets, which already have good opportunities to exploit economies of scale due to a large home market, can lower the production costs by also delivering to other regions, i.e. by increasing their exports. When exports increase, there will also be increases in incomes, which induce more producers of differentiated products to start production in the large region. Increased exports also imply an increased demand for differentiated inputs, which will induce more producers with their internal scale economies to start producing such inputs. As a consequence, we have a situation with cumulative causation or positive feed-backs initiated by the effects of ICT on geographical transaction costs. Thus, as first conclusion we may assume that *investments in ICT and particular in communications equipment stimulate further agglomeration*.

The original Krugman version of the NEG theory has nothing to say about the role of knowledge in regional economic growth. Increasing returns is the result of the exploitation of economics of scale in production only. However, since the development and exploitation of ICT is intimately associated with the development, diffusion, appropriation and use of knowledge it is necessary to integrate knowledge and knowledge externalities in the above framework. The *literature on innovation systems* strongly indicates that *knowledge flows, including spillovers are at the core of regional development* (Karlsson & Johansson, 2006). Since knowledge sources have been found to be geographically concentrated (Audretsch & Feldman, 1996), location is crucial in understanding knowledge flows (Karlsson & Andersson, 2007; Andersson, Gråsjö & Karlsson, 2007). In addition, the capacity to absorb flows of new knowledge is facilitated by geographical proximity (Jaffe, Trajtenberg & Henderson, 1993; Baptista & Swann, 1998). Already Marshall (1920) identified the exchange of ideas as a type of externality leading to localisation, i.e. clustering, of economic activities.

Large, dense regions offer special advantages in terms of knowledge flows and knowledge spillovers, since they combine the localisation of clusters in specific industries with industrial diversity, i.e. with a range of different industrial clusters. This suggests a formulation of a NEG model based upon knowledge externalities. When a (large) functional region has achieved an initial advantage in knowledge production due to e.g. a large pool of well-educated labour and a rich supply of ICT capital assets, it will attract (i) knowledge-creating and knowledge-utilising firms, since it offers opportunities to take advantage of increasing returns in knowledge production and knowledge use including imitation, and (ii) knowledge-rich labour, which wants to take advantage of the increasing demand for its

skills. With increased knowledge intensity in larger regions we can expect increased investments in ICT capital assets, which will further reduce geographical transaction costs.

2.2.1 ICT and spatial transformations

The claim above that the interaction between knowledge and ICT will stimulate further agglomeration clashes with the predictions of some cyber prophets and technological optimists. They have claimed that the emergence of the digital economy would kill distance and make urban regions superfluous (Friedman, 2005; Cairncross, 1997; Knoke, 1996; Naisbit, 1995; Negroponte, 1995; Toffler, 1980), and at the same time eliminating the scale disadvantages of smaller and more peripheral regions. Their basic idea was that the spread of the use of ICT has the potential to replace face-to-face activities, i.e. to substitute physical movements that formerly occurred in central locations, which would strongly reduce or even eliminate agglomeration economies and hence make all economic activities totally "foot-loose". These deterministic views see developments and investments in ICT as radically reshaping society, and by extension, cities.

However, the difficulties in forecasting the future spatial and social impact of ICT is illustrated by Salomon (1998), who demonstrates the *complexity* by reviewing the case of telecommuting as a travel substitute. In his study, he stresses that technologies are social constructs and thus, in order to forecast the impact of such technologies, the way the individual decision-maker penetrates such a technology must be understood, as well as the extent to which individuals (and firms) adopt it and change their behaviour accordingly. Nevertheless, *the relationship between transport technology and ICT* has received much interest in recent decades (Salomon, 1986; Nilles, 1988; Mokhtarian, 1991; Hepworth & Ducatel, 1992; Mokhtarian & Salomon, 2001). There are many obvious reasons for this. Both technologies belong to the class of "friction-reducing technologies", both have a network structure, and there is, in some cases, a (probably overstated) potential for substitution between physical travel and virtual travel. As both technologies facilitate remote activities, there has been much interest in this potential substitution (Garrison & Deakin, 1988; Boghani, Kimble & Spencer, 1991). However, Mokhtarian & Meenaksisundaran (1999) remind us that alongside substitution effects between transportation and ICT, there is considerable evidence suggesting stimulation or generation effects as well, i.e. ICT can stimulate more physical travel and transport. Moreover, ICT can change travel and transport behaviour, not just the decision about the travel or the transport itself. ICT also offer tools to increase the quality of transportation networks and services.

In the literature, it is argued that *ICT open new complementarities and potential synergies*, which are most evident in the way ICT networks are becoming integral to an increasing array of traffic and transport operations (Giannopoulus & Gillespie, 1993, Eds.; Nijkamp, Pepping & Banister, 1995). Through better monitoring with the help of ICT, a better, faster, and timelier flow of goods and persons from their origin to their place of destination can in principle be realised. ICT is in this sense first and foremost a complementary technology to existing distribution and transportation networks. While the term e-commerce seems to imply a process of substitution of physical commerce, ICT is rather likely to increase the efficiency of the distribution and transport delivery systems through reduction in transport costs and better usage of transport infrastructure whether by ship, rail, road, or air transport. Substitution might occur but rather between different, alternative transport infrastructure systems (Soete, 2006).

Today it seems clear that the "death of distance" picture is at least single-sided. As ICT have been adopted for decades (and if we include the telephone for more than a century), most researchers today seem convinced that cities are not going to disappear (Cohen-Blankshtain & Nijkamp, 2004). Graham and Marvin (2000) stress that most *applications of ICT are largely metropolitan phenomena* and that ICT and large metropolitan are mutually supportive phenomena. Not least, the development of new technologies and new products seems likely to remain grounded in the large urban regions in the advanced countries, which imply that these regions will keep their locational attractiveness. There is also increasing evidence that *increased investments in and use of ICT actually reinforces the position of large cities* and not least the leading urban regions (Castells, 1989 & 1996; Moss, 1991; Hall, 1998; Wheeler, Aoyama & Warf, 2000, Eds.). Kolko (1999) suggests that ICT have led to the "death of distance", but not to the "death of cities". However, Graham (2002) claims that both distance and cities are far from being dead, and that *geography still matters* (cf. Nijkamp, Linders & de Groot, 2002). Beyers (2000) accentuates that ICT may enable living far from the city, but he also argues that not only are many businesses in the information society strongly tied to localised markets, but it is also in urban areas that the people working in these sectors want to live, for reasons related to consumption and tastes, and dictated by spousal relationships and other social relationships.

Bellini et al (2003) examine the impact of ICT on the location patterns of industries in Italy and find evidence for increasing convergence of industrial structure across regions in line with the "death of distance" hypothesis. However, they also find that knowledge-intensive industries tend to cluster together suggesting that knowledge-intensity acts as a counterbalancing force to the dispersion effect of ICT.

Investments in ICT may not necessarily encourage the dispersion of economic activities due to the network and technology effects of the supply of ICT infrastructure (Ogawa, 2000). Grant & Bergiust (2000) argue that ICT networks will play the same role in the twenty-first century that streets and highways played in the twentieth century, since they both are "spatial technologies" (Couclelis, 1994). Just as the car affected the shape of urban regions, there is an expectation that ICT will change the cities. The "information highway" now inherits the role of physical highways. Therefore, while transport was the "maker and breaker of cities" (Clark, 1957), ICT are now expected to inherit or share this role.

Already in the early 1990s, Goddard (1991) developed a conceptual model to assess the possible effects of investments in ICT on the urban form, which emphasizes the *effects of ICT on organisations*. He identifies three levels of analysis that are needed to evaluate the expected future effects: (i) the effects on the organisational level, (ii) the effects on infrastructure, and (iii) the effects on different sectors. Often much of the research about the effects of ICT on the urban form is concentrated on one single channel of research. In most cases there is no aggregate analysis that examines the overall and interrelated effects of these technologies on the city on the whole (and on the system of cities). Thus, the empirical evidences are eclectic and there is still no integrated picture of foreseeable changes.

The large urban regions in the advanced countries are concentrations of knowledge – human capital, universities and R&D activities – and *knowledge constitutes a critical input for productivity, economic growth and development*. These regions are also leading centres of innovation and imitation. Desrochers (1997) points out the importance of geographical location for the transmission of tacit knowledge and innovations between competitors, suppliers, and customers via face-to-face interactions. Cities are a means of reducing the

fixed travel costs involved in face-to-face interactions. Even if in principle improvements in ICT could eliminate the demand for face-to-face interactions and make cities obsolete in this respect, empirical results point in the direction that the use of mediated contacts is mainly a complement to face-to-face interactions (Gaspar & Glaeser, 1998). The conclusion is that as ICT improve, the demand for interactions of all varieties, including face-to-face interactions, should rise. Furthermore, these regions are the home for new propulsive and emergent growth sectors such as tourism and cultural industries based upon face-to-face interaction (Andersson & Andersson, 2006).

It should in this context be observed that *the provision of network infrastructures vary substantially* making only certain locations viable for communication intensive organisations and activities. Thus, it should be no surprise that the majority of the firms in the Internet industry is concentrated in key metropolitan regions (Bristow, 2003; Zook, 2002) and that the same general pattern prevails for both the so-called Internet 'backbones' in the United States (Malecki & Gorman, 2001) and the multimedia industry. Interestingly, Zook (2000) shows that over time there seems to be a stronger connection between Internet content and the information-intensive industries than between Internet content and the industries providing the computer and telecommunications technology necessary or the Internet to operate. Even if these agglomerations interact digitally over long distance, their existence does not suggest a geography of general dispersion or that the industries in question should be indifferent to distance or proximity (Leamer & Storper, 2001). On the contrary, these industries are heavily concentrated in existing large agglomerations, thereby at least in the short run reinforcing existing patterns of uneven development.

2.2.2 ICT and the location of firms

Over time, we expect ICT to affect *patterns of concentration and convergence of industries*. Concentration is the tendency of an industry to cluster geographically, while convergence is the tendency of an industry to become more uniformly distributed geographically. Traxler & Luger (2000) illustrate the complicated and multidimensional *effects of ICT on firm location*. In their study, they examined possible spatial effects of these new technologies on the location of firms and concluded that ICT can have two opposite effects: *dispersion and reinforcement of concentration*. Indeed a relatively large body of literature comes up with such contradictory conclusions about the expected effects of ICT, emphasising the complex effects of these technologies on the behaviour of people. Kolko (2002) found that ICT intensive industries exhibit slower convergence, i.e. de-concentration, than other industries. This result indicate that *clusters of ICT intensive industries persist not because they are ICT intensive per se, but because they tend to rely on highly skilled labour*.

However, the effects of ICT go much further than to the ICT intensive industries. Investments in and the use of ICT have had a very strong effect on trends, that started well before the general diffusion of ICT. In recent decades, we have witnessed a gradual denationalisation of in particular large companies. Internationalisation and globalisation of production and markets have created the preconditions for *locational choices based upon global rather than national considerations*. The possibilities for companies to move their activities within and between countries have increased considerably. A clear tendency is that company units and plants are located where the conditions are the best whether we are talking about R&D or the production of standardised components. It is in particular two technological conditions, which have made the new scenarios possible. They are *production decomposition* and *network control*. Production decomposition implies that the production

of a certain product can be divided into separate stages that take place in different production units. To keep such a production system running there is a need for network control.

These new scenarios involve increased outsourcing as well as increased off-shoring of production. Famous historical examples of this is the production of semi-conductors where production is globally decomposed and involves multiple locations in several countries and the value chain controlled in an integrated way, often by multinational enterprises but also the production of products, such as mobile phones, computers, cars and airplanes. The degree of off-shoring is among other things a function of how easy it is to decompose a production process into different stages, and the labour-intensity of the intermediate production steps (Grunwald & Flamm, 1985) While outsourcing and off-shoring of production has been present in several decades, what is much more recent is the outsourcing and, in particular, the off-shoring of service production, which have become possible due to technological advances in ICT, declining real prices of ICT, large investments in ICT network infrastructures, e.g. broadband and mobile phone networks, rapid increases of telecommunication connections, including broadband connections, and decreased costs for air travelling (Kirkegaard, 2004b). These developments have made services increasingly tradeable (ICT-enabled services) and reduced the constraints on the choice of location for the production of services (Friedman, 2005; Abramovsky & Griffith, 2005).

Technical progress has reduced the optimal scale for a large number of economic activities. This implies that many small production units can replace a large production unit without efficiency and productivity losses. Thus, it has become possible to divide the production of goods and services between several or even many separated, local production and control units. In this case production is decomposed in a production chain, where several, separated production units each produces different components, while others take care of assembly, distribution and administration. However, a precondition is that production and flows of goods are controlled by means of ICT applications.

The degrees of freedom regarding the choice of location have increased manifold due to improvements and cost reductions within freight transportation, air travelling and ICT. The use of ICT and, in particular, the Internet makes it possible for companies to have *frequent interactions with suppliers, customers and their own production units* without daily face-to-face interaction, as long as the interactions concern routine contacts and standardised, well co-ordinated information flows.

2.2.3 ICT and regional economic growth

Having discussed the relationship between ICT and regional transformations above it is now time to turn to the relationship between ICT and regional economic growth. One of the most stylized facts about economic growth is that productivity growth, rather than factor accumulation, accounts for most of the growth differentials across countries. Easterly & Levine (2001) argue that in the search for the secrets of long-run economic growth, a high priority should go to rigorously defining total factor productivity (TFP), empirically dissecting it, and identifying the policies and institutions most conducive to its growth. Even if the inflow of labour can play a somewhat larger role for economic growth at the regional than at the national level, we have strong reasons to believe that the major effect of ICT on economic growth goes via its effect on TFP in ICT-producing as well as ICT-using industries.

However, the development of ICT as well as the application of ICT seem to be critically dependent upon the availability of human capital in general and human capital with ICT-

competence, in particular. We can look upon ICT and human capital as complementary factors, Hence, we start our discussion of the relationship between ICT and regional economic growth from a theoretical perspective according to which the underlying source of sustained growth in per capita income, namely the *accumulation of knowledge is endogenised* through formal education, on-the-job training, basic and applied research, learning-by-doing, and process and product innovations (Aghion & Howitt, 1992), which implies that the indigenous innovative activities of regions become critical. This approach fully incorporates the *Schumpeterian view of innovation* as a result of deliberate efforts. New knowledge is not pure public goods, since even if it is non-rivalrous it is at least partly excludable. It is produced using existing knowledge and human capital through investments in R&D, which are re-numerated by the temporary extra rent provided by the (partial and at least temporary) appropriability of the results of innovation in markets characterised by monopolistic competition (Romer, 1990; Grossman & Helpman, 1991). However, the existing accessible pool of knowledge increases because the benefits of generating new knowledge are not fully appropriated by the innovating firm due to knowledge spillovers, which benefits other firms in their innovative activities. Knowledge is a special type of "product", since it is not exhausted after use. Instead, it is cumulative by being based on the existing pool of knowledge.

This theoretical perspective, which includes innovative efforts into the determinants of growth, allows for permanent disparities in regional growth rates. Regions that are *well-endowed in terms of knowledge and capital, due to their accumulated pool of knowledge will have a continuous advantage over regions less well endowed*. The reason is that knowledge consists of organised or structured information that is difficult to codify and interpret, generally due to its intrinsic indivisibility (Karlsson & Johansson, 2006). As a consequence, knowledge is difficult to transfer without direct face-to-face interaction. This implies that *proximity matters for knowledge transfer*. Thus, knowledge flows much faster within than between regions. Even if ICT to a certain extent may change the conditions for knowledge flows, it is by no means given that this helps the less well-endowed regions. One can argue that *the more well-endowed regions are in a better position to take advantage of the possibilities offered by ICT*.

In a context like this, it is crucial to understand how knowledge is transferred between as well as within regions as well as among the actors involved. How is knowledge transferred between its source and its potential users? Starting with *inter-regional knowledge transfers* it is obvious that *multinational firms play a critical role*. Their intra-firm knowledge networks that also include the mobility of staff between different regions provide major links for knowledge transfers. Besides these links, embodied knowledge, which is the most critical part of knowledge, is transferred mainly via the mobility of knowledgeable people and capital goods including software. Turning to *intra-regional knowledge transfers* much evidence points in the direction the mobility of knowledgeable people and direct face-to-face interaction between such people are the most important channels for intra-regional knowledge transfers.

With *knowledge spillovers* given such a central role in the growth process, it is natural to ask which regional economic milieus are most conducive to knowledge spillovers? Does the specific mix of economic activities undertaken within any particular region matter (Feldman & Audretsch, 1999)? Glaeser et al. (1992) consider the factors that influence innovative activities in urban regions, and identify two relevant models in the economics literature. The first model, the so-called *Marshall-Arrow-Romer* model formalises the insight that *the concentration of a particular industry within a specific urban region* (Lösch, 1954) *promotes*

intra-regional knowledge spillovers across firms and therefore stimulates innovation in that particular industry. The basic assumption here is that knowledge spillovers mainly take place across firms within the same industry.

The second model regards *inter-industry spillovers* as the most important source of new knowledge. Specifically, Jacobs (1969) argues that the *agglomeration of firms in urban regions fosters innovation due to the diversity of knowledge sources located in such regions*. Thus, the variety of industries within an urban region can be a powerful engine of growth for that region, and the exchange of complementary knowledge across diverse firms and economic agents leads to increasing returns to new knowledge.

Given the relative importance of the two specialisation mechanisms, *different regions may exhibit different growth experiences given their historically given economic structure*. Given that ICT represent a general purpose technology and that the development of ICT is strongly concentrated to a limited number of urban regions a critical question is to what extent different regions offer good opportunities for knowledge related to ICT and the use of ICT to penetrate ICT-using sectors and industries, which in principle are all sectors and all industries represented?

Obviously, there are several factors that have to be accounted for to understand the regional growth, since regions have different capabilities to absorb and to transform accessible knowledge into (endogenous) economic growth (Crescenzi, 2005). It seems, for example, that *the ability of regions to adopt and to adapt new technologies depends on the institutional infrastructure, education, geography, and resources devoted to R&D* (Maurseth & Verspagen, 1999). These and other factors that influence innovation form a system of innovation, i.e. *the network of institutions in the public and the private sector whose activities and interactions initiate, import, modify, and diffuse new technologies* (Freeman, 1987). The systems approach is not a theory but a focusing device for identifying factors relevant for the innovation process (Edquist, 1997). Systems of innovation can be identified at the national level (Lundvall, 1992) but here we concentrate on *regional systems of innovation* (Andersson & Karlsson, 2006; Andersson & Karlsson, 2004), which exist as self-consistent and self-organised systems within the national ones (Howells, 1999).

Regional innovation systems can be seen as key building blocks and *the engine in the innovative process*. The process of innovation is still in a general sense governed by the national system of innovation but it is localised and embedded in a regional innovation system. These regional innovation systems should be understood in terms of relationships and interactions between the various economic actors that make up the innovation system (Cooke, 1997), i.e. the innovative milieu (Camagni, 1995), where probably most actors are located in the region in question but others located in other regions nationally as well as abroad and integrated via various forms of network configurations.

Trying to understand the role of ICT for regional growth it is also important to acknowledge that ICT is nothing constant but instead in continuous change. Being a general purpose technology it changes over time as a result of scientific and technological advances, which increases its potential applications as well as reduces its costs, but also due to changes in the selection environment, which contribute to determine the timing and type of uses of the new technology. The selection environment is made up by all non-technological factors such as markets, supply of labour with the relevant training, infrastructure investments, institutional factors, and government regulation that to a varying degree affect the R&D carried out in the field, the kind of innovations launched and the speed of adoption of these innovations. However, despite powerful influences from the selection environment, ICT has

rules and a momentum of its own, which determine the direction of how the technology develops. This implies that certain regions that have specialised in certain types of ICT might find that they are on the wrong trajectory as technology continuous to develop. The specialisation in mainframe and mini-computers in certain regions are obvious examples.

The effect of ICT on regional economic growth does come from two sources: the involvement of each region in ICT production and the speed of adoption of ICT in each region. Since, the involvement of different regions in the development and production of ICT as well as their selection environments for the adoption of ICT differ a lot, we shall naturally expect different effects of the diffusion of ICT on economic growth in different regions.

The extent to which different regions are involved in ICT production depends among other things upon historical initiatives by industry and/or national and/or regional governments and the past success of these initiatives. In those regions where the right conditions have prevailed ICT producing clusters have emerged based upon innovation, imitation and often the development of backward and/or forward linkages. Not least has technological imitation within different ICT industries played an important role in many successful ICT clusters, since such imitation is coupled with further technological innovation both by the imitating firms and by those firms whose innovations are subject to imitation. A critical factor for such dynamic processes to evolve is of course that knowledge to a substantial degree can spillover between the firms involved.

Technological imitation stands for the inter-firm diffusion of innovations, i.e. for what might be called production or supply-side diffusion of innovations. The speed of inter-firm diffusion and the path of investments in production capacity by the firms in the industry is one factor determining regional economic growth. To the extent that the region is the market for the innovation the capacity growth and the competition between the suppliers will be one of the factors determining the speed by which the innovation is diffused in the region.

In terms of ICT production it seems as if regions can take advantage of ICT without being producers of ICT hardware, i.e. production of ICT hardware is not a necessary condition for ICT to have an effect on regional economic growth. Probably, the same prevails for ICT software in many cases. Furthermore, investments in ICT network infrastructure by different regions play an important role for the regional growth effects of ICT. However, due to the network structure of ICT infrastructures effects of investments in ICT infrastructure in one region may benefit other regions as well.

General purpose technologies, such as ICT undergo uncountable transformations over time. Naturally, suppliers invest resources to provide successively better and better versions of the products embodying ICT. These ongoing innovative activities within the ICT sector are yielding series of incremental improvements in existing ICT products at the same time as totally new ICT-products are developed. On the user side and here we focus on firms as users of ICT a similar process proceeds because as each user firm use a new piece of ICT to its production process or as an input in its products, it tends to make qualitative and quantitative changes in equipment, and to refine or add new features to its products as well as develop new products. Thus, ICT is used for product and process development in different user industries, in principle, in all industries including the ICT industry itself. Product and process development may involve the introduction of totally new products and processes, respectively, as well s the renewal of old products and processes. In terms of

traditional production theory, product and process development based upon ICT give rise to new production functions.

Product and process development based upon ICT must be seen as part of the competitive strategy for a firm in a given industry. Every firm within an industry occupies a specific place in the competitive spectrum. Its strengths and weaknesses with respect to particular products, to particular markets or vis-à-vis particular competitors will influence its choice of competitive strategies. Actually, product and process develop, together with sales or market promotion can be viewed as the major instruments for firms in the competitive struggle. In this competition, firms have three major strategic options: i) innovative competition based upon product development, ii) price or cost competition based upon process development, and iii) marketing competition based upon sales or market promotion. From a regional point of view it is obvious that the growth effect of ICT is much dependent upon the ability and the willingness of the firms in the region to adopt and implement ICT as a strategic competitive tool.

The potential of firms to use ICT to develop new products is depending upon the accessible market potential in different regions. The total market potential of a region consists of its own market potential and the accessible market potential in other regions. How accessible markets in other regions are depends upon the geographical transaction costs of different products. Obviously, firms in larger regions have an advantage when it comes to develop new ICT-using products due to a larger market potential – the home market effect. The potentials of smaller regions mainly are to be found in hardware and possibly software production given that they fully can take advantage of location economies by developing strong enough clusters. Another niche for smaller regions given that their ICT network infrastructure is good enough is to specialise on different types of call-centre activities. However, the development and supply of more advanced ICT-based services seems mainly to be a prerogative for larger regions, which have a large enough supply of qualified labour and a large enough supply of qualified customers, since the development and the supply of such services is critically dependent upon often frequent face-to-face interaction.

The adoption of innovations by firms at the regional level is on the one hand dependent upon their characteristics and on the other hand on the regional selection environment including the regional economic milieu offered by the actual region. Important firm characteristics are: i) size of firms, ii) economic and financial characteristics of firms, iii) the human capital characteristics of firms including the characteristics of their management, and iv) the internal and external communication networks of firms. The regional economic milieu is made up by among other things i) accessibility to regional and interregional market potential, ii) availability of production factors, and in particular, regionally "trapped" factors, such as accessibility to educated labour, iii) the existence of external economies of scale in the form of localisation and urbanisation economies, and iv) the institutional framework including regional policies to stimulate innovation and innovation adoption as well as the social capital in the region. This implies that transport and ICT infrastructure is important since they are factors determining the prevailing accessibilities.

It is important to observe that there exists an optimal rate of innovation adoption and innovation diffusion, which implies that all new innovations should not be adopted immediately by all potential user firms. Due to the fact that many firms recently have adopted earlier varieties of ICT inputs for their products and/or ICT capital goods for their production processes, it is quite rational for them not to adopt every new potentially useful innovation immediately. Due to their recent investments these firms have a sunk-cost

advantage of postponing an adoption until the sunk-cost advantage has vanished. This implies that regional policies aiming at stimulating the adoption of ICT innovations to stimulate regional economic growth must consider what is rational from the potential user firms' point of view.

Of course, there can exist and probably exist various market failures that might motivate certain regional policy initiatives to stimulate the adoption of ICT innovations by firms. One might here mention lack of information about new ICT innovations and their potential, lack of labour with the right ICT qualifications, the existence of unexploited positive external economies including learning economies, lack of ICT network infrastructure, etc. However, it is important also to consider the potential problems and costs of regional ICT policy in terms of the long time lags involved before policies have effects, the existence of asymmetric information, the lack of detailed information and knowledge about ICT among policy makers, the existence of vested interest in industry as well as among policy makers, the risks of distorting the function of markets, etc. Given this situation the best regional ICT policy to stimulate regional economic growth may in many cases be rather to improve the general economic milieu in the region in terms of transport and ICT network infrastructure, regional institutions and higher education including ICT education than to try to directly influence the ICT adoption decisions by firms.

2.2.4 Insights from the literature on ICT and regional dynamics

This brief insight into the literature dedicated to the ICT and Regional Dynamics points at additional and fundamental observations to take on board for the conceptual and methodological elaboration of ICT Poles of Excellence. Some of those points are overlapping and confirming the first points extracted from the agglomeration literature in the earlier Section 2.1 of this chapter.

First, the literature on ICT and Regional Dynamics positions the ICT within the category of General Purpose Technologies. By doing so, it not only describes the specific characteristic of such technologies (generality and complementarity), as seen from an economic and sociological point of view, but also their major consequences on agglomeration and globalisation.

On one hand, the observations of how ICT affect the spatial distribution of activities appear to be inconclusive: ICT favour both concentration (agglomeration at local level) and convergence (dispersion at international level). For many authors, the so-called "death of distance" is obviously not at hand! The agglomeration effects – and the related knowledge spillovers – are seen to be strongly anchored in the knowledge intensity of the industries rather than to the nature of ICT business activities themselves. But ICT skills would be an indirect factor favouring agglomeration – through the knowledge function.

Reversely, ICT are claimed to be central in the internationalisation process, both by allowing the decomposition of the economic activity, hence its global distribution, and its central control through information gathering, processing as well as support to decision making. This would apply not only to manufacturing, but more and more to ICT-enabled services.

This point of the literature review invites for an investigation for EIPE that would capture both local and global features of a location, as well as take a balanced approach to both knowledge and business functions. This extends the geographical scope of the cluster theory – strongly inward-looking -, and relates to that of network analysis.

The local focus will need to be guided by an approach to "functional regions" rather than administrative ones – with the additional difficulty of capturing such entities. Globalisation will rather be captured through the observation of the internationalisation process (inward and outward exchanges) and of network positioning.

In the literature, the functional regions are often associated with large urban ones, seen as better prepared for knowledge spillovers. Interestingly enough, part of this preparedness seems to be rooted in ICT: (telecom) infrastructures, level of ICT diffusion, education and ICT skills, and the presence of an ICT supply-side, all four expected to serve knowledge spillovers. Only the Regional Innovation System concept is not necessarily associated with any ICT feature in the literature.[23] ICT infrastructures and use as pre-conditions to agglomeration and their efficiency might be a hypothesis to be explored later.

The globalisation aspect refers to industrial as well as knowledge production: R&D and Innovation have entered internationalisation processes for some time. The presence and role of multinationals is cited as fundamental in this process, as they might reveal to participate strongly in both internationalisation and positioning in global networks.

Basically, the literature offers a very useful two-dimensional matrix crossing Local / Global and Knowledge / Production functions, while detailing some of the aspects that would best describe each cell in that matrix.

Compared to the earlier literature review on agglomeration economies, this synthesis supports all assumptions about agglomeration processes (no "death of distance"), attributes more specifically the knowledge and production functions to different geographical scopes (local/global) and establishes an initial hypothesis about the role of multinationals and about the urban status of most if not all relevant agglomeration economies . On the other hand, it limits partly the role of ICT in local networking and agglomeration: it also does not allude to performance or resilience within the concept of global positioning strategy.

2.3 Empirical approaches

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Following the review of conceptual insights analysing agglomeration of economic and R&D&I activity in Section 0 and the role of ICT in regional dynamics in Section 2.2, this section aims at drawing from the experience of empirical exercises addressing the problem of mapping the geographical location and the spatially bounded agglomerations of business, industrial, research or inventive activity.

A number of conceptual aspects, methodological tools, potential quantitative indicators and metrics can be contrasted and /or borrowed from these studies for the current EIPE exercise. Second, inventories or ranking of locations are generated in some of these studies: "regions" identified as exceptional in terms of agglomeration of (ICT-related) R&D&I and economic activities on the map of Europe. Such lists offer a rich potential for contrasting and for assessing at a later stage the consistency of our observations with those of these major European exercises.

[23] And this might come as a surprise. A possible explanation can be the time lag of scientific publication. Many observations date back to times where social networking tools, the so-called WEB 20, were still in infancy if at all. We might assume that today they participate also to the preparedness for local spillovers, as a way for codifying tacit knowledge and establishing informal relations.

The first part of the section presents a review of recent efforts devoted to the mapping of geographically concentrated business activities. In the second part, the report gathers those efforts that were giving a particular emphasis to R&D&I. More precisely:

- first, the (ICT-related*) business activity*, i.e. the production of (ICT) goods and services.
- second, the (ICT-related) *inventive activity*, i.e. R&D and Innovation.

Although there is no clear-cut separation between these two types of activities in the real economy, the review of studies proceeds along this division for simple didactic reasons.

2.3.1 Identification and mapping of (ICT) business activity

The two most prominent examples of databases that track the locations of geographically concentrated business activity (primarily clusters) are:

i. The European Cluster Observatory – commissioned by the European Commission (EC 2011) and developed by the Stockholm School of Economics.[24]

ii. The Cluster Mapping Database (CMD) [25] – developed by Harvard Business School and the Council of Competitiveness in the US and in particular its report on "Clusters of Innovation" co-authored by Professor M. Porter, the Monitor Group, its affiliate ontheFRONTIER and the Council on Competitiveness (n.d.).[26] The CMD is itself partly based on work developed by the Monitor Group which we will present briefly.

These studies and databases serve as diagnostic tools that can be used to map and benchmark clusters across regions and countries. They highlight varying strengths, weaknesses and trends, help to target emerging or declining areas of business activity and to issue recommendation to the public or private players.

Several reports and papers target more specifically ICT business activities agglomeration are:

iii. The Karlson et al. series of reports (2010) commissioned by the JRC-IPTS on ICT-related activities location and their impacts, these reports were a direct follow-up of the Barrios, Mas et al (2007) report and aimed at deepening the earlier results in terms of descriptive indicators, impact analysis, micro data and qualitative analysis.

iv. The Barrios, Mas et al (2007) Report[27] developed at JRC-IPTS was, to our best knowledge, a first ever systematic attempt to map the ICT business activity at *regional* level for the whole of Europe (and indirectly gain some hints about its R&D activity).

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[24] See at: http://www.clusterobservatory.eu/index.html

[25] See at: http://www.compete.monitor.com/Home.aspx

[26] Porter M.E., Monitor Group, ontheFRONTIER, Council on Competitiveness, n.d. Clusters of Innovation: Regional Foundations of U.S. Competitiveness. Ed.: Clusters of innovation Initiative, Council on Competitiveness. USA. See at: *http://www.compete.monitor.com/App_Themes/MRCCorpSite_v1/DownloadFiles/A.%20%20National%20Report.pdf)*

[27] Barrios, S., M. Mas, et al. (2007). Mapping the ICT in EU Regions: Location, Employment, Factors of Attractiveness and Economic Impact. Seville, JRC IPTS.
See at: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1554

v. The Karlsson, Mellander, Paulsson (2003 and 2004) methodological paper[28] on employment-based industry location.

vi. The Koski, H., P. Rouvinen, et al. (2002) seminal ICT industry firm-based location paper.[29]

i). The European Cluster Observatory - Stockholm School of Economics (EC 2011)[30]

Definition / objective

Originally launched in 2007, the European Cluster Observatory is an online platform[31] that provides a single access point to information and analysis of clusters and cluster policy in Europe, a cluster library, and a classroom for cluster education.

The European Cluster Observatory also produces analysis and reports on regional competitiveness conditions, transnational cluster networks, clusters in emerging industries and studies on best practices in cluster organisations. The Observatory is aimed at three main target groups: policy makers and government officials at the European, national, regional and local levels; cluster management staff; academics and researchers.

The Cluster Observatory is financed by the European Commission. It is a part of the European INNOVA initiative, and financed under the Competitiveness and Innovation Framework Programme (CIP) which aims to encourage the competitiveness of European enterprises.

It is managed by a consortium, coordinated by the Stockholm School of Economics (Sweden). The other consortium members are Ivory Tower (Sweden), Orkestra (Basque Country, Spain), Clusterland Upper Austria (Austria), ZENIT (Germany) and Fondation Sophia Antipolis (France).

Data and data processing

The Cluster Mapping database is based on regions and sectors in Europe.[32] By combining the two dimensions of geography and industry, the European Cluster Observatory statistically traces clusters, defined fundamentally as regional agglomerations of employment, across Europe.

The Observatory offers indicators:

- for the clusters analysis: employees, employees growth, employees per enterprise, enterprises, enterprises growth, wages per employee within an Observatory "star" rating ranking Size, Specialisation and Focus (see below).

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[28] Karlsson, C. (2003). Spatial ICT Clusters in Sweden - An Empirical Method to Identify a Necessary Condition for Existence, European Regional Science Association. This paper was republished alos in 2004 as CESIS Working paper and again as chapter of a book entitled Entrepreneurshiop and Dynamics in a Knowledge Economy by Routledge in 2004.
See at: http://www-sre.wu-wien.ac.at/ersa/ersaconfs/ersa03/cdrom/papers/222.pdf

[29] Koski, H., P. Rouvinen, et al. (2002). "ICT clusters in Europe. The great central banana and the small Nordic potato." Information Economics and Policy 14(2): 145-165.
See at: http://www.sciencedirect.com/science/article/pii/S0167624501000646

[30] Most of the information presented here has been extracted from the original source.

[31] See at: http://www.clusterobservatory.eu/index.html

[32] Europe is here larger than the EU27, including for example Russia and Ukraine.

- and general indicators for the regions themselves, such as area, population, population density, GDP per capita, Growth of GDP per capita, Disposable income per capita.

In particular, the European Cluster Observatory measures the degree of agglomeration, which is considered in the Report as one driver behind the knowledge spillovers, labour pooling, inter- and intra-industry trade that characterise dynamic and competitive clusters.

Each regional cluster – a combination of a sector and a region – is assigned 0, 1, 2 or 3 stars depending on how many of the criteria below are met. This is how the Report defines its criteria:

- *Size Star*: if employment reaches a sufficient share of total European employment, it is more likely that meaningful economic effects of clusters will be present. The size measure shows whether a cluster is in the top 10% of all clusters in Europe within the same cluster category in terms of the number of employees.
- *Specialisation Star:* if a region is more specialised in a specific cluster category than the overall economy across all regions, this is likely to be an indication that the economic effects of the regional cluster have been strong enough to attract related economic activity from other regions to this location, and that spillovers and linkages will be stronger. The specialisation measure compares the proportion of employment in a cluster category in a region over the total employment in the same region, to the proportion of total European employment in that cluster category over total European employment. The measure needs to be at least 2 to receive a star.
- *Focus Star:* if a cluster accounts for a larger share of a region's overall employment, it is more likely that spill-over effects and linkages will actually occur instead of being drowned in the economic interaction of other parts of the regional economy. The focus measure shows the extent to which the regional economy is focused upon the industries comprising the cluster category and relates employment in the cluster to total employment in the region. The top 10% of clusters which account for the largest proportion of their region's total employment receive a star."

The data is divided geographically in 404 regions. The regions are predominantly NUTS2[33] regions, which are defined by EU as subdivisions of the member countries for statistical purposes.[34] For the industry dimension, the Observatory uses data on the 4-digit industry level of NACE classification (or a country's equivalent industry classification system).[35]

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[33] NUTS2: Nomenclature of Units for Territorial Statistics after the French Nomenclature d'Unités Territoriales Statistiques. The current NUTS classification (valid from 1 January 2008 until 31 December 2011) lists 97 regions at NUTS 1, 271 regions at NUTS 2 and 1303 regions at NUTS 3 level.

[34] However, the European Cluster Observatory uses NUTS1 regions in Ireland, Slovenia, Bosnia and Herzegovina, and Croatia because of data availability. Also, because the NUTS definitions have been changing over time, three of the German regions and one Italian region are NUTS1 regions. Russia and Ukraine are not covered by the NUTS classification, and for these countries the European Cluster Observatory has labeled and grouped the regions according to classifications adopted by the local statistical offices.

[35] In a few cases, only 3-digit data is available, and for those a split from the 3-digit level down to the 4-digit level is estimated. Data for NACE Rev. 2.0, which is available for approximately half of the countries in the database is also provided. For the other countries, as well as for data for older years, conversion data from NACE 1.0 and NACE 1.1 to NACE 2.0 is provided.

Outputs

The public version[36] of the Cluster Observatory is a modern interactive website, including an appealing visualisation tool. It is an ambitious tool, but probably encountering usual impediments of comprehensiveness, updating, etc.

The Cluster Mapping tool gives access to an advanced data set on clusters and regions in Europe. It provides statistical information from a wide range of sources, both on the geographic concentration of various industries and indicators of economic performance. In addition, the Observatory offers data on the framework conditions that shape regional competitiveness. Users can access data for standard sectors and regions, or use special definitions that will be added gradually to the mapping tool.

Additionally, the Cluster Observatory offers a cluster Calendar, a Classroom (videos and other educational materials), wiki pages and a Cluster Library that is a European depository for cluster-related documents.

Lessons learned for EIPE

The Cluster Observatory is, as clearly expressed, a cluster-focused exercise characterised by a search for business activities. Being its general mission, it is not sector specific. Still, the Cluster Observatory is a major source of general and specific economic information at NUTS 2 level.[37]

Even though complementary, the aims and outputs of the Observatory contrast with those of EIPE on many aspects:

- the NUTS2 level is a broad geographical entity with mainly administrative/ statistical meaning. EIPE need to somehow offer a narrower and more functional spatial approach.
- the Observatory focuses on business activity. EIPE need to encompass more than the industrial activity and take in account inventive activity.
- the data to be used for EIPE needs to go beyond Eurostat data. This is due to several reasons such as time-lag, geographical coverage or the absence of indicators tracking specific activities and/or businesses in official statistics.
- finally, the notion of performance, at the core of the definition of Poles of Excellence needs to be embedded in the observation.

Still, the outputs of the study will certainly need to be contrasted with those of the Cluster Observatory.

The observation of external relations, and more generally the incorporation of network theory and analysis is, in our view, a missing feature of the Observatory (which confirms it to be a consistent implementation of cluster theory). The Observatory proposes, legitimately for its own purpose, to observe the inward characteristics of NUTS2 regions to spot industrial clusters, and if needed to benchmark those characteristics as to compare

[36] We did not try to access any restricted version, if such version exists for example for EC staff only.

[37] Still, this information will need to be taken with caution as it does not seem to be part of the objectives of the Observatory to have exhaustive information, but to assemble the available one. Also some of the data presented in the Cluster Observatory might generate confusion: the Regions database, for example, presents a very broad and international set of names corresponding to a variety of locations such as cities, regions and countries from the whole world. Also, the "user generated content" option proposed by the Observatory affects the quantity and reliability of the information collected.

clusters. It is not within its purpose to describe the international reach of those clusters, neither to observe them within the networks of global division of labour and its hierarchy.

ii). The Cluster Mapping Database - The Clusters of Innovation Report (n.d.)[38]

The Clusters of Innovation Report[39] is an ambitious attempt in the USA to assess regional economic performance, by mapping statistical and qualitative data and interpret it within Porter's cluster theory. Developed with the direct involvement of Professor M. Porter himself, and multiple additional authors,[40] the report[41] is structured around the following topics:

- Regional Competitiveness and Innovative Capacity,
- The Economic Performance of Regions,
- The Composition of Regional Economies,
- The Evolution of Regional Economies,
- The Determinants of Regional Competitiveness and Innovative Capacity,
- Clusters,
- The Development of Clusters,
- Creating and Implementing a Regional Economic Strategy,
- Action Agendas for the Public and Private Sectors.

Clearly aimed at affecting the policy agenda, the report offers, as the Cluster Observatory described above, many similarities to our work.

Method / Data / Data processing

Utilizing a database developed at Professor's Porter Institute for Strategy and Competitiveness at the Harvard Business School, the report offers to systematically measure the relative strength of regional economies and their clusters and track their economic and innovation performance over time.

In addition, the authors have conducted surveys, in-depth interviews, and strategic analyses in order to assess the strengths and challenges of five pilot regions: Atlanta, Pittsburgh, the Research Triangle in North Carolina, San Diego, and Wichita.

The report draws heavily upon the five regional studies and synthesizes the implications for any region that seeks to improve its economic performance. The report examines the composition and performance of regional economies, how industry clusters develop and innovation arises, how clusters affect a region's economic future, and how a region can establish a strategy and action program to drive its economy and clusters forward.

The methodology used builds clearly on Michael Porter's cluster categories, defined by the agglomeration of co-located industries (Porter 1990). Clusters categories are defined by

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[38] Most of the information presented here has been extracted from the original source.

[39] See at: http://www.compete.monitor.com/App_Themes/MRCCorpSite_v1/DownloadFiles/A.%20%20National%20Report.pdf)

[40] Listed in Annex 4.

[41] See at: http://www.compete.monitor.com/App_Themes/MRCCorpSite_v1/DownloadFiles/A.%20%20National%20Report.pdf)

using native four-digit industrial classification systems relevant to the geographies included in the database.

The type of data used in the Global Cluster Mapping Database can be grouped into two categories: performance data and business environment data. The latter one includes areas from education to the responsiveness of government and has more than 40 subcategories. All together this results in a total of more than 200 indicators.[42] The data used in the database includes statistics and survey data.

Clearly, in terms of method,[43] this report reveals a major effort in quantitative and qualitative data accompanied with an important expert interpretation. The overall architecture - database, case studies, interpretation - can be taken as model for our own study. Similarly, the depth in data gathering as well as the organisation of surveys show the way for ambitious longitudinal efforts.[44]

Regional Performance

The report states that economic performance is best measured on multiple levels to capture prosperity, productivity and innovative capacity. Still, it offers a synthetic approach of such performance measurement on a two-level approach, reminding the business and innovation functions developed across the literature.

Table 1: Economic Performance Indicators

Overall Economy	Innovation Output
Employment growth	Patents
Unemployment	Firms formation
Average wages	Venture Capital
Wage growth	Initial Public offerings
Cost of living	Fast growth firms
Exports	

Source: Porter et al, n.d.

The *business environment is covered much more extensively with categories of indicators such a* Basic research, Skills of workforce, Education, Physical infrastructure, Supply of risk capital, Quality of Life *and what the authors call* cluster-specific business environment measures: specialised research centres, specialised talent base, specialised training, sophistication of demand, intensity of rivalry, degree of cooperation, etc.

Regional performance is measured on the basis of the above main topics, detailed in further various indicators and measurements such as e.g. employment, employment growth, employment concentration, establishments, establishment growth, establishment concentration, wages, wage growth, exports, export growth and value-added/revenues, etc.

Cluster Performance

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[42] Available in Annex 3.

[43] The interested reader will find a further summary explanation in the original report, on pages A1 to A4 of the Annexes. See at: http://www.compete.monitor.com/App_Themes/MRCCorpSite_v1/DownloadFiles/A.%20%20National%20Report.pdf

[44] In line with existing EU efforts such as those of the ICT firm survey, the CIS, the LFS, etc. which in some cases could be improved with more detailed questions as developed in the above case.

The steps for assessing regional clusters are said to be similar to those used for assessing a regional economy. A regional cluster is benchmarked to other regional clusters in the categories of economic performance and innovation output, composition, and business environment. The report looks at both economic performance and innovation output measures for each regional cluster, and benchmarks a regional cluster against national averages and rival clusters in other regions.

The breakdown of cluster composition in sub-clusters and industries aims at explaining the economic performance and innovation output of the cluster, but also identifies leverageable strengths and areas of weakness. Strength across a range of sub-clusters is seen as desirable, as is strength in narrow industries (i.e., the subset of the industries that are most correlated with a given cluster).

Finally, the report assesses a regional cluster's business and innovation environment, and benchmarks it against other regions and clusters. As with the regional economy, the report uses a combination of surveys and interviews to gather cross-cluster comparable data.

Selected Outputs

A variety of outputs are presented in this report, the following being the most relevant to our study:[45]

- Any regional economic development effort has to start with an assessment of regional economic performance.
- The most important sources of prosperity are created not inherited. The evolution of regional economies is a lengthy process. While inherited factors, geography, climate, and population are important, other factors such as entrepreneurship, the presence of research and training institutions, the composition of the regional economy, and public and private sector actions are important influences.
- Regional economies are composed of three types of industries: traded, resource-driven and local industries. While local industries account for the majority of employment in regional economies, traded industries are the dynamic core of a regional economy.
- Formal and informal institutions for collaboration such as regional economic development organizations and alumni of large influential companies are important contributors to cooperation in advanced economies.
- Higher levels of innovation output lead to higher levels of prosperity: Above-average economic performance measures are not enough to ensure regional prosperity. Maintaining, much less increasing, a region's standard of living requires the steady growth of productivity, which in turn requires innovation.

Within cluster-related observations, the following findings are listed:

- Proximity fosters productivity and innovation,
- Clusters share common industries,
- Cluster strength is often disproportionately concentrated in a few sub-clusters,
- Clusters with depth and breadth normally enjoy advantages over narrower clusters,

[45] As the following are only selected extracts, we advise any interested reader to go back to the original document (133 pages) available at: http://www.compete.monitor.com/App_Themes/MRCCorpSite_v1/DownloadFiles/A.%20%20National%20Report.pdf

- Cluster-specific institutions for collaboration facilitate the flow of information and resources throughout the cluster.

The report states that those findings recommend to harness proximity, build on sub-cluster strengths, take opportunity from cluster overlap. Unfortunately, the report does not rank the 43 clusters of the US economy.

The above conclusions definitely are a master-class regarding spillovers within a agglomeration economy.

Lessons learned for EIPE[46]

The Cluster Mapping Database (CMD) demonstrates to be very exhaustive and strongly rooted in theory. This is an encouraging signal for EIPE, even if one has to admit that US statistics seem to offer a much broader and deeper range of observations than what we are used to in Europe.

The CMD is a cluster-focused exercise, characterised by a search for business activities and rather biased towards inward-looking relations within the cluster. It is (of course) not sector specific. More generally, the cluster approach is motivated by regional economic growth aims: eventually, the analysis needs to start with a diagnosis of regional prosperity. Our earlier literature review of the relations between ICT and regional dynamics disconnects partly this intuitive association: the local presence of ICT does not seem to correlate automatically with local wealth. In innovation and knowledge-intensive activities, the geographical concentration is presented as largely beneficial to the knowledge function, but not necessarily so to the business one. The business function develops in the global reach: the CMD integrates indicators of trade and exports which reflect probably this aspect. One of its central findings points in that same direction: traded industries are the dynamic core of a regional economy.

Many lessons can be taken out of the CMD. Beyond the wealth of indicators, a clear favourable analysis towards heterogeneous concentrations of industries ("broadness"), innovation processes or the role of policy and institutions enrich and confirm a conceptual framework inherited from a robust theoretical and empirical basis.

Interestingly, the comparative exercise benchmarks US clusters and regions with other US ones. While this underlines the particularities of Europe benchmarking itself against the best of US, it nevertheless might indicate a weakness of CMD in perceiving US clusters within a global environment. Also, the report includes brief insights into 5 case studies in the USA that might be relevant for the EIPE at later stages.

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[46] Importantly, the US Department of Commerce published also in 2005, with the same Council of Competitiveness, a methodological report on "Measuring Regional Innovation" which offers further insights in metrics and sources. Available at: http://www.compete.org/images/uploads/File/PDF%20Files/Regional_Innovation_Guidebook.pdf

Box 5: Monitor Group services[47]

Headquartered in Cambridge, Massachusetts, USA, Monitor Group is an international advisory and investment firm with 28 offices worldwide. It is closely related to the CMD presented above. The Monitor Group's offerings include a series of services, some of which can be seen as inspiring for our study. In particular, the *Economic Strategy and Implementation*[48] service gathers national, regional, and cluster based initiatives focused on benchmarking and improving economic development. Similarly, the *Constituency Mapping and Management*[49] service can be seen as a network analysis approach to actors and locations. Both have adopted visualisation tools to help decision-making.

The Monitor Group describes *Economic Strategy and Implementation* as a rigorous economic and cluster analyses of a region and its key competitors, developed closely with a coalition of public and private sector leaders to gather their input and build a consensus behind a comprehensive economic strategy and detailed implementation plan. It is claimed to be a unique approach to mapping and enhancing the competitiveness of nations, regions, and clusters. Rooted in Regional Innovation Systems theory and focused on clusters and regions, this approach offers similarities to the current developments of Smart Specialisation in Europe, within a regional consensus-building diagnosis strategy.

The Monitor Group presents *Constituency Mapping and Management* as able to map stakeholders against key issues, and quantify their relative importance allowing for a prioritization. It categorizes behavioural drivers for these key stakeholders and identifies overlaps in positions and sources of value, within a decision-support visualization tool aimed at the assessment of the information. Clearly rooted in network and actors theories, the service claims to help multinationals gain a better understanding of key decision makers in regions, organizations tap into and harness collaborative knowledge networks relevant to their innovation needs.

The Monitor group claims a global reach, but from the available documentation, it seems to have only a weak presence in Europe.[50]

Once adapted to the specific constraints of the EIPE study, such methodology is certainly relevant for further exploitation.

iii). Karlsson et al. series of reports (2010)[51] commissioned by the JRC-IPTS.

The Karlsson et al series of reports (2010) commissioned by the JRC-IPTS on ICT-related activities location and their impacts were a direct follow-up of the Barrios, Mas et al (2007) report (See below) and aimed at deepening the earlier results in terms of descriptive indicators, impact analysis, micro data and qualitative analysis.

The literature review of this study has been already used earlier in this report (in Section 2.2), when referring to ICT regional dynamics. The study included also 5 case studies.[52]

The case studies were selected on the basis of a quantitative exercise whose methodology can be of direct interest to EIPE. The study analysed quantitative data for a total of 18 NUTS2 (or assimilated) regions from 10 European countries.[53] The data used for the

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47 Most of the information presented here has been extracted from the original source.

48 See at: http://www.compete.monitor.com/Services_StrategyImplementation.aspx

49 See at: http://www.compete.monitor.com/Services_ConstituencyMapping.aspx

50 It claims having intervened in the Baltics, Greece, Italy, North Ireland, Norway, Portugal, Scotland, and Spain.

51 The Karlsson et al. report (2010) is one of seven reports produced within the IGICT project at JRC-IPTS. Out of the seven reports, only one has been published that far as Technical Note and is used partly in the earlier section of this chapter.

52 The material produced during that study has not been made public yet, with the exception of the literature review.

53 List: 1. Upper Austria (Austria); 2. Northern Estonia (Estonia); 3. Southern Estonia (Estonia); 4. Pays de la Loire (France); 5. Midi Pyrénées (France); 6. Slovenia; 7. Lower Silesia Voivodship (Poland); 8. Pomeranian

selection of case studies was structured around the following main topics:[54] economic performance, ICT profile (ICT-related structure and structural changes), regional innovation system.

The gathered indicators and their comparative analysis stay as an interesting guide for EIPE, in particular because of their sector-specific ICT focus and regional scope. The resulting selection of case studies, guided by additional criteria of geographical coverage (capital cities, rural areas, etc.) reveals of less direct interest in the present report.[55]

iv). Barrios, Mas et al (2007) Report[56] – developed at JRC-IPTS

Another example of mapping ICT-related business activity in Europe is the Barrios, Mas et al. 2007) report published by the JRC-IPTS. It is to our knowledge, the very first attempt to map the ICT business activity at regional level across the whole of Europe (and indirectly gain some hints about its R&D activity).

The study documents the regional presence of ICT by mapping the location of the ICT industry in the EU25, analysing the volume and nature of ICT employment across European regions, identifying the determinants of EU regions' attractiveness for ICT business location and, finally, assessing the contribution of ICT investment to regional growth and convergence.

It provides also evidence for the prominent role played by the Computing Services sector in recent employment and skills' changes in the ICT industry, as well as for the emergence of new regional growth poles in the EU.

This study uses two main databases: the first is the Eurostat Structural Business Statistics (SBS) and, the second one, the Labour Force Survey (LFS). The SBS is used for mapping the location of ICT activities, using employment data and the LFS is used for analysing the nature of employment in EU regions, focusing on education levels and the category of occupation of people employed in ICT industries. Both datasets provide data at NUTS 2 level and allow for a sectoral breakdown up to Nace 2 digits.

Basing themselves first on ICT employment shares in total European ICT employment by NUTS2 regions, Barrios et al. state in their report that the ICT industries are rather concentrated geographically around the so-called blue-banana of Europe, i.e., the area going from the South of the UK, the Benelux and Denmark, the French region Ile de France, the Western regions of Germany and the North of Italy. This broad picture is in line with the one put forward in an earlier study by Koski et al. (2002) and also ESPON (2005), both presented in the current report. More generally, these results are aligned with the evidence based on the economic geography literature concerning the location of hi-tech industries in Europe and GDP differentials across EU regions (Combes and Overman, 2004).

Voivodship (Poland); 9. Podkarpackie Voivodship (Poland); 10. Lombardy (Italy); 11. Emilia Romagna (Italy); 12. Thuringia (Germany); 13. Upper Bavaria (Germany); 14. South Eastern Region (Ireland); 15. Border, Midland and Western Region (Ireland); 16. West Sweden (Sweden); 17. South Sweden (Sweden); 18. Länsi-Suomi (Finland).

[54] A more detailed list of questions is presented in Annex 5.

[55] The 5 detailed case Studies were: Upper Austria (Austria); Northern Estonia (Estonia); Lower Silesia Voivodship (Poland); Lombardy (Italy); Upper Bavaria (Germany); South Eastern Region (Ireland).

[56] Barrios, S., M. Mas, et al. (2007). Mapping the ICT in EU Regions: Location, Employment, Factors of Attractiveness and Economic Impact. Seville, JRC IPTS.
See at: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1554

There are some differences, however, compared to these previous works. First of all, the so-called blue-banana, when considering the location of ICT industries, extends to other parts of the EU, including Scottish regions, the Madrid region and Central Italian regions, the South of Finland and Western regions of Sweden as well as regions located in EU10 such as Kozep-Magyarorszag (HU), Mazowieckie (PL) and Praha (CZ).

ICT employment shares in total ICT employment are compared by the authors with the one concerning the regional distribution of total employment (i.e., including ICT and non-ICT sectors). The total employment of all sectors of the economy appear to be much more spread geographically compared to that of ICT industries.

The top 10 regions in ICT employment shares are also among the most populated ones and represent also the largest share in total EU employment as, for instance, the region Ile-de-France (FR), the Lombardia region or even Denmark (which is considered a NUTS2 region on its own). However, the share of these regions in ICT employment outpaces by far their share in total employment. The ten largest regions in terms of ICT employment represent 29% of ICT employment while they represent only 13.4% of total employment. These regions are also among the richest EU regions (in terms of GDP per capita). Interestingly also, none of the regions located in the EU10 appear among the ten first regions for employment in the ICT sector.

The authors also observe that, while the ten largest ICT employing regions are located in the EU15 regions and show an ICT employment share largely above the corresponding total employment shares of these regions, the same cannot be said about the largest employing regions of the EU10 where, except for a few cases, regions hosting the largest shares of ICT employment in EU10[57] do also tend to be the largest ones in terms of overall employment. Put differently, ICT employment tends to concentrate in the so-called blue-banana regions.

There are many interesting lessons for EIPE in this study, starting with its quantitative methodology and the use of original sources of data. Its sub-sector level specific results indicate that efforts in that direction might draw relevant results, even though they might be very difficult to emulate in the absence of data, and of control on the validity of such data. The observations date back to 2004, and are anchored in a NUTS 2 level analysis. The deepening of those methods and the update of the data would be very welcomed.

Lessons learned for EIPE

This study showed very innovative use of existing official data to create proxies for ICT industrial activity at regional level. Also, even though outdated, the outputs of the study will need to be contrasted with those of the EIPE.

[57] Those ten regions of EU10 are (in decreasing order of share of ICT employment): Kozep-Magyarorszag (HU) starting with a share of ICT employment of 1.29%, Mazowieckie (PL), Praha (CZ), Slaskie (PL), Lietuva (LT), Slovenija (SI), Severovychod (CZ), Jihovychod (CZ), Wielkopolskie (PL), Dolnoslaskie (PL) with a share of ICT employment of 0.37%.

v). Karlsson C., Mellander C. and Paulsson T. (2003)[58]

This early attempt of empirical ICT cluster identification, based upon regression analysis, proposes to categorise regions, municipalities, or cities with respect to their over- or under-representation in number of establishments and employment for any arbitrary industry.

According to the authors, to be defined as a region with an ICT cluster, a region must exhibit a significant overrepresentation of both ICT plants and ICT employment given its size in terms of population. By using this method the author proposes to identify macro, meso and micro clusters, examine the life cycles of these clusters in terms of births, growth, decline and disappearance as well similarities and differences between the different clusters in terms of, for example, industrial composition and regional factor endowments. Finally the author proposes to compare the development of the ICT sector in regions with ICT clusters with the development of the ICT sector in regions specialised in large scale ICT production and in regions specialised in small scale ICT entrepreneurship.

The framework suggests that a necessary condition for the existence of a cluster entails a significant overrepresentation in both the number of establishments as well as in employment for any given sector in a region. Furthermore, this over-representation should be related to the size of the region, i.e. reflecting regional specialisation of business or inventive activity.

The method proposed here is in line with usual cluster-related approaches, but it proposes several additional interesting assumptions related to the number of firms and other factors, opening up the field to the observation of company churn and its possible relation to innovation.[59]

vi). Koski, H., P. Rouvinen, et al. (2002)[60]

The Koski, Rouvinen et al paper is often seen as the seminal work about the location issue of the ICT industry in Europe. Its results are still quoted today at many conferences.

The issue of technological or industrial specialization of regions is first discussed by the authors. In their work they consider ICT trade, production, and technology specialization, as measured by, respectively, the relative share of ICT in the total manufacturing exports, value added, and R&D. Though this work is limited to country level (EU15 Member States at the time), the authors conclude that there is a clear and intensifying geographic concentration tendency of ICT-related production and R&D. Even more important to EIPE, they develop a firm-based location methodology and observe the emergence of a new large geographical concentration of ICT industries around what they coin as "the small Nordic potato", in contrast to the traditional North-South industrial corridor from UK to Italy, coined as the "blue-banana".

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[58] Karlsson C., Mellander C., Paulsson Th. (2003). Spatial ICT Clusters in Sweden - An Empirical Method to Identify a Necessary Condition for Existence, European Regional Science Association.
See at: http://www-sre.wu-wien.ac.at/ersa/ersaconfs/ersa03/cdrom/papers/222.pdf

[59] Such proposal is in line with the more recent proposal of the High level group of experts invited by the Commission to debate and develop an indicator for Innovation. This illustrates somehow the time gap between scientific publication and policy decision.

[60] Koski, H., P. Rouvinen, et al. (2002). "ICT clusters in Europe. The great central banana and the small Nordic potato." Information Economics and Policy **14**(2): 145-165.

Here again, the authors identify with 1999 data, NUTS 2 regions which show higher figures in specific indicators, namely the share of employees in ISCO occupational categories ICTE,[61] [62] and also the share of IT employees.[63]

Beyond the reputation of this early article, interesting are its results showing the steady dominance of the EU north-South industrial corridor, the sensitivity of any rankings to the selection of indicators and also, at least intuitively, the changing geography of the ICT economy with the fate of some well known and advanced regional cases like Utrecht or Vien, or national cases like UK.[64]

Again, this article is deeply rooted in cluster theory, with a dominant business focus itself approached through employment data. On this basis, the authors develop several different ratios allowing for a variety of observations. Obviously the EIPE study will need to embark on such approach, while complementing with some specificity related to topics such as R&D and Innovation.

Also, even though outdated, the outputs of the study will need to be contrasted with those of the EIPE.

2.3.2 Identification and mapping of (ICT-related) innovative activity

Except for the indicators and metrics used, the general methodology of identifying and mapping inventive activity does not significantly differ from the methodology of identifying and mapping business activity. Fundamentally, only the indicators differ as they intend to capture inventive rather, or in addition to, the business activity.

In this section, we will briefly describe:

i. The European Innovation Scoreboard 2011 (EIS)[65] – MERIT – JRC-IPSC,

ii. The report "Strong Clusters in Innovative Regions" - Stockholm School of Economics (2011),[66]

iii. The Atlantic Century II: Benchmarking EU & U.S. Innovation and Competitiveness (2011),[67]

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[61] ITCE consists of the following International Standard Classification of Occupations (ISCO): computer professionals (ISCO 213), computer associate professionals (ISCO 312), and optical and electronic equipment operators (ISCO 313).

[62] The corresponding regions are: Stockholm (SW) starting with 40 600 ITCE employees (4.9%), Île de France (FR), Utrecht (NL), Uusimaa (FI), Zuid-Holland (NL), Berkshire, Bucks, Oxfordshire (UK), Noord-Holland (NL), Rég. Bruxelles Cap. (BE), Brabant Wallon (BE), Wien (AU), Bedfordshire, Hertfordshire (UK), Inner London (UK) with 35 400 ITCE employees (3.1%).

[63] The corresponding regions are: Berkshire, Bucks, Oxfordshire (UK) starting with 60 700 (5.6%) of IT employees Stockholm (SW) , Bedfordshire, Hertfordshire (UK), Île de France (FR), Surrey, East–West Sussex (UK) , Uusimaa (FI), Avon, Gloucestershire, Wiltshire, N Somerset (UK) Hampshire, Isle of Wight (UK, Utrecht (NL), Communidad de Madrid (ES), Lazio (IT), Oberbayern (DE) with 50 700 IT employees (2.6%).

[64] For some data on ICT employment trends in UK, see for example in the annual ICT R&D reports published at: http://is.jrc.ec.europa.eu/pages/ISG/PREDICT.html

[65] Innovation Union scoreboard 2011, The Innovation Union's performance scoreboard for Research and Innovation. Available at http://www.proinno-europe.eu/inno-metrics/page/innovation-union-scoreboard-2011. The IUS report, its annexes and the indicators' database are also available at http://www.proinno-europe.eu/metrics

[66] Center for Strategy and Competitiveness, CSC Stockholm School of Economics (2011). Available at: http://www.clusterobservatory.eu/common/galleries/downloads/Strong_Clusters_in_Innovative_Regions_Report.pdf

iv. The Report on Trends and Evolution of the EU ICT Research and Deployment Landscape, by Malerba et al.(2010),[68]

v. The Regional Innovation Scoreboard 2009 (RIS)[69] – MERIT – JRC-IPSC,

vi. Mc Kinsey´s Innovation Heat Map (n.d.),

vii. DG REGIO: "ESPON" Programme (2007-today),[70]

viii. The Report "Strategic Planning in the Technology-driven World: A guidebook for Innovation-led Development". U.S. Department of Commerce, Economic Development Administration (EDA 2001),[71] (EDA 2005)

ix. The more ancient methodological article by Cortright and Mayer (2001). High Tech specialisation: a comparison of high technology centres.[72]

i). The European Innovation Scoreboard 2011 (EIS)[73] [74] – MERIT – JRC-IPSC

Definition / objective

The second edition of the Innovation Union Scoreboard (IUS) has been published in February 2012. Based on the previous European Innovation Scoreboard (EIS), the tool is meant to help monitor the implementation of the Europe 2020 Innovation Union flagship by providing a comparative assessment of the innovation performance of the EU27 Member States and the relative strengths and weaknesses of their research and innovation systems. It is a national level analysis.

The report has been prepared by the Maastricht Economic and social Research and training centre on Innovation and Technology (UNU-MERIT) with the contribution of DG JRC IPSC of the European Commission.

Data and data processing

The IUS 2011 largely follows the methodology of previous editions in distinguishing between 3 main types of indicators – Enablers, Firm Activities and Outputs - and 8 innovation dimensions, capturing in total 25 different indicators.[75]

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67 Available at: http://www.itif.org/files/2011-atlantic-century.pdf. see also ITIF page at: http://www.itif.org/publications/atlantic-century-ii-benchmarking-eu-us-innovation-and-competitiveness

68 Malerba F., Vonortas N., Corrocher N., Cusmano L. (2010) Trends and Evolution of the EU ICT Research and Deployment Landscape. Final Report. Bocconi University.
Available at:http://ec.europa.eu/dgs/information_society/evaluation/studies/s2008_03/index_en.htm
Available at: http://ec.europa.eu/dgs/information_society/evaluation/studies/s2008_03/index_en.htm

69 Available at: http://www.proinno-europe.eu/page/thematic-papers

70 Homepage at: http://www.espon.eu/main/Menu_Programme/

71 Available at: http://www.eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED465123&ERICExtSearch_SearchType_0=no&accno=ED465123

72 Available at: http://www.brookings.edu/research/reports/2001/01/01-high-tech-regions-cortright

73 Innovation Union scoreboard 2011, The Innovation Union's performance scoreboard for Research and Innovation. Available at http://www.proinno-europe.eu/inno-metrics/page/innovation-union-scoreboard-2011. The IUS report, its annexes and the indicators' database are also available at http://www.proinno-europe.eu/metrics

74 Most of the information presented here has been extracted from the original source.

75 All domains, indicators and sources are listed in Annex 6.

The *Enablers* capture the main drivers of innovation performance external to the firm and differentiate between 3 innovation dimensions. 'Human resources' include 3 indicators and measure the availability of a high-skilled and educated workforce. 'Open, excellent and attractive research systems' include 3 indicators and measure the international competitiveness of the science base. 'Finance and support' include 2 indicators and measure the availability of finance for innovation projects and the support of governments for research and innovation activities.

Firm activities capture the innovation efforts at the level of the firm and differentiate between 3 innovation dimensions. 'Firm investments' include 2 indicators of both R&D and non-R&D investments that firms make in order to generate innovations. 'Linkages & entrepreneurship' include 3 indicators and measure entrepreneurial efforts and collaboration efforts among innovating firms and also with the public sector. 'Intellectual assets' capture different forms of Intellectual Property Rights (IPR) generated as a throughput in the innovation process.

Outputs capture the effects of firms' innovation activities and differentiate between 2 innovation dimensions. 'Innovators' include 3 indicators and measure the number of firms that have introduced innovations onto the market or within their organisations, covering both technological and non-technological innovations and the presence of high-growth firms. The indicator on innovative high-growth firms corresponds to the new EU2020 headline indicator, which will be completed within the next two years. 'Economic effects' include 5 indicators and capture the economic success of innovation in employment, exports and sales due to innovation activities.

The IUS uses the most recent statistics from Eurostat and other internationally recognised sources, as available at the time of analysis. International sources have been used wherever possible in order to improve comparability between countries. It is important to note that the data relates to actual performance in 2007 (1 indicator), 2008 (9 indicators), 2009 (3 indicators) and 2010 (11 indicators).

The Report offers a benchmarking with main global competitors. Europe's main global competitors include Australia, the BRICS countries (Brazil, China, India, Russia and South Africa), Canada, Japan and the US. For these countries data availability is more limited than for the European countries (e.g. comparable innovation survey data are not available for many of these countries). Furthermore, the economic and/or population size of these countries outweighs those of many of the individual Member States and the report thus compares these countries with the aggregate of the Member States or the EU27. For the international comparison of the EU27 with these countries a more restricted set of 12 indicators is used of which most are nearly identical to those of the IUS.

The overall innovation performance of each country has been summarized in a composite indicator (the Summary Innovation Index).[76]

The approach, both in terms of structure, indicators, sources and data processing is highly inspiring.[77] Still, the EIPE sector-specific focus (ICT) and regional disaggregation will be very important obstacles to emulate directly the IUS methodology.

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[76] The methodology used for calculating this composite innovation indicator is presented in Annex 6.

[77] A full methodological report for the IUS is accessible at: http://www.proinno-europe.eu/inno-metrics/page/methodology-report-0

ii). Strong Clusters in Innovative Regions (2011)[78] [79]

This report is a topical report of the earlier described European Cluster Observatory. Interestingly enough it attempts to address regions' innovation capacity, and identify their industrial specialisation.

Most relevant to our study is the identification of the highly performing NUTS2 level IT and Telecom clusters. The corresponding report, dated mid 2011, describes the method as following:

"This report presents the strongest cluster agglomerations in the most innovative regions in the European Union. Among 3-star clusters (see below), 100 were selected based on the regional innovativeness according to the Regional Innovation Scoreboard (RIS) 2006. Some NUTS2 regions, not covered by RIS, are therefore not included in the analysis: Bulgaria, Romania, Trentino/Alto Adige (IT), Ionia Nisia (GR) and several regions in Poland.

Table 2[80] limits itself to present the 10 clusters relevant to the ICT industry, as identified with the Observatory method.

Table 2: Strong Clusters in Innovative Regions

Region	Sector	Specialisation	Employees
Austria			
Wien	**Telecom**	**2,64**	**21 505**
Finland			
Etelä-Suomi/Åland	**Telecom**	**2,96**	**27 921**
Germany			
Karlsruhe	**IT**	**3,29**	**28 836**
Mittelfranken	**IT**	**6,03**	**33 814**
Oberbayern	**IT**	**3,35**	**50 338**
Ireland			
Ireland	**IT**	**3,43**	**28 498**
Poland			
Mazowieckie	**Telecom**	**2,38**	**31 787**
Sweden			
Stockholm	**IT**	**4,23**	**25 206**
Stockholm	**Telecom**	**3,17**	**24 002**
United Kingdom			
Berks, Bucks and Oxon	**IT**	**3,01**	**30 184**

Source: Centre for Strategy and Competitiveness, CSC. Stockholm School of Economics, 2011. Strong Clusters in Innovative Regions. Available at: http://www.clusterobservatory.eu/common/galleries/downloads/Strong_Clusters_in_Innovative_Regions_Report.pdf

As clearly expressed, this table is a result at the crossroad of two assessments: the Regional Innovation Scoreboard 2006[81] and the employment-based indicators used by the Observatory.

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[78] Center for Strategy and Competitiveness, CSC Stockholm School of Economics (2011). Available at: http://www.clusterobservatory.eu/common/galleries/downloads/Strong_Clusters_in_Innovative_Regions_Report.pdf

[79] Most of the information presented here has been extracted from the original source.

[80] Annex 7 presents the full results: the table lists the 100 3-star clusters that are located in the regions that rank highest innovation rank in RIS.

[81] Available at: http://www.google.co.uk/search?hl=en&q=regional+innovation+scoreboard+2006&meta=

The "Strong clusters in Innovative regions" ranking gives a useful insight in the Cluster Observatory methods, when it comes to integrate lessons learned into the EIPE exercise: the aim of the Observatory being that of mapping clusters, its central indicator is employment on which basis it executes traditional Balassa-type[82] and other calculations. The *cluster* phenomenon is captured by employment figures at regional level, presented as "*one driver behind the knowledge spillovers, labour pooling, inter- and intra-industry trade that characterise dynamic and competitive clusters*".

Consequently, the ICT aspect is strictly determined by the measurement of ICT employment (IT or Telecom) at regional level. Simultaneously, a tentative to assess *innovative performance* is built upon the final results of the Innovation Scoreboard that takes in account a variety of variables such as human resources, employment in manufacturing, expenditure on R&D and patents. Such cross-assessment is a useful attempt to capture a complex reality. But such construction is probably too weak to capture Poles of Excellence and it raises some methodological questions such as the correlation of indicators across the databases used.

Still, the outputs of the EIPE study will need to be contrasted with those presented here.

iii). ITIF: The Atlantic Century II: Benchmarking EU and U.S. Innovation and Competitiveness (July 2011)[83]

In 2009, at the height of the crisis, ITIF[84] published the first edition of The Atlantic Century, a report that assessed the global innovative-based competitiveness of thirty-six countries and four regions (the European Union (EU)-15 region, the EU-10 region, the EU-25 region, and the North Atlantic Free Trade Agreement region), both as they stood approximately in 2007 and in terms of their progress between the early 2000s and then.

The report relied on sixteen indicators from the following broad categories: (1) human capital; (2) innovation capacity; (3) entrepreneurship; (4) IT infrastructure; (5) economic policy; and (6) economic performance.

The results were a surprise to most. The United States did not rank number one as many assumed. In fact, it ranked fourth out of thirty-eight nations or regions. And the EU-15 ranked even lower, 16 percent below the United States. But the results regarding the rate of progress were even more disconcerting. The United States ranked last in improvement in international competitiveness and innovation capacity over the last decade and the EU-15 region as a whole ranked just twenty-eighth behind fourteen non-EU-15 nations, including China, Singapore, Japan, Russia and S. Korea.

The 2011 Atlantic Century II Report updated ITIF's 2009 report on the United States' innovation-based competitiveness. It used again 16 key indicators, such as scientists and

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[82] For more details on such quantitative approach to specialisation, and its application, see at: http://ftp.jrc.es/EURdoc/eur23067en.pdf

[83] Most of the information presented here has been extracted from the original source. Available at: http://www.itif.org/files/2011-atlantic-century.pdf.
See also ITIF page at: http://www.itif.org/publications/atlantic-century-ii-benchmarking-eu-us-innovation-and-competitiveness

[84] ITIF = Information Technology and Innovation Foundation. ITIF presents itself as a " non-partisan research and educational institute – a think tank – whose mission is to formulate and promote public policies to advance technological innovation and productivity internationally, in Washington, and in the states. Recognizing the vital role of technology in ensuring prosperity, ITIF focuses on innovation, productivity, and digital economy issues. See at: http://www.itif.org/content/about-us

engineers, corporate and government R&D, venture capital, productivity and trade performance. The 2011 report found that America has made little or no progress since 1999[85]. The United States' and EU-15's ranks remain unchanged, fourth and eighteenth respectively. The United States leads Europe in twelve of the sixteen indicators, including knowledge (higher education and number of researchers); innovation (corporate and government R&D; information technology (IT investments, e-government, and broadband); overall business climate; entrepreneurship (new firms and venture capital), and productivity. The EU-15 leads the United States in just four of the indicators: academic publications, a lower effective corporate tax, trade performance, and foreign direct investment (FDI) inflows.

In terms of progress and rate of change the picture is even more troubling. Of 44 countries and regions, the United States ranks second to last in terms of progress over the last decade, ahead of only Italy. This is slightly better than in 2009 when the United States ranked last. And the EU-15 ranks thirty-sixth in the rate of change behind twenty non-EU-15 nations. The two regions of the globe making the fastest progress are Eastern Europe and Southeast Asia. In terms of the former, the EU-10 still lags behind the United States and the EU-15, with overall scores at just 60 percent of the U.S. score. But five Eastern European nations – Cyprus, Slovenia, Estonia, the Czech Republic, and Latvia – are in the top ten in terms of rate of progress between 1999 and 2011. However, the crisis had a disproportionate impact on them, with Latvia actually ranking last in progress in the last several years, and Lithuania thirty-sixth. Southeast Asia, China and S. Korea are the top two nations in the rate of change over the last decade and Singapore ranks eighth. Some of these findings reflect a simple process of catch up. Countries that are less advanced when it comes to innovation can perhaps advance more easily than countries at the leading edge. But some of the nations that have shown faster progress than the United States or the EU-15 are advanced nations, such as S. Korea, Japan, Australia, and Canada.

Still, measured at States level against the foreign countries and regions, Massachusetts, California, Connecticut, New Jersey, Washington, Delaware, Maryland, Colorado, and New Hampshire would all be ranked number one in innovation-based competitiveness if they were their own countries. Even the least competitive (Mississippi) would still fall towards the middle of the pack. Were Massachusetts its own nation, it would be the most innovative economy on the planet.

This report is very interesting for EIPE, beyond its methodological aspects. It offers a worldwide analysis in comparative effort, and snapshots of two periods in time. But even more so, it raises the issues related to the assessment of rhythms of relative progress in innovativeness and their relation to contextual factors. With an insight into European MS, it intends to distinguish absolute and relative scores within a historical explanation encompassing Enlargement.

[85] The full ranking is presented in Annex 9.

iv). Malerba et al (2010). Report on Trends and Evolution of the EU ICT Research and Deployment Landscape[86]

Definition / objective

This evaluation study, commissioned by DG INFSO, assesses the effectiveness of network collaborations and knowledge transfers in the innovation and deployment stages of the Information Society at a regional level. It suggests ways for strengthening the links between IST-RTD and ICTPSP policies, innovation and deployment at EU and regional levels.

Data and data processing

The study uses both quantitative and qualitative approaches, contains the results of interviews with key regional players, examines data at European and regional levels, and applies network analysis. In particular, the study has systematically collected, classified, and coded a large set of information at an organizational level related to collaborative European ICT R&D programs (IST-RTD and ICT deployment activities, such as eTen, eContent and ICT-PSP within the CIP) and has analysed it in order to assess the effectiveness of network collaboration and knowledge transfers between IST-RTD and different types of networks at the regional level. Applying social network analysis to research and deployment projects the study has selected a number of regions for field interviews with regional players in order to enhance and support ICT monitoring and evaluation procedures at the regional level.

Regarding network analysis, the study identifies the most central actors and describes where they cluster at the regional level (NUTS2). Therefore, the evaluation of the centrality of regions in EU RD networks reflects the assessment performed at the level of participating organizations. Following the methodologies of their previous studies, the authors specifically look at network hubs, i.e. nodes with a large number of connections and, alternatively, nodes that are highly influential by playing the role of network connector, i.e. one which connects nodes that would otherwise remain unconnected.[87]

Further, the authors also have examined for each region, the intensity of participation (number of regions' participants in research and/or deployment programmes) and the strategic position of regional players (number of hubs across research or deployment programmes). Combining these two types of information, the regions are classified into four broad typologies:

a) Core members (high frequency of participation and strategic positioning),

b) Followers (high frequency of participation, but small connecting role),

c) Peripheral participants (low frequency of participation and small connecting role),

d) Selective players (low frequency of participation, but strategic positioning).

The network analysis was complemented with an empirical investigation of available data concerning the technological and economic development of regions (Eurostat data).[88] Finally, existing research on regional innovation systems was also used.

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[86] Malerba F., Vonortas N., Corrocher N., Cusmano L. (2010) Trends and Evolution of the EU ICT Research and Deployment Landscape. Final Report. Bocconi University.
Available at: http://ec.europa.eu/dgs/information_society/evaluation/studies/s2008_03/index_en.htm

[87] Some additional details about the method are presented in Annex 8.

[88] In particular, the authors have used information from the Regional Innovation Scoreboard to characterize European regions in terms of their economic and innovation performance. A full list of regions classified in accordance with these criteria is provided in the Technical Annex of their report.

To summarize, a final selection of a sample of 6 regional case-studies was established upon the following criteria:

- Degree of participation and centrality in IST-RTD (FP6 and FP7) projects;
- Degree of participation and centrality in eTen, eContent (eContentplus) and CIP-ICTPSP projects (first two calls);
- GDP per capita (level and growth rate over the past five years) and techno-economic level of development;
- Innovative performance and trends as measured by the most recent Regional Innovation Scoreboard (2009) and as resulting from available empirical analyses of the regional innovation systems.

The resulting selection is made out of 6 regions: Oberbayern, Lombardy, Cataluña, Prague, Thüringen and Lisbon. The 3 first are presented as "core of the European network, in both research and deployment initiatives".

Box 6: The report's comments about the sample of Regions (p.6)

"Our sample is meant to include, on the one hand, both innovation leaders and followers (or declining players) among the cases of regions which have participated extensively in European programmes; and, on the other hand, regions that rank high in the Regional Innovation Scoreboard, or that have significantly improved their performance over the last few years, but do not stand at the core European RTD and deployment networks. Consistently, the following six regions are identified for in-depth study: three from Southern Europe – Lisbon, Lombardy and Cataluña; two from Central Europe – Thüringen and Oberbayern; and one from a New Member state – Prague.

Oberbayern, Lombardy and Cataluña are at the core of the European network, in both research and deployment initiatives. However, their innovation performance is significantly different, especially in dynamic terms. Whereas Oberbayern is one of the most innovative regions in Europe, Lombardy and Cataluña represent interesting cases of advanced manufacturing regions that experience a complex transition from the traditional industrial cores towards knowledge intensive production modes in both manufacturing and services. Lisbon is catching up in terms of participation in the European projects and is very active in other Community Initiatives. The region's organizations participate extensively in RTD projects, but are generally not placed at strategic junctions of the network. Lisbon exhibits a relative strength in S&T indicators related to public investment and human resources, but is weak in terms of business R&D expenses and patenting performance. Finally, Prague and Thüringen constitute two very interesting cases, in terms of recent growth and potential, and in terms of different involvement in European networks. These are Eastern European regions that have been rapidly catching up, but exhibit different structure and orientation in their innovation system. Prague is emerging as a "Science and Service Centre", largely based on Higher Education, Government Sector and knowledge intensive services, and extensively participates in European RTD programmes. Thüringen is characterized by a strong core of mid-high tech manufacturing and by a limited presence of advanced services, and plays a relatively marginal role in European networks."

Outputs

In addition to factual observations, the report issues a certain amount of interpretative conclusions mostly relate to the assessment of European R&D programs. Still, we extract here some of those we see as relevant to our study.

According to the authors, in both research and deployment networks, leading regions have a few organizations which participate in a very large number of projects. (...) The organizations that are already well connected have a higher probability of attracting partners and therefore of being active members of the network in the future.

In the selected regions, universities and public research organizations are the most active organizations in European research and deployment networks. However, multinational corporations constitute the majority of gatekeepers. Investment needs imply that large industry actors can play a pivotal role and also highlights the difficulties that Universities and Public Organizations face in effectively playing a bridging role.

Participation to research networks is considered a valuable mechanism for training specialists and upgrading their competences. Collaborative projects are unique opportunities to network with specialized suppliers and key users of ICT technology and high tech services. The participation of advanced final users is a major driver of participation in EU networks for specialized suppliers, which consider EU projects as a privileged space for interacting and "co-innovating" with competent adopters (e.g. the development of customized ICT systems in the area of e-health, generation of web 2.0 applications, etc.).

The dissemination and exploitation of project outcomes at the regional level are not frequently prioritized by participants in EU networks. This is partly explained by the international perspective of the research projects, but is also related to the perception participants have of a lack of absorptive capacity by potential local users or adopters.

The dissemination activities rely mostly on personal contacts, rather than on systematic mechanisms. Limited financial instruments and difficulties in identifying and targeting a specific and interested (local) audience hinder the diffusion process. Also, there are limited, unspecific and poorly developed channels available to diffuse ICT products, processes and services at the regional level outside those already in the project.

Excessively large networks can be highly dispersive and lack focus. At the same time, excessive homogeneity among partner negatively affects the project functioning and outcome. It limits the advantages from a combination of complementary expertise and can make networks highly self-referential and closed to new ideas and new members.

Malerba et al (2010) study is of course a very promising exercise for EIPE as it encompasses ICT inventive activity, a European-wide analysis and a network analysis methodology. Of course, being aimed at analysing and assessing the European framework Program, it diverges strongly from the EIPE objectives. Still, the observations summarised above validate empirically many of the conceptual aspects presented in the early sections of this report by considering the differentiated roles of heterogeneous actors (Universities, Public centres of research, Multinationals) networking in the co-innovation process, where local agglomeration favours knowledge transfer and spillovers while transnational reach feeds the need for a large – and educated - market.

v). The Regional Innovation Scoreboard 2009 (RIS)[89] [90]– MERIT – JRC-IPSC

Definition / objective

While the European innovation Scoreboard (EIS) benchmarks performance at the level of Member States, innovation is considered to play an increasing role in regional development. Recognising this, innovation policy is increasingly designed and implemented at regional level. However, despite some advances, there is an absence of regional data on innovation indicators which could help regional policy makers design and monitor innovation policies.

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[89] Available at: http://www.proinno-europe.eu/page/thematic-papers-0

[90] Most of the information presented here has been extracted from the original source.

The European Regional Innovation Scoreboard (RIS) aims at addressing this gap and provides statistical facts on regions' innovation performance. The RIS provides a comparative assessment of innovation performance across the NUTS 2 regions of the European Union and Norway.

As the reader might have noted, the Regional innovation scoreboard serves occasionally as secondary source of analysis in other exercises, like in the Cluster Observatory topical report presented earlier.

Data and data processing

A Regional Innovation Scoreboard 2009 Methodology report, [91] [92] authored by MERIT and JRC-IPSC accompanies the Regional Innovation Scoreboard (RIS) 2009 report. It describes very thoroughly a large amount of useful information regarding data needs, data definitions and data availability at regional level.[93]

In 2002 and 2003 under the European Commission's "European Trend Chart on Innovation" two Regional Innovation Scoreboards had been published. Both were using a more limited number of indicators as compared to the EIS. In 2006 a Regional Innovation Scoreboard was published providing an update of both earlier reports by using more recent data and also including the regions from the New Member States but with *an even more limited set of data* as regional CIS data were not available.

Following the revision of the EIS in 2008, the 2009 RIS aimed at using as many as possible of the EIS indicators at the regional level for all EU Member States, including regional data from the Community Innovation Survey (CIS) where available.

However the use of some data at regional level presents certain limitations regarding data availability and data reliability. Of the 29 indicators used in the EIS, data at the regional level were only available from public sources for 8 indicators, and a further 8 indicators were potentially available, if using regional data collected directly from Member State Community Innovation Surveys (CIS). This methodological report examines hence the available data and discusses how they can be used to develop the Regional Innovation Scoreboard.

In consequence, the 2009 report offers richer information mainly thanks to the availability and processing of regional Community Innovation Survey (CIS) indicators. As a result, the 2009 Regional Innovation Scoreboard uses 16 of the 29 indicators used in the EIS for 201 Regions across the EU27 and Norway (See pp.7-9 of the Report).

Despite this progress, the data available at regional level remains considerably less than at national level, and in particular four Member States - Germany, Sweden, Ireland and the Netherlands – were not able to provide regional CIS data.

Also, following the revised EIS methodology, the RIS paid more attention to wider measures of innovation including among others non-R&D and non-technological innovation.

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[91] Hollanders H., Tarantola S., Loschky A. (2009). The Regional Innovation Scoreboard 2009 Methodology report. Available at: http://www.proinno-europe.eu/page/thematic-papers-0

[92] All the information presented here is extracted from the original document.

[93] See Annex 10 for details on indicators definitions and data availability.

Outputs

Due to the above data limitations, the 2009 RIS does not provide an absolute ranking of individual regions, but ranks regions in 5 different groups, the high innovators, medium-high innovators, average innovators, medium-low innovators and low innovators.

The main findings are:

- There is considerable (intra-national) diversity in regional innovation performances. The most heterogeneous countries are Spain, Italy and Czech Republic where innovation performance varies from low to medium-high.
- The most innovative regions are typically in the most innovative countries. Nearly all the "high innovators" regions are in the group of "Innovation Leaders" identified in the European Innovation Scoreboard (EIS). Similarly all of the "low innovators" regions are located in countries that have below average performance in the EIS.
- However, the results also show regions that outperform their country level:
    - Noord-Brabant is a high innovating region located in an "Innovation follower" country (the Netherlands).
    - Praha in the Czech Republic, Pais Vasco, Comunidad Foral de Navarra, Comunidad de Madrid and Cataluña in Spain, Lombardia and Emilia-Romagna in Italy, Zahodna Slovenija in Slovenia, and Oslo og Akershus, Sør-Østlandet, Agder og Rogaland, Vestlandet and Trøndelag in Norway are all medium-high innovating regions from moderate innovators and catching up countries.
    - The capital regions in Hungary and Slovakia show an innovation level at the EU average but are located in catching up countries whose overall innovation performance is well below average.
- Regions have different strengths and weaknesses. A more detailed analysis was conducted for those regions with good data availability. This shows that regions are performing at different levels across three dimensions of innovation performance included in the EIS: innovation enablers, firm activities, and innovation outputs. Although there are no straight forward relationships between level of performance and relative strengths, it can be noted that many of the "low innovators" have relative weaknesses in the dimension of innovation enablers, in particular on human resources.
- Regional performance appears relatively stable since 2004. The pattern of innovation is quite stable between year 2004 and 2006, with only a few changes in group membership. More specifically, most of the changes are positive and relate to Cataluña, Comunidad Valenciana, Illes Balears, and Ceuta (Spain), Bassin Parisien, Est and Sud-Ouest (France), Unterfranken (Germany), Közép-Dunántúl (Hungary), Algarve (Portugal), and Hedmark og Oppland (Norway). Longer time series data would be needed to analyse the dynamics of regional innovation performance and how this might relate to other factors such as changes in GDP, industrial structure and public policies.

The major lesson for EIPE here is the low availability of regional data on Innovation in Europe. While the EIPE aims at analysing sector-specific data – ICT – and agglomeration economies (functional regions) at a local level, the RIS methodological report supports strongly the assumption that the EIPE will need to develop on the basis of novel indicators

and novel sources of data, in conjunction with the available official data (EUROSTAT mainly) when relevant and available.

Second the outputs of the EIPE study will need to be contrasted with those of the EIS and the RIS. This goes for final rankings as well as for any more detailed analysis.

vi). Mc Kinsey´s Innovation Heat Map (n.d.)

The global consultancy McKinsey has partnered with the World Economic Forum to create the "Innovation Heat Map"[94] [95] a database and a visualization tool that aims at mapping and comparing the characteristics of the most successful innovation hubs (metropolitan regions) around the world.

As part of this effort, McKinsey claims it has examined the evolution of hundreds of such clusters around the world and analyzed over 700 variables, including those driving innovation (business environment, government and regulation, human capital, infrastructure, and local demand) along with proxies for innovation output (for example, economic value added, journal publications, patent applications) to identify trends among the success stories. In the process, McKinsey has found patterns that suggest the critical ingredients required to grow, nurture, and sustain innovation hubs and compiled data that may be used to identify bottlenecks and benchmark the performance of cities, regions, and countries by measuring how they are evolving.

The following box offers the authors' firsthand insights in the framework.

Box 7: Building an innovation nation[96] (André Andonian, Christoph Loos, and Luiz Pires, 2009)[97]

Creating a cluster: Of fundamentals and focus

Our analysis identified a set of fundamentals that are needed to establish a minimum infrastructure base. Criteria such as the quality of the physical infrastructure (for example, electrical, transportation, and telecommunications) and governance indicators (for instance, rule of law and government stability) are essential for a location to "earn the right to play." Meeting this minimal threshold is an important prerequisite. Further improvements to this base, interestingly, are associated with only incremental growth in innovation capacity.

Once a base is established, innovation hubs must then develop a specific sector focus. Our analysis of the world's most successful clusters shows that they have first established themselves as world-class players in an emerging specialty before expanding. This focus allows locations to concentrate limited resources, such as labor and capital, on developing competence and credibility. When successful, the result of these first two steps is the emergence of what we call an "innovation hot spring": a small and fast-growing hub that relies on a small number of companies to establish itself as a relevant world player in a narrow sector. Our analysis indicates that these early innovation hubs have historically followed one of three primary paths.

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[94] Partly accessible at: http://whatmatters.mckinseydigital.com/innovation/building-an-innovation-nation

[95] This analysis was presented at the IPTS workshop "TRANSEUROPA: The drivers of transformation of the European Economy and its Geography at the horizon 2030-2050 of March 2009 by Mr Alan Marcus, Head of IT and Telecom Industries of the Chair of innovation of the Davos Economic Forum.

[96] This is a full extract from : http://whatmatters.mckinseydigital.com/innovation/building-an-innovation-nation

[97] André Andonian is a Director in McKinsey's Munich office and leader of the Europe, Middle East, and Africa high-tech practice; Christoph Loos is an Associate Principal in the Frankfurt office; and Luiz Pires is the EMEA high-tech Practice Manager in the Munich office.

- Heroic bets: large, government-led, targeted investment efforts that focus on a specific promising sector and provide substantial initial support in the form of subsidies, tax holidays, and direct investments, to name a few. While this has been an attractive option for many locations, it has historically been a challenging path: governments are often ill equipped to identify the right sectors, to define non-distorting incentive structures, and to ensure an effective path out of the initial support phase.
- Irresistible deals: regions which are able to attract established companies (often foreign players) who want to capitalize on a significant local advantage, such as low cost of qualified labor or access to large local markets. When done effectively, the location can build on this base to add greater value over time, moving, for example, from manufacturing to basic engineering to design and innovation. To be successful, regions need to create mechanisms that encourage the effective transfer of knowledge to the local ecosystem, as well as tools and processes to raise the skills of the local labor pool.
- Knowledge oases: locations with a critical mass of highly specialized talent (for instance, a large research university or government R&D lab). These hubs capitalize on breakthrough technical advances for commercial success. This path is less frequently successful, however. It requires that locations attract the capital and entrepreneurial skills needed to bridge the chasm between idea creation and commercialization.

While innovation clusters may grow quickly in the short term, only a small proportion of these promising hot springs stand the test of time. Most hit a ceiling of limited resources that severely constrains their growth.

Nurturing the cluster: Securing the talent base

Our work has shown that critical drivers of innovation vary from sector to sector. The local regulatory environment, for example, is a critical determinant for some sectors; for others, the availability of venture capital or the presence of a demanding local customer base are key. However, the single common factor that drives—or, indeed, constrains—innovation across all sectors is the availability of a well-qualified and specialized talent pool. While a hub's initial success can often be fueled by relying primarily on local talent, the importance of attracting, developing, and retaining a vibrant base of world-class talent increases as clusters mature and grow in complexity.

While the need for talent is the same all over the world, different locations are currently facing very different challenges. Japan and Western Europe must overcome a severe demographic challenge—their fast-aging populations and growing number of retirees need to be replaced or their labor efficiency further enhanced. North America is struggling with the challenge of replacing a large number of highly specialized immigrants who are now choosing to stay or return home. Emerging Asian economies, while able to draw from a very large demographic pool, need to train a larger proportion of their population to reach world-class levels. They also must increase the attractiveness of their hubs to better compete for top global talent. While simply meeting basic infrastructure needs is sufficient to sustain initial growth, a region must establish itself as an attractive destination for global talent in order to establish itself as an innovation hub.

Sustaining the cluster: Sowing the seeds of reinvention

While focus is critical for emerging innovation hubs, as they mature, they need to broaden their portfolios of businesses and sectors. This diversification is vital to the long-term survival of an innovation hub—it allows the hub to survive the unavoidable downturns that affect specific sectors and provides the impetus for continuous reinvention. New innovators typically emerge in adjacent industries, or as hubs attract nonlocal players that want to capitalize on the local infrastructure and available talent. Our data indicate that, depending on the strategy, mature innovation clusters will evolve toward one of the following categories:

- Dynamic oceans: large and vibrant innovation ecosystems with continuous creation and destruction of new businesses. Leading innovators and primary sectors change organically as the hub frequently reinvents itself through significant breakthrough innovations.
- Silent lakes: slow-growing innovation ecosystems backed by a narrow range of very large established companies that operate in a handful of sectors. These clusters are frequently the source of a steady stream of "evolutionary" innovations and step-wise improvements.

- Shrinking pools: innovation hubs that are unable to broaden their areas of activity or increase their lists of innovators and so find themselves slowly migrating down the value chain, as their narrow sector becomes less innovation driven and increasingly commoditized.

The data-driven methodology of the Innovation Heat Map sheds new light on the innovation process and allows for an objective diagnosis of both innovation output and local bottlenecks. Going forward, we look to build upon this approach to evaluate conventional wisdom about the drivers of innovative environments and thus bring new perspectives to this vitally important topic.

The favourable results point strongly at Silicon Valley in the US, and in Europe, mainly to German cities. Some observers have suggested that this excessively optimistic view of the Heat Map about Silicon Valley and the US contradicted other findings, such as those of an earlier report by the Information Technology and Innovation Foundation (ITIF), presented earlier in this report, which ranked the United States as sixth among forty countries in innovation.[98]

As well inside as outside the Mc Kinsey website, the debate goes largely about the robustness of the conceptual framework (including the cluster categories proposed), the validity of the indicators and finally the availability of comparable worldwide data. This last aspect is probably a major challenge in this exercise.

This very unique world-wide benchmarking exercise of Innovation at local level delivers several key ideas to serve as source of inspiration for EIPE: it clearly frames its observation within a dynamic perspective, allowing to discus the mergence, nurturing and sustainability of Poles within what can be seen as a life-cycle. It allows indicates the diversity of Poles profiles that might show at the initial step (Government-led, Multinational-led, University-led) as at the final stage (breakthrough innovations, evolutionary innovation, commoditization).

vii). DG REGIO: "ESPON" Programme (2007–today)[99]

The European Observation Network for Territorial Development and Cohesion (ESPON) programme was adopted by the European Commission on 7 November 2007. The programme budget is currently part-financed at the level of 75 % by the European Regional Development Fund under Objective 3 for European Territorial Cooperation. The rest is financed by 31 countries[100] participating.

The mission of the ESPON 2013 Programme is to: "*Support policy development in relation to the aim of territorial cohesion and a harmonious development of the European territory by (1) providing comparable information, evidence, analyses and scenarios on territorial dynamics and (2) revealing territorial capital and potentials for development of regions and larger territories contributing to European competitiveness, territorial cooperation and a sustainable and balanced development*".

The actions include strongly interrelated operations:

1. Applied research on different themes of European territorial dynamics is the core business, providing scientifically solid facts and evidence at the level of regions and

[98] In a later comment, the authors stated that when normalising their innovation output proxies by the size of each country's population or economy – as done by the ITIF – they arrive at very similar findings. Simply, they had chosen to avoid direct comparisons between large heterogeneous countries and small city states, and choose instead to look at the 'metropolitan region' level whenever possible.

[99] Homepage at: http://www.espon.eu/main/Menu_Programme/

[100] Namely, 27 EU Member States and Iceland, Lichtenstein, Norway and Switzerland.

cities. These results make it possible to assess strength and weaknesses of individual regions and cities in the European context.

2. Targeted Analyses together with stakeholders is an important project type that makes use of ESPON results in practice.
3. Scientific Platform development is supported by an ESPON Database project and actions dealing with territorial indicators and monitoring as well as tools related to territorial analyses, typologies, modelling and updates of statistics.
4. Capitalisation of ESPON results that includes media activities and different ESPON publications.

ESPON can mainly be seen as an applied research program, aiming at improving facts and evidence on European territorial structures, trends, perspectives and policy impacts. A particular focus is given to territorial potentials and challenges for a successful development of regions and cities of Europe. In addition, the understanding of different types of regions and territories is given priority. The applied research themes chosen deal with socio-economic as well as ecological issues that are always addressed in a territorial context, providing a European wide coverage of comparative information on regions and cities.

The applied research also takes up territorial phenomena, such as urban structures, potential accessibility and urban sprawl, in order to enrich policy development with further elements relevant for territorial development and cohesion.

The impact of EU policies is another area of applied research within ESPON. Projects will support policy makers with information on impacts of concrete EU sector policies as well as tools for the ex-ante assessment of impacts of policy initiatives, in strategy documents and in EU Directives.

Of interest for EIPE is the development of the Scientific Platform and analytical Tools of ESPON. In particular, the further development and improvement of the ESPON Database, innovative work on territorial indicators/indices and on a territorial monitoring and reporting system are among the challenges. In the work on improving the ESPON Scientific Platform, efforts are made to relate to the growing number of spatial observatories set-up for national and cross-border territories, and to ensure compliance with European standards for spatially referenced data and maps.

viii). Strategic Planning in the Technology-driven World: A guidebook for Innovation-led Development. U.S. Department of Commerce, Economic Development Administration (EDA 2001).[101]

This report has as purpose to help economic development decision-makers to adopt a realistic, principles-based approach to strategic planning applicable to areas with widely different technology assets. It examines successively regional development in technology-driven economy and provides a framework for understanding elements of innovation-led development.

The document offers[102] a very comprehensive set of indicators aiming at measuring regional innovation. It articulates its approach similarly to the Porter's Cluster Database by starting with an analysis of the wealth of the region with demographics, income,

[101] Most of the information presented here has been extracted from the original source.
[102] See Annex 8 of the EDA Report.

employment and quality of life indicators. The Innovation and entrepreneurship measurements come second and are organised around three topics: Business formation i.e. business starts, spin-offs, Business innovation and fast growth companies i.e. SBIR awards, Idea generation and commercialisation: i.e. patent activity, etc. Assessing Knowledge assets comes next with skills and experience of the labour force, knowledge and ideas, access to financial capital, quality of place and investments in infrastructure. Finally the grid assesses the degree collaboration among organisations within economic development organisations, R&D consortia and Venture clubs.

An important contribution of the EDA report is that, when studying the regional innovative competitiveness, it goes beyond traditional metrics of innovation input and output and addresses social aspects of the innovative process. The motivation behind this approach is that a crucial element in the innovation process consists of the networks of researchers, entrepreneurs and firms.

Another novel contribution of the EDA report is that it acknowledges the role of cultural conditions in the regional innovation. The argument goes that innovation is about change. Thus, a regional business culture is the degree to which business leaders are willing to collaborate and share ideas even when they compete in other circumstances. This standpoint is supported in the report by the case of Silicon Valley in the 1980s, a region whose success is explained by the willingness of Silicon Valley entrepreneurs to share ideas and information.

Unfortunately, measuring any concepts related to culture remains very difficult and, as shown in the EDA report, data gathering is limited to individual surveys capturing such issues as appreciation for diverse views and backgrounds, willingness to collaborate or understanding and appreciation for the entrepreneurial process.

Three main outputs might be of direct usefulness within the EIPE study: the list of indicators as well as an inventory of players considered to have an important role in regional innovation and development.

Next, the report goes beyond traditional metrics of innovation input and output and addresses social aspects of the innovative process, considering networks of researchers, entrepreneurs and firms as a crucial element in the innovation process.

ix). Cortright and Mayer (2001). High Tech Specialization: A Comparison of Technology Centers

According to this early study on high-tech specialization (Cortright and Mayer 2001), any statistical analyses or rankings that group inherently disparate firms such as semiconductors, telecommunications and software together into a single category of ICT, and attempt to explain their behaviour, assuming that they are homogenous units driven by a common set of factors, are likely to produce substantially misleading and incomplete results.

The above point is illustrated by their comparative study of a selection of 14 "high tech" metropolitan areas in the USA.[103] The paper includes the two most frequently studied centres of high technology; two smaller, but fast growing high tech centres, and several of the other mid-sized metropolitan areas.

[103] Namely: Atlanta, Austin, Boston, Chicago, Denver, Minneapolis, Phoenix, Portland, Raleigh, Sacramento, Salt Lake City, San Diego, San Jose, Seattle, Washington DC.

The comparative analysis founds that high technology varies dramatically from place to place. Each metropolitan areas tend to specialize in relatively few products or technologies. This specialization can be seen, among others, in the following measures: employment concentration, patent activity, and venture capital flows. Metropolitan areas that show high concentrations of high tech employment in one technology, like software, will show very low concentrations in hardware. Other regions show the opposite pattern. Similarly, the majority of the patents issued in any given area are granted to only a handful of firms specializing in one or more related technologies. And finally, venture capital flows not only to a few high tech metropolitan areas, but also to a specific set of technologies within those areas.

This early empirical observation by Cortright and Mayer calls for a detailed analysis when comparing various locations. A way of dealing with the issue of specialisation in business and inventive activity is addressed in (Karlsson et al. 2003). In the EIPE case, we will probably tend to develop further such approach towards the concept of technological profile

The empirical literature we have reviewed above shows to offer a wealth of information and orientations regarding the possible conceptualization, structure of the metrics, nature of indicators, type of measurements, data processing, data sources and data itself. Identically, some of the results themselves will invite for crosschecking with any EIPE ranking of regions.

Employment data is centre stage in many of the attempts, building upon a tradition of cluster identification. All efforts to go beyond a strict employment focus, offering dynamics observations and encompassing both innovation and network patterns show the way forward.

Still, our sector-specific focus (ICT) and high regional disaggregation will be very important obstacles to emulate directly any of the above methodologies or results. Many of the reports support the assumption that the EIPE will need to develop on the basis of novel indicators and novel sources of data, in conjunction with the available official data (EUROSTAT mainly) only when relevant and available.

2.4 An inventory of labelling initiative

Authors: G De Prato, D Nepelski, and M Bogdanowicz

A variety of documents gather, inventory, label and even rank players, group of players or locations under the generic wording of "excellence" or "innovative". It is worth here briefly referring to those, keeping in mind that this information should stay part of our general toolbox, allowing for later feed-back, contrasting and interpretation.

We will successively briefly describe and refer to the following labelling and/or ranking initiatives:

On "Excellence":

i. Centres of Excellence,[104]

ii. Networks of Excellence (NoE),[105]

[104] See at: http://ec.europa.eu/research/area/prepdocs_en.html
[105] See at: http://cordis.europa.eu/documents/documentlibrary/66621951EN6.pdf

iii. Excellence in Business,

iv. Excellence in Science.[106]

On "Innovation":

v. Pôles de Compétitivité, French Government,[107]

vi. ICT Labs network, EIT,[108]

vii. Innovation-led clusters. (Economist Intelligence Unit, December 2011),[109]

viii. Europe is on fire (WIRED 2011, Issue 9).[110]

2.4.1 On "Excellence"

i). Centres of Excellence

According to EC (2000), a simple definition of centres of excellence could be: "A centre of excellence is a structure where RTD is performed of world standard, in terms of measurable scientific production (including training) and/or technological innovation".

This concept of centres of excellence was coined for the informal meeting of Research Ministers in Lisbon in March 2000 (EC, 2000). There, it was argued that in practically all areas and disciplines, Europe has public or private centres where research and technological development is performed at a very high, often world-class level.

Such centres are recognised as excellent, because they comprise and attract excellent researchers and developers, earning a reputation as a significant resource for the progress of science and technology and the spread of innovation. A European example of a centre of excellence is CERN.

In this view, a centre of excellence has, among others, the following characteristics:

- a "critical mass" of high level scientists and/or technology developers;
- a well-identified structure having its own research agenda;
- capability of integrating connected fields and to associate complementary skills;
- capability of maintaining a high rate of exchange of qualified human resources;
- a dynamic role in the surrounding innovation system;
- high levels of international visibility and scientific and/or industrial connectivity;
- a reasonable stability of funding and operating conditions over time (the basis for investing in people and building partnerships);
- sources of finance which are not dependent over time on public funding.

Explicitly, Centres of Excellence are discrete organisational units, not agglomeration of Units as EIPE would aim for. Centres of Excellence are among those actors EIPE will be composed of, be them private or public.

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[106] See on University rankings at: http://www.topuniversities.com

[107] See at: http://competitivite.gouv.fr/politique-des-poles/la-mise-en-oeuvre-de-la-politique-des-poles-depuis-2005-472.html

[108] See at: http://eit.europa.eu/?id=148

[109] See at: http://www.managementthinking.eiu.com/sites/default/files/downloads/EIU-ATIC_Report2_Web_Revised.pdf

[110] See at: http://www.wired.co.uk/magazine/archive/2011/09

ii). Networks of Excellence (NoE)

Networks of Excellence (NoE) are, since the 6th Framework programme a European union's research financing instrument for strengthening excellence by tackling the fragmentation of European research, where the main deliverable is a durable structuring and shaping of the way that research is carried out on the topic of the network.

NoE were designed to strengthen scientific and technological excellence on a particular research topic through the durable integration of the research capacities of the participants. They aim was to overcome the fragmentation of European research by:

- gathering the critical mass of resources,
- gathering the expertise needed to provide European leadership,

NoE also had to spread excellence beyond the boundaries of their partnership.

The Provisions for the implementation of NoEs[111] detail the aspects taken in account for their selection. Those criteria are the following:

- Relevance to the objectives of the programme.
- Potential impact: strategic need, goals of the network, clear added value in carrying out the work at European level; effective plan for spreading excellence, exploiting results and disseminating knowledge; likeliness to have a durable structuring impact on European.
- Research.
- Excellence of the participants: current excellent research relevant to the topic; capable of important contributions to the joint programme of activities; collective necessary critical mass of expertise and resources.
- Degree of integration and the joint programme of activities: design and commitment.
- Organisation and management: adequacy.

Also, performance indicators[112] within Networks of Excellence were published by the Commission. The indicators listed were clearly indicated as not constituting any exhaustive list but were offered as examples "*of what could be expected from a network aiming at achieving a satisfactory level of integration at the end of the Community funding period.*"

They probably do represent an interesting attempt for tracking observable behaviours of less- and informal transfer or (tacit) knowledge as well as of loose cooperation.

One can consider the later FP7 JTI and Technological Platforms[113] as the follow-up instruments of the Network of Excellence, further focused as instruments on building up European-wide Public Private Partnerships towards the integration of research agendas. Still, in concrete terms, there was here no specific will in developing any specific locations (but rather networks), neither to identify excellence (but rather at joining forces and aiming at economy of scale and scope).

The international networking favoured by NoE and associated policies rely on the same conceptual views as those EIPE would. The aim is different as with NoE, it is attempted to

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[111] Available at: http://cordis.europa.eu/documents/documentlibrary/66621951EN6.pdf
[112] Available at: http://ec.europa.eu/research/fp6/pdf/performance_indicators_noes.pdf
[113] More on ENIAC and ARTEMIS, the two ICT FPT JTI in Annex 11.

fight the fragmentation of the European research area much more than to offer, including beyond Europe, a global reach to support the knowledge and business functions of an EIPE.

Box 8: Extract from: Performance indicators in the frame of Networks of Excellence

(http://ec.europa.eu/research/fp6/pdf/performance_indicators_noes.pdf)

Communications inside the network

.. Fast and high-performance electronic connections among the network's participants;

.. Compatible and harmonised computer tools, including software;

.. Common methodology of data classification;

.. Common data codification;

.. Common data base, directly accessible to all participants etc.etc.

Sharing and common management of equipment, installations, infrastructure

.. Common installations, equipment, infrastructure (common ownership, or ownership of one participant with agreement regarding its use);

.. Existing agreements regarding the use of equipment, installations, infrastructure;

.. Common arrangements for the use of equipment, installations, infrastructure;

.. Conditions for use which are evidently more beneficial to network members than on the open market etc.etc.

Common management of human resources

.. Mobility programmes (short/long duration) among participants' personnel;

.. Common training programmes for the network personnel ;

.. Training programmes addressed to students and researchers outside the network partnership;

.. Harmonised working conditions (salaries, social protection, and codification of personnel...) etc.

Common knowledge management

.. Sharing of the pre-existing knowledge of the network's participants;

.. Fair distribution of the intellectual property rights following the results generated by the network's activities;

.. Common patents etc.

Network management

.. Setting up of a common legal structure representing all participating organisations in the network and having a legal identity of its own;

.. Decisional framework;

.. Management according to general principles shared by all participants (ethics, gender...);

.. Effective and active participation of all participating organisations in the decisional process, possibly with weighting according to transparent and objective criteria;

.. Regular meetings of the Steering Committee (at least every three months) etc.

"Insurance" of continuation after the conclusion of the Community's funding period

.. Portfolio of projects involving all the network's participants (including those aiming at obtaining future Community funding);

.. Search of external funding sources (both public and private);

.. Decreasing dependence on Community funding.

iii). Excellence in Business

In business literature, there is a number of empirical studies that attempt to define a methodology for assessing excellence in companies. Interestingly, they do not limit the scope to a simple ranking of most successful companies by their revenues or profit. Rather, they include a wide set of criteria and indicators. Multiple excellence measures are proposed (Doyle 1992). In particular, those are profitability, acquisitive growth, shareholder value, quality and service. Some of these goals can be achieved faster; some of them

require more time. The ultimate choice depends on each company's objectives and these goals are often interconnected. Therefore, some authors suggest companies to go for a 'balanced performance over time' rather then to excel in one goal.

For example, in search for excellent firms, the probably most famous study (Peters and Waterman 1982) focuses on a group of top performing American companies and aims at studying their organizational characteristics. The authors use such measures of productivity as asset and equity growth, average return on total capital, ratio of market to book value. They consider a company as excellent if it was in the top half of its industry in at least 4 productivity measures during a 20-year long time span. However, even such a precise definition does not necessarily guarantee robustness (Soeters, 1986). It turns out that one third of those companies would not be considered as excellent in the following years. Another interesting comment is raised in a comparison of this list of excellent companies with the list of the "100 best American companies to work for" (Mitchell, 1985). Only 21 of the most liveable companies appear in the sample studied by Peters and Waterman.

Taken together those observations suggest the importance of time in performance: aspects such as life-cycle, time lag or resilience need probably to be taken on board to ensure the robustness of observations and interpretation.

Also, the wording "pole", in some cases, has been used playing to describe a role in business practices and also in different science and research fields (health care system, manufacturing, technologies). Considered poles are taken as a reference because performing better than the competitors or similar entities, representing some sort of best practice (or excellence), in most of cases with regard to the business, or productivity performances. The level of adequacy reached by the pole to what is consider the possible best implies that the pole can be taken as a model or can provide a pattern for guidance. In this sense, the expression "pole of excellence" has been used to indicate a concept close to "centre of competence". In some cases companies make use of the concept of "pole of excellence" to identify areas or type of activities in which they considered being best performers. Often such poles of excellence are virtual entities connecting various expertises in different departments in order to better exploit the knowledge or competence of a company or a research institute to achieve a top level performance toward an objective. Pole of excellence of a company could be, to make an example, the corporate social responsibility, or R&D. In the EIPE perspective however, self attributed labels or organisational strategies will not be considered relevant.

iv). Excellence in Science

The measurement of excellence in scientific research is even more challenging than in business activity. The main difficulty is related to the availability of objective and accepted indicators of scientific activity. As a result, although there are attempts of defining and measuring excellence in scientific research, their outcomes are strongly dependent on the subject of judgment and selected indicators.

Because of these difficulties, most of the studies and approaches attempting to measure excellence in research use traditional research and innovation metrics, such as quality of research publications or quality of patents. In both cases, those proxies are debated at

length (See: (Brion, Jarwal et al. 2009),[114] (Schankerman and Pakes 1986), (Trajtenberg 1990; Hall, Jaffe et al. 2000), (Putnam 1996), (Tong and Frame 1994)).

In particular, the use of patents as a measure of research and innovation quality suffers from serious limitations as well. For example, it has long been recognized that patented innovations vary enormously in their technological and economic value and that the distribution of such value is extremely skewed. Hence, it is necessary to control for the quality of patents as well. Practical approaches of adjusting for variation in the quality of patents include, among others, use of patent renewals (Schankerman and Pakes 1986), patent citations (Trajtenberg 1990; Hall, Jaffe et al. 2000), patent family size (Putnam 1996), and the number of claims in the patent application (Tong and Frame 1994). All these allow for emphasizing both the technological and value dimensions of an innovation and, hence, are more likely to reflect higher quality and/or excellence of research. When using patent metrics in EIPE, we will have to take such observations in account.

University rankings are also among such Science measurements, focusing on the academic activity world wide. Among the most relevant to the EIPE study, the Computer Science and Electronic Faculties ranking originates from the QS World University Rankings®, which was created to meet the increasing public interest for comparative data on universities and organisations, and the growing demand for institutions to develop deeper insight into their competitive environment.[115] The QS World University Rankings® currently considers over 2,000 and evaluates over 700 universities in the world, ranking the top 400. As any ranking at the global love, it is constrained by the availability of data from every part of its scope. When attempting to exercise evaluations at a more granular level this becomes even more complex. There are, however, some indicators that transcend the direct involvement of the institutions and can be better stratified by subject discipline.

Based on natural groupings, response levels and expert advice, the ranking includes 52 subject disciplines among which the Computer Science. To construct measures of faculty performance, the QS uses its proprietary datasets that enable to drill down by subject area, namely academic and employer reputation surveys and the Scopus data for the Citations per Faculty indicator in the global rankings. These are combined to produce the final results.

More detailed information on these scores are presented in the methodological Working Paper 2 of EIPE.

2.4.2 On "Innovation"

v). Pôles de Compétitivité, French Government[116]

The French program "Pôles de Competitivité" is a long standing national initiative, started in 2005 aiming at reinforcing the French industrial potential as well as at creating the conditions for the emergence of new industrial activities with high international reach.

A "Pôle de Competitivité" is expected to be the grouping of companies, training centres and public or private research units in a given geographical area, committed to a partnership-

[114] These authors provide very sobering answers to the question of the usefulness of bibliometric indicators as the journal impact factor, citations number and 'ranked journals' as indicators of research excellence. According to them, caution should be exercised when using these indicators as proxies for research quality.

[115] More information under: http://www.topuniversities.com (last accessed 01.02.2012).

[116] The section below is largely inspired from the official documentation of the French Government, starting with: http://competitivite.gouv.fr/politique-des-poles/la-mise-en-oeuvre-de-la-politique-des-poles-depuis-2005-472.html

based approach intended to generate synergies in relation to common projects of an innovative nature. This partnership is structured around a market and the related technological and scientific field, and must achieve the critical mass needed for competitiveness as well as international visibility. These three main ingredients (companies, training and research and innovation), brought together by the three priorities of partnership, concrete common projects and international visibility, comprise the key elements of competitiveness clusters. The critical mass achieved by this grouping must enable it to develop a virtuous circle of growth.

Other partners such as public authorities can also be associated. The aim is to have the companies reach world-class level positions.

This new industrial policy, focusing on the development of Poles results from a decision of the le Comité interministériel d'aménagement et de développement du territoire (CIADT) of Septembre 14, 2004.[117] [118] It is implemented through successive public calls for projects and has labelled 71 Poles across France. An evaluation of the 1st phase of the policy (2005-2008) was organised in 2008[119] and a second phase launched for the period 2009-2012.[120]

This second phase, with an announced funding of 1.5 Bill Euros maintains the focus on R&D but reinforces its support to the strategic piloting of the Poles, adapts funding instruments (in particular access to the funding[121]) and encourages private investment as well as interregional coordination.

The implementation of the policy introduces to a categorisation of the selected Poles as of World-class ("Pôles de Compétitivité mondiaux"), Potentially of world-class ("Pôles de compétitivité à vocation mondiale"), or simple "Pôles de compétitivité".

When it comes to the ICT industry, only two Poles were acknowledged by the French Government in 2005 as Pôles de Compétitivité: Provence-Alpes-Côte d'Azur, and Ile-de-France.[122] Since, the ICT have gained acknowledgement and have multiplied among the World-class Poles category, occupying 4 out of the 7 positions with "Aerospace Valley" around Toulouse, "Systematic" in Paris Region, "Minalogic" close to Grenoble, "Solutions communicantes sécurisées" in the region of Cannes.

The lessons out of this long-standing and strongly financed French initiative are many as similarities with the EIPE study are numerous. In particular, the French Poles pay a dedicated attention to innovative process and outputs, as well as they take in consideration

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[117] Available at: http://www.territoires.gouv.fr/ciadt-du-14-septembre-2004

[118] The initial implementation and financial details were described at large in http://www.territoires.gouv.fr/sites/default/files/datar/ciadtdossierdepresse140904.pdf and in the Circulaire du 2 août 2005 relative à la mise en oeuvre des pôles de compétitivité, available at: http://www.territoires.gouv.fr/sites/default/files/datar/joe-20050806-0182-0002.pdf

[119] Available at: http://competitivite.gouv.fr/la-mise-en-oeuvre-de-la-politique-des-poles-depuis-2005/levaluation-de-la-1ere-phase-2006-2008-de-la-politique-des-poles-de-competitivite-473.html

[120] Documented at: http://competitivite.gouv.fr/politique-des-poles/la-2e-phase-2009-2012-de-la-politique-des-poles-dite-pole-20-478.html

[121] Available at: http://competitivite.gouv.fr/les-appels-a-projets/les-appels-a-projets-de-r-d-dans-le-cadre-du-fui-fonds-unique-interministeriel-380.html

[122] The 2005 Pôles de Compétitivité were:

- Out of 6 "World-class Poles", 2 are ICT Poles: Provence-Alpes-Côte d'Azur, and Ile-de-France
- Out of 9 "Potentially World-class Poles", 1 is an ICT Pole, in Bretagne.
- Out of the remaining simple "Poles", only 3 appear to be ICT-related: in the Region du Centre, in Basse-Normandie and in Limousin, Midi-Pyrénées.

the global reach of each Pole. Still, contrary to EIPE, which is based on a bottom-up statistical observation of selected indicators, the Pôles de Compétitivité show rather to be a top-down labelling exercise, becoming next a unique source of information (both qualitative and quantitative) about ICT industries agglomerations, selected and labelled ex-ante as Poles.

For all the above reasons, the Poles de Compétitivité and their accompanying documentation will become a first-hand benchmarking tool and information source for secondary analysis for the case of France. This source can in addition be complemented by DG REGIO's report "Etude sur l'évolution des diagnostics et des stratégies régionales d'innovation dans les régions françaises dans le cadre des PO FEDER 2007-2013" of July 2010.[123]

Box 9: "Competitiveness Clusters"

Interestingly enough, the CORDIS page about nanoelectronics research in the EU (http://cordis.europa.eu/fp7/ict/nanoelectronics/prog-europe_en.html) adopts explicitly the concept of Pôles de Compétitivité but extends their application to out-of-France cases

"The competitiveness clusters approach is a response to economic dynamics on a global scale, involving networks of excellence and innovation, partnerships and clusters. In different European regions, the establishment of competitiveness clusters is aimed at enhancing the attractiveness of a region and at developing employment via increased economic activity and a strengthening of synergies between stakeholders. To do this, it is necessary to rely on the region's potential for knowledge, research and innovation, which must be transformed into an economic asset.

Well-known examples of competitiveness clusters (French 'pôle de compétitivité') in nanoelectronics are the areas of Grenoble, Dresden, the triangle Leuven-Eindhoven-Aachen and the emerging Irish cluster around Intel Ireland. We should highlight that the latter manufactures Intel's most advanced microprocessors, used in most of the new generations of computers worldwide."

vi). ICT Labs network, EIT [124] [125]

The European institute of Innovation and Technology (EIT) is a body of the European Union established in March 2008. Its mission is to increase European sustainable growth and competitiveness by reinforcing the innovation capacity of the EU (Article 3, EIT Regulations). This translates into developing a new generation of innovators and entrepreneurs. To do so, the EIT has created integrated structures – the Knowledge and Innovation Communities (KICs) - which link the higher education, research and business sectors to one another thereby boosting innovation and entrepreneurship.

The KICs focus on priority topics with high societal impact, currently: Climate change mitigation, Information and Communication Technologies (EIT ICT Labs), Sustainable Energies. In short, the EIT's mission is to facilitate the following transitions from idea to product, from lab to market, from student to entrepreneur by integrating the three sides of the Knowledge Triangle (higher education, research and business) in areas of high societal need.

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[123] Available at:
Factsheets:http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/france_innovation/fiches_regions.pdf
Synthesis:
http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/france_innovation/synthese_en.pdf

[124] See at http://eit.europa.eu/?id=148

[125] Most of the information presented here has been extracted from the original source.

EIT ICT Labs is EIT's KIC for the Information Society. It breeds entrepreneurial ICT top talent by transforming higher education towards promoting innovation and entrepreneurial spirit. Its Co-location Centres and mobility programs help bring people from different countries, disciplines and organisations together.

The goal of EIT ICT Labs is to bring more innovation in the domain of Information and Communication Technologies (ICT) to market. To reach this goal EIT ICT Labs connect excellent European organisations in Education, Research and Industry to speed up innovation.

EIT ICT Labs is one of the first three Knowledge and Innovation Communities (KICs) selected by the European Institute of Innovation & Technology (EIT) to accelerate innovation in Europe. It is made out of 6 "nodes": Berlin, Eindhoven, Helsinki, Paris, Stockholm and Trento. Each node co-locates essential "local" partners.

Box 10: ICT Labs network members

As example, the Berlin Node consists of six core partners (Deutsche Telekom AG, Siemens AG, SAP AG, Fraunhofer Gesellschaft e.V., DFKI gGmbH and TU Berlin) plus six affiliate partners: Max Planck Institute for Informatics, Saarland University, TU Darmstadt - Center for Advanced Security Research Darmstadt (CASED), TU München, Karlsruhe Institute of Technology (KIT) and EICT GmbH.

The co-location has a strong focus on innovation and is well connected with education and research activities with a visible record in European projects. The direct integration of leading VCs, like Investment Bank Berlin (IBB) and industry-driven VCs from Deutsche Telekom and Siemens is of particular importance. Berlin forms an avant-garde hotspot for design, culture and innovations integrating media, art, and services in a multidisciplinary way.

Systematic university-industry collaboration and integration with leading research institutes is well established practice for stakeholders in the Berlin Co-location Centre. Public Private Partnerships (PPP) like Deutsche Telekom Laboratories (T-Labs), DFKI, and EICT provide well-running examples to further build upon. In education, Berlin has established a track record for new, truly multidisciplinary education programmes integrating universities from the Berlin area to form a joint virtual university.

Being among the leading R&D and economic hubs in European ICT, partners in the Munich region reinforce the Berlin Node. This affiliated hotspot includes Siemens ICT corporate research and Technische Universität München with its associated institutes CDTM, UnternehmerTUM, and fortiss – strong partners in entrepreneurial education and innovation centres for cyber-physical systems.

vii). Innovation-led clusters, Economist Intelligence Unit, December 2011 [126]

This media report casts a spotlight on new ideas and common factors in the success of cluster initiatives globally. It reviews some of the practices and ideas being used by clusters around the world. It is an experts' opinion-based report with qualitative information and anecdotal evidence.

[126] Article: Fostering innovation-led clusters. A review of leading global practices (Economist Intelligence Unit, December 2011). This presentation if fully based on the original document. Available at: http://www.managementthinking.eiu.com/sites/default/files/downloads/EIU-ATIC_Report2_Web_Revised.pdf

Box 11: Summary of the key findings

Government has a crucial role to play; so does the market. Although many advocate a wholly "bottom-up" approach to cluster development, it is clear that many clusters have succeeded on the back of government intervention. What is difficult to get right is the scale and type of support: a heavy hand can stifle progress, while too little intervention can lead to a lack of vital support. But while some clusters might work without government backing, none will work without market forces.

Clusters are about collaboration, not just locating firms in the same place. Although innovation networks are increasingly globalised, nearly all experts agree that ideas flow fastest in a local community. As such, a key part of cluster development is fostering such collaboration, especially in countries where this has not been part of the local business culture.

Talent is the single most important factor in developing successful clusters. A government's overarching aim should be to develop a continuous supply of workers with world-class skills. A related focus should be on encouraging the inward migration of talent from around the world. Attracting a star name in a given field can be a crucial catalyst.

Governments need to work to promote a culture of innovation and entrepreneurship. This is especially vital in countries where either the state or state-owned firms are seen as the primary pathways to success. It is also important to create a culture that tolerates different opinions, creativity and risk-taking.

Clusters work best when they are focused and can compete. Many successful clusters are highly specialised: Once a specific focus emerges, governments need to identify it, and then work to remove any barriers to competition.

Governments can do much to create an attractive business environment—and a good place to live. Easing planning rules, tweaking the tax code, removing penalties for failure, smoothing visa and immigration processes, ensuring intellectual property (IP) protection—there is much a government can and must do to support cluster development. What shouldn't be forgotten is the importance of also ensuring a good quality of life for prospective employees, to support efforts to attract and retain talent.

A strong local market will help attract R&D investment, but is not crucial for global success. Some clusters have succeeded in spite of the absence of a significant local market, as firms are forced to think globally from the outset. But from an R&D perspective, the relative sophistication of local demand is more important than the quantity.

viii). Europe is on fire (WIRED 2011, Issue 9)[127]

This media article, published in the well-known WIRED magazine, focuses on metropolitan areas where it estimates innovation is happening: Stockholm, Paris, London, Moscow, Tel-Aviv (Seen as Europe!). While the metropolitan focus is in line with an expectable framing of such inventory,, the methodology, if any, is entirely based on the anecdotal evidence of long-standing or emerging start-ups.

The result is by far from being original. Still it usefully reminds us of the necessity for observing start-ups, spin-offs, and the overall ICT companies churn as a signal of creative destruction in a region.

[127] See at: http://www.wired.co.uk/magazine/archive/2011/09

2.5 A synthetic review of the empirical studies

A synthetic review, presented in the table below, of all the empirical studies[128] mapping business and/or innovation (ICT) activities demonstrates that none would cover our focus of interest: the European ICT Poles of Excellence.

Such observation comes in contrasts with the richness of the conceptual literature reviewed in Sections 2.1 and 2.2, a literature that acknowledges the existence of rather consensual definitions (Clusters, ICT sector, Innovation systems, etc.) and underlines the important transformations resulting from the internationalisation and the networking of the economic activities. This contrast probably results from the scarcity of the necessary data to develop empirical studies that would implement and test the conclusions of these conceptual frameworks.

In particular, there is only scarce data when it comes to systematically analyse Europe-wide regional and sub-regional areas, the location of ICT-specific activities or their nature (i.e. R&D related). Furthermore, methods and indicators for measuring processes, such as internationalisation or global networking, are still under development in this decade.

The absence of such metrics and data will become the major challenge of the EIPE project. Using often proprietary data and developing new indicators will be centre-stage to the EIPE study, while exploiting when available, existing and validated methods for processing data.

The next page offers a synthetic review of the empirical studies, by simply identifying the presence or absence in those 16 studies of those aspects that were seen as essential in the conceptual framework for EIPE.

Those aspects are the following:

- geographical coverage of the whole EU-27; Regional approach (NUTS2 or lower),
- ICT-sector specific,
- assess the production and the knowledge (R&D and Innovation) functions,
- assess the vitality of three processes: Agglomeration, Internationalisation and Global networking.

Out of a total of 16 empirical studies published since 2000 and reviewed in the earlier Sections 2.3.1 and 2.3.2, we find that:

- less than half offer an acceptable geographic coverage or are ICT –sector specific.
- less than half propose any approach to internationalisation of global networking.

Better is the empirical approach to aspects such as Agglomeration (10 out of 16), or the production/knowledge functions (up to 14 out of 16 for the production).

This gives some indication of the difficulties ahead for the methodological development of EIPE, in terms of indicators development and data availability.

[128] We do not present here the labelling cases of Section 2.4.

Table 3: Synthetic review of the empirical literature

A. Empirical approaches to (ICT) business activities										
Authors	**Short title**	**Date**	**Regional coverage**	**ICT-specific**	**Production**	**R&D**	**Innovation**	**Agglomeration**	**Internationalisation**	**Global Networking**
Stockholm School of Economics	European Cluster Observatory	2012	EU 27 NUTS2	NO	YES	NO	NO	YES	NO	NO
Stockholm School of Economics	European specialisation data by region	2011	EU27. NUTS2	NO	YES	NO	NO	YES	NO	NO
Maier et al	Regional selection Report and empirical approach	2010	18 NUTS2 regions	YES.	YES	NO	YES	YES	NO	NO
Barrios, Mas, Navajas, Quesada	Mapping the ICT in EU Regions	2008	EU27 <NUTS2	YES	YES	YES	YES	YES	YES	NO
Karlsson, Melander, Paulsson	Spatial ICT Clusters in Sweden	2004	81 "Functional" regions of Sweden	YES	YES	NO	NO	YES	NO	YES
Koski, Rouvinen, Ila-Antilla	ICT clusters in Europe	2001	EU15, Japan, USA. National levels	YES	YES	YES	YES	YES	YES	NO
Harvard Business School	Clusters of Innovation	2001	USA	NO	YES	YES	YES	YES	NO	YES
B. Empirical approaches to (ICT-related) innovative activities										
Authors	**Short title**	**Date**	**Regional coverage**	**ICT-specific**	**Production**	**R&D**	**Innovation**	**Agglomeration**	**Internationalisation**	**Global Networking**
MERIT-JRC	Innovation Union Scoreboard 2011 (EIS)	2012	EU27, MS	NO	NO	YES	YES	NO	YES	YES
Stockholm School of Economics	Strong clusters in innovative regions	2011	EU27. NUTS2	YES	YES	YES	YES	YES	YES	NO
Malerba et al	Trends and Evolution of the EU ICT R&D landscape	2010	EU27. 6 selected NUTS2 regions	YES	YES	YES	YES	NO	YES	YES
World Economic Forum - Mc Kinsey	Innovation Heat Map IHM		World at nation and cities level	NO	YES	YES	YES	YES.	NO	NO
ITIF	The Atlantic Century II	2011	WORLD, countries (EU27 taken as a whole)	NO	YES	YES	YES	NO	YES	NO
MERIT-JRC	Regional Innovation Scoreboard 2009	2009	EU27, NUTS2	NO	NO	YES	YES	NO		
DG REGIO	ESPON project	2007	EU27, NUTS 2, urban, etc	NO	YES	NO	YES	NO	NO	NO
US Dpt of Commerce, EDA	Strategic Planning in the Technology-driven World	2001 2005	USA. Local level	NO	YES	YES	YES	YES	YES	NO
Cortright, Mayer	High Tech Specialization: A Comparison of Technology Centers.	2001	14 hitech metropolitan areas	YES	YES	NO	YES	NO	NO	NO

3. Definition of European ICT poles of world-class excellence

The EIPE study aims to identify ICT R&D&I-related agglomeration economies that demonstrate world-level excellence, and also the signals that point to a changing ICT-related economic geography in Europe. Both of these identification processes are based on quantitative data, built on a set of relevant criteria leading to measurable indicators.

This undertaking needed to be rooted in the vast body of scientific literature that has described and analysed for almost a century[129] the spatial concentration of economic activities and, more recently, knowledge-intensive and ICT-related activities, at local and global levels.

Within the EIPE study tasks, whose results are presented in a series of IPTS working papers,[130] this Working Paper synthesises the conceptual and empirical literature that has been reviewed during the study. It summarises the most prominent concepts discussed in the relevant literature as well as the methods used in the corresponding empirical studies and leads to a definition of European ICT Poles of Excellence that will guide the later work.

The increasing globalization of economic activity on the one hand, and the pervasive role of knowledge in the economy on the other, are widely affecting the spatial distribution of economic activity. These changes in the spatial distribution of economic activities are evident both in the changing role of countries and in the emergence of different productive realities within countries. While production of both goods and services becomes more transnational, activities which have higher knowledge intensity show a tendency to concentrate and cluster (Dunning 2002).

In particular, analysts observe parallel, yet opposite, forces towards the geographical redistribution of economic and knowledge-intensive activities, and the concentration and clustering of these activities in limited spatial areas or regions. This has been referred to as the paradox of 'sticky places within a slippery space' (Markusen 1996; Dunning 2002).

The concept of European ICT Poles of Excellence in this context can be interpreted and used in many different ways, as we have seen in the earlier pages. In order to define what EIPE are, the following four-step investigation strategy has been pursued in this report:

- First, this report has taken into account the theoretical literature related to agglomeration economies (Section 2.1). This review has allowed us to introduce the essential features of clustering, internationalisation and networking into our conceptual and methodological framework.
- Second, the theoretical literature on the role of ICT in regional dynamics (Section 2.2) has also been investigated, offering important insights into the impacts of general purpose technologies on the economy and on regional knowledge dynamics.
- Third, existing European and non-European empirical efforts (Section 2.3) have been investigated in order to compare their objectives, scope, assumptions and methods. Many of these exercises are explicitly or implicitly embedded in the cluster theory and focus on industrial production activity, some expand their analysis towards

[129] Starting in particular with Marshal and Weber in the conceptualisation of industrial districts.

[130] Forthcoming. These will be available, when authorised for publication, at: http://is.jrc.ec.europa.eu/pages/ISG/EIPE.html

innovation-related activities, and only a handful integrate the insights of network analysis.

- Finally, a brief review of miscellaneous attempts to label businesses, regions or industrial agglomerations as "excellent" or "innovative" (Section 2.4) have been explored for the sake of exhaustiveness. They offer a range of common sense approaches to excellence and innovation that help to position these words in business and media use.
- All of the above approaches offer numerous indications of methods and indicators, as well as locations, all being useful checkpoints at further stages of this study. The later EIPE working papers will again contrast their approach and results with these works.

The definition of European ICT Poles of World-Class Excellence (EIPE) proposed by this report is meant to reflect and put together the main concepts and models emerging from this vast academic and non-academic literature as well as from policy initiatives.

It also aims to differentiate the concept of Poles of Excellence, as researched here, from neighbouring concepts such as those of clusters, innovative regions or centres of excellence to name a few. It is clear that none of these terms, be they theoretically or empirically founded, have met fully the requirements and specificity which this study has determined for a location to be considered a European ICT Pole of Excellence.

In particular, after reviewing the literature, we consider that a European ICT pole of Excellence needs to clearly demonstrate better performance in the business and the knowledge functions, both of which must be characterised by strong and observable agglomeration, internationalisation and global networking.

This view overlaps with the concept of industrial clusters, but it broadens the perspective on several essential points:

- by expanding the scope of industrial activities from business (production) to knowledge-related activities (R&D and Innovation), acknowledging hence the importance of the knowledge function in the phenomenon that this study aims to observe, and that of its performance in both functions.
- by incorporating a global perspective of the internationalisation of activities that sets these activities in their true global environment, in order to assess this aspect of their performance.
- by putting an additional emphasis on the network position of specific individual agglomerations, the centrality of an individual cluster or location in a network being taken as a measure of its strategic role in the global landscape of economic and R&D&I activities.[131]

In addition, the definition is technology specific: it focuses on the ICT industry. Nevertheless, the definition does not embark on sub-sector-level observations as suggested by some authors. Considering the large amount of recent literature on the evolving ICT industrial ecosystem - the strong and factual interdependence between the various sub-sectors

[131] Several authors consider that this central position gives access and control over resources or information that are crucial for the overall activity of an industry or a market (Becker 1970; Powell, Koput et al. 1996; Nepelski and De Prato 2012).

within an innovation trajectory[132] - we consider this focus rather as an ex-post insight to embed in our later observations (case studies). We do not take the analysis of ICT sub-sector levels as an ex-ante criterion for searching for EIPEs with quantitative indicators. Importantly, we will need to check – and if necessary adapt – for a potential bias towards specific subsector activities.[133] In essence, we do not consider that subsector specificities define EIPEs.

Similarly, we leave for secondary analysis (case studies) the use of ICT as a General Purpose Technology (GPT), which enables innovation in the rest of the economy. This may, and probably will, appear as an explanatory factor of agglomeration, illustrating the debate about industrially homogeneous and heterogeneous clustering for this specific industry. GPT certainly offer the potential for heterogeneous agglomerations to develop.

Hence, in contrast to the approaches and definitions found in the literature review, we propose the following definition of EIPE:

> *European ICT Poles of World-Class Excellence (EIPE) are geographical agglomerations of best performing Information and Communication Technologies production, R&D and innovation activities, located in the European Union, which play a central role in global international networks.*

This definition needs now to be made operational, by investigating, partly on the basis of the above literature, the indicators and measurements that could identify and locate EIPE in Europe on the basis of a set of quantitative observations.

This will be the subject of EIPE Working Paper 2 entitled "Measurements: data sources, methods, indicators".

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[132] Apple's iPhone is often cited as a paradigmatic case of an ICT integrated ecosystem, as it is a hardware company producing telecom equipment whose main sources of revenue are related to software (apps) and content production.

[133] Typically, ICT Manufacturing R&D activities are several times more intensive (BERD/VA) than the equivalent activities in the ICT Services sub sector. This difference might affect the interpretation of quantitative indicators, if not taken into account.

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Annex 1: The EIPE study objectives

The European ICT Poles of Excellence study has two main objectives:

1. **Develop a methodology and tool for EIPE identification and analysis.** Such objective encompasses the need for a conceptual definition, which also includes a robust understanding of the conditions or characteristics of EIPE, a quantitative tool and a method allowing the identification.

   Hence, in detail, the intermediary tasks leading to the creation of a methodology and tool for EIPE identification and analysis include the following:

   - **Define EIPE**: As there is no ready available definition of EIPE, one of the project tasks will frame the concept of EIPE within existing concepts of aggregation, concentration and performance measurement of R&D&I and business activity. This will result in a definition of EIPE. (Del 1)
   - **Identify EIPE characteristics and corresponding indicators**: There are numerous advantages to the use of metrics to assess excellence and performance of innovation or business activity. However, most of the commonly used qualitative indicators suffer from serious quality drawbacks themselves. Consequently, in search for excellence, it is necessary to use a combination of indicators and account not only for the quantity of the measures but also for the quality of the information used. This motivates the search for a set of indicators characterising EIPE. (Del 2)
   - **Synthesise information through indicators, composite indicators and rakings**: In order to synthesise the information contained in the indicators collected and presented above, two composite indicators will be constructed for the identification of existing and emerging EIPE. (Del 3)
   - **Collect and harmonize data and develop a database** (Del 4)
   - **Develop dynamic online visualization tools**: In order to enable an easy access to the comprehensive source of information and collected data, this project will make use of a dynamic online visualisation tool. (Del 5)
2. **Identify and analyse existing and emerging EIPE**. In order to achieve this objective, the methodological tool described above together with the data collected in the course of the project will be used. (Del 6)

Annex 2: EIPE study research questions, methodology and major outputs

The EIPE study has a set of first-layer research questions that constitute building blocks of the workflow of the study. These questions together with a description of the methodology and research outputs are described below:

RQ 1: What is an ICT Pole of Excellence?

Methodology:

1.1 Covering an initial thorough literature review as to position the concept in contrast to usually explored ones such as that of industrial districts, clusters or R&D and business innovation and business networks,

1.2 Reviewing case study literature analysing the existing locations of intense ICT activity,

1.3 Taking in account existing Commission's and non-EC similar efforts such as DG ENTR Cluster Observatory, the Regional Innovation Scoreboard, the US-based HBS Cluster mapping project and reporting their results with respect to the existing locations of intense ICT activity.

Outputs:

1.1 Review of literature on industrial districts, clusters or R&D and business networks,

1.2 Dataset with a list of existing locations of intense ICT activity identified through the review of case studies and existing initiatives,

1.3 Definition of EIPE.

RQ 2: What are the salient characteristics and the corresponding quantitative indicators of existing and emerging EIPE?

Methodology:

2.1 Selecting a limited set of observable indicators based on the concepts identified and discussed in the earlier task and the definition (output 1.3), with a specific focus on issues such as those of specialisation, scale, growth and R&D&I and economic activity and the dynamics of EIPE,

2.2 Synthesising the above described set of observable indicators in two ways:

2.2.1 Constructing an indicator of *existing* EIPE that will be composed of R&D&I and economic activity pillars and will aim at identifying existing poles of excellence.

2.2.2 Constructing an indicator of *emerging* EIPE that will be composed of the R&D&I and economic activity pillars and will aim at measuring the growth in the relevant areas and signalling the emergence of EIPE.

Outputs:

2.1 Set of observable indicators of *existing* EIPE,

2.2 Composite indicator of *existing* EIPE,

2.3 Set of observable indicators of *emerging* EIPE,

2.4 Composite indicator of *emerging* EIPE.

RQ 3: What are the current EIPE?

Methodology:

3.1 Identifying and listing the current EIPE on the basis of the quantitative indicators identified above and offer one or several hierarchised lists of EIPE. As different lists will result from different selection or weight given to indicators, they will be commented in terms that will clarify the choices established in the initial logic of each list as well as their comparison across lists.

3.2 Identifying and listing the existing EIPE on the basis of the composite indicator defined in output 2.2.

Outputs:

3.1 Operational lists of existing EIPE based on selected indicators defined in output 2.1,

3.2 Operational list of existing EIPE based on the composite indicator of existing EIPE defined in output 2.2.

RQ 4: What are the emerging EIPE?

Methodology:

4.1 Identifying and listing the emerging EIPE on the basis of the quantitative indicators defined in output 2.3.

4.2 Identifying and listing the emerging EIPE on the basis of the composite indicator defined in output 2.4.

Outputs:

4.1 Operational lists of emerging EIPE based on selected indicators defined in output 2.3,

4.2 Operational list of emerging EIPE based on the composite indicator of emerging EIPE defined in output 2.4.

RQ 5: What are the lessons learned from the analysis of the identified EIPE and how can the methodology and tool for EIPE identification and analysis be improved?

Methodology:

5.1 Issuing second-layer research questions and hypotheses to be investigated related to such issues as public/private R&D funding, EIPE lifecycle, companies growth.

5.2 Selecting a short list of EIPE for further analysis, taking in account explicit selection criteria. The selection will be finalised in direct collaboration with INFSO representatives and 5 EIPE will be selected for further study on the basis of agreed and explicit criteria.

5.3 Drawing conclusions from the case study analysis with respect to the improvement of the methodology and tool for EIPE identification and analysis.

Outputs:

5.1 Second-layer research questions concerning further analysis of selected characteristics of EIPE,

5.2 5 case studies on EIPE,

5.3 Recommendations for improving the methodology and tool for EIPE identification and analysis.

Annex 3: Measures used in the "Clusters of Innovation" report (Harvard Business School, USA)

Source: The Clusters of Innovation report (Harvard Business School – Council on Competitivenress, USA)

Information downloaded from: http://www.compete.monitor.com/App_Themes/MRCCorpSite_v1/DownloadFiles/A.%20%20National%20Report.pdf)

OUTPUT MEASURES

Measure	Definition	Calculation	Source
Employment	Number of persons employed per MSA/cluster	Sum of employment in all counties constituting the Metropolitan Statistical Area (MSA)	County Business Pattern Data on 4-digit Standard Industrial Classification (SIC) industries per county
Wages	Payroll of region/cluster per employed in MSA/cluster	Total payroll dived by total employment per region/cluster; calculated as employment weighted average of wages per county (for region) or industry (for cluster)	County Business Pattern Data on 4-digit SIC industries per county
Productivity	Value of shipment per employee in MSA/cluster	First, NAICS-based shipment data is transformed to SIC codes using the bridging methodology provided by the 1997 Economic Census. The weights of each NAICS code assigned to a SIC industry are based on the proportions of total sales/ receipts/shipments each NAICS accounts for that SIC code. However, this transformation does not generate data for all industries defined in the SIC code. Also, some data is suppressed to avoid disclosing individual company data. Second, the value of total industry shipments is divided by total industry employment. Of the 720 SIC industries listed, information is available for 110 industries.	Census Bureau Shipment Data; County Business Pattern Data on 4-digit SIC industries per county

OUTPUT MEASURES (Continued)

Measure	Definition	Calculation	Source
Exports	Value of manufacturing and non-manufacturing commodity exports per industry and MSA	Direct use of data.	U.S. Department of Commerce's International Trade Administration data on the two-digit SIC level

INNOVATION MEASURES

Measure	Definition	Calculation	Source
Patents	Number of patents registered per MSA/cluster	Direct use of data for MSAs. For clusters, we need to distribute the aggregate number of regional patents to individual industries.	Commerce Department data on patents per MSA
Venture Capital Investments	Value of Venture Capital Investment per MSA/cluster	Direct use of data	PriceWaterhouse-Cooper's Money Tree Database
Fast Growth Firms	Number of companies on Inc. 500 list and/or Gazelle-type company per MSA	Direct use of data Inc. Magazine lists companies by sales growth. "Gazelle"-firms are defined by employment growth above 100% over four years	Inc. Magazine Top 500 list of high-growth companies Cognetics "Gazelle" companies' list
Initial Public Offerings	Number of IPOs per MSA	Direct use of data	Hoover's IPO Central.com

COMMON BUSINESS ENVIRONMENT MEASURES

Measure	Definition	Calculation	Source
Basic research	Federal funds for research universities per MSA	Direct use of data	National Science Foundation WebCASPAR Database System
Skills of workforce	Number of employees per skill and MSA	Direct use of data: Number of scientists / engineers, technicians in scientific and engineering fields, managers and professionals, and science and technology graduates in the regional workforce	US Bureau of Labor Statistics, Occupational Employment Statistics
Education	Expenditure and performance per student and MSA	Direct use of data: High school graduation rates, student/teach ratios, average expenditures per student, and SAT scores	California Department of Education, National Center for Education Statistics
Physical infrastructure	Transportation System, Communications System, Utilities	Direct use of data	Texas Transportation Institute Annual Mobility Report, Clusters of Innovation Initiative Regional Survey Data, Secondary Sources
Supply of Risk Capital	Size of local venture capital industry	Direct use of data: Number of local venture capital firms, and total funds management by local venture capital firms	Alternative Assets
Quality of Life		Direct use of data: Cost of housing, and level of traffic congestion	Clusters of Innovation Initiative Regional Survey Data, Secondary Sources

CLUSTER-SPECIFIC BUSINESS ENVIRONMENT MEASURES

Measure	Calculation	Source
Specialized research centers	Direct use of average questionnaire response: How available are local research centers to use by private firms, and how frequently do they transfer technology and knowledge to the private sector?	Clusters of Innovation Initiative Regional Survey, and interviews
Specialized talent base	Direct use of average questionnaire response: Is there a sufficient number of qualified scientists, researchers, technicians, and business managers to sustain and grow companies in the region?	Clusters of Innovation Initiative Regional Survey, and interviews
Specialized training	Direct use of average questionnaire response: Do local institutions supply a sufficient number of qualified scientists, researchers, technicians, and business managers, and will this improve or worsen in the future?	Clusters of Innovation Initiative Regional Survey, and interviews
Sophistication of demand	Direct use of average questionnaire response: Are local customers sophisticated in their demand for new and better products, and do companies receive regular feedback from these customers?	Clusters of Innovation Initiative Regional Survey, and interviews
Intensity of rivalry	Direct use of average questionnaire response: How many local rivals are there in your cluster, and would you characterize competition as more intense or more mild?	Clusters of Innovation Initiative Regional Survey, and interviews
Degree of cooperation	Direct use of average questionnaire response: Do firms share knowledge with each other, and do they consistently contribute to cluster-wide projects and initiatives?	Clusters of Innovation Initiative Regional Survey, and interviews
Related and supporting	Direct use of average questionnaire response: What is the quality of local suppliers and supporting industries, how frequently do firms source from outside the region, and how much feedback to related industries give on improving products and processes?	Clusters of Innovation Initiative Regional Survey, and interviews

Annex 4: Authors of the "Clusters of Innovation" report (Harvard Business School, USA)

Source: The Clusters of Innovation report (Harvard Business School – Council on Competitiveness, USA)

Information downloaded from:

http://www.compete.monitor.com/App_Themes/MRCCorpSite_v1/DownloadFiles/A.%20%20National%20Report.pdf)

Authors:

Michael E. Porter is Professor at the Harvard Business School and a leading authority on competitive strategy and international competitiveness. He co-chairs the Clusters of Innovation Initiative at the Council on Competitiveness and is a member of the Council's executive committee.

The author of 16 books and over 75 articles, Professor Porter's ideas have guided economic policy throughout the world. Professor Porter has led competitiveness initiatives in nations and states such as Canada, India, New Zealand, and Connecticut; guides regional projects in Central America and the Middle East; and is co-chairman of the Global Competitiveness Report. In 1994, Professor Porter founded the Initiative for a Competitive Inner City, a non-profit private sector initiative formed to catalyze business development in distressed inner cities across the United States. The holder of eight honorary doctorates, Professor Porter has won numerous awards for his books, articles, public service, and influence on several fields.

The Council of Competitiveness: The Council is a non-profit, 501(c)(3) organization whose members are corporate chief executives, university presidents, and labour leaders dedicated to setting an action agenda to drive U.S. economic competitiveness and leadership in world markets. The Council helps shape the national debate on competitiveness by concentrating on a few critical issues including technological innovation, workforce development, and the benchmarking of U.S. economic performance against other countries.

The Council's work is guided by a 30 member executive committee. Chief executives of 40 of the country's most prominent non-profit research organizations, professional societies and trade associations contribute their expertise as national affiliates of the Council.

Monitor Group is a family of competitive service firms linked by shared ownership, management philosophy, and inter-related assets. Each entity in the Group is dedicated to providing products and services which fundamentally enhance the competitiveness of our clients. Our aspiration is to operate as an "intelligent switch" in a closely-linked global network of expertise and experience, not merely as a narrowly defined consulting firm, a research company or a merchant bank. We are dedicated to creating innovative, winning, action-oriented solutions by deploying our human, knowledge, and social assets in

unique combinations dictated by each client's unique circumstances—consulting interventions, capital infusions, deal structuring, management development programs, customized software, cutting-edge market research, and so on as appropriate.

Monitor Group is organized into three major operating units:

- **Monitor Action Group**, which consults to top management to help resolve their most important and intractable competitive problems;
- **The Monitor Merchant Banking Group**, which marries capital investment with advisory services to enhance company competitiveness;
- **The Intelligent Products Group**, which provides customized data and software products to support competitive decision making.

ontheFRONTIER, a Monitor Group company, has extensive experience in competitiveness assessment and cluster development projects throughout the United States and the world. Our private and public sector client base spans over twenty countries in North and South America, Europe, Asia, Africa and the Middle East. In addition, we have collaborated extensively with development agencies such as the World Bank Group and the United States Agency for International Development (USAID) on microeconomic development issues.

ontheFRONTIER's work focuses on improving business competitiveness through building winning strategies, fostering cooperation among clusters of firms, and facilitating productive dialogue between private and public sector leaders to promote innovation. Our vast network of partners forms the basis of our collaborative effort to diffuse a new web-based set of offerings. We are working with financial institutions, industry associations, multilateral agencies, and others to diffuse web-based business strategy tools and insights to businesspeople around the world.

Annex 5: List of questions from Karlsson et al., 2010

1. Economic performance

- What is the economic growth performance of the region between 1995 and 2005 (or comparable recent period)?

2. ICT profile (ICT related structure and structural changes)

- Are there specific strengths in ICT-production (hardware, software), or in ICT- use in the region?
- What is the level of e-readiness in the region (indicators)?
- Are there specific strength in ICT-use in firms and between firms in the region?
- Are there any significant changes in the organisation of economic activity both within and between firms and/or changes in organisation of markets both final and intermediate product and services markets due to ICT use in the region?

3. Regional innovation system

- What are the most important institutions of knowledge generation and diffusion in the region (universities, research institutes, dominant knowledge producing companies, etc.)?
- What are the most important institutions of knowledge exploitation in the region (dominant firms and clusters of firms)?
- To what extent are these institutions (knowledge generation and knowledge exploitation) focused on ICT?

Annex 6: Indicators for the European Innovation Scoreboard (MERIT – JRC-IPSC)

Source: European Innovation Scoreboard 2009 and 2011 – Methodology reports

ENABLERS

• Human resources

- S&E and SSH graduates
- S&E and SSH doctorate graduates
- Tertiary education
- Life-long learning
- Youth education

• Finance and support

- 1.2.1 Public R&D expenditures
- 1.2.2 Venture capital
- 1.2.3 Private credit
- 1.2.4 Broadband access by firms Broadband access by households (2006)

FIRM ACTIVITIES

• Firm investments

- 2.1.1 Business R&D expenditures
- 2.1.2 IT expenditures
- 2.1.3 Non-R&D innovation expenditures

• Linkages & entrepreneurship

- 2.2.1 SMEs innovating in-house Eurostat
- 2.2.2 Innovative SMEs collaborating with others
- 2.2.3 Firm renewal (SMEs entries + exits)
- 2.2.4 Public-private co-publications

• Throughputs

- 2.3.1 EPO patents
- 2.3.2 Community trademarks
- 2.3.3 Community designs

OUTPUTS

- Innovators
  - 3.1.1 Product and/or process innovators
  - 3.1.2 Marketing and/or organisational innovators
  - 3.1.3 Resource efficiency innovators
  - 3.1.3a Reduced labour costs
  - 3.1.3b Reduced use of materials and energy
- Economic effects
  - 3.2.1 Employment in medium-high & high-tech manufacturing
  - 3.2.2 Employment in knowledge-intensive services
  - 3.2.3 Medium and high-tech exports
  - 3.2.4 Knowledge-intensive services exports
  - 3.2.5 New-to-market sales
  - 3.2.6 New-to-firm sales
  - 3.2.7 Technology Balance of Payments flows

Table 4: Dimensions, indicators and sources for the Innovation Scoreboard 2011

ENABLERS		
Human resources		
1.1.1 New doctorate graduates (ISCED 6) per 1000 population aged 25-34	Eurostat	2005 – 2009
1.1.2 Percentage population aged 30-34 having completed tertiary education	Eurostat	2006 – 2010
1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education	Eurostat	2006 – 2010
Open, excellent and attractive research systems		
1.2.1 International scientific co-publications per million population	Science-Metrix / Scopus	2006 – 2010
1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	Science-Metrix / Scopus	2003 – 2007
1.2.3 Non-EU doctorate students [1] as a % of all doctorate students	Eurostat	2005 – 2009
Finance and support		
1.3.1 R&D expenditure in the public sector as % of GDP	Eurostat	2006 – 2010
1.3.2 Venture capital (early stage, expansion and replacement) as % of GDP[2]	Eurostat	2006 – 2010
FIRM ACTIVITIES		
Firm investments		
2.1.1 R&D expenditure in the business sector as % of GDP	Eurostat	2006 – 2010
2.1.2 Non-R&D innovation expenditures as % of turnover	Eurostat	2004, 2006, 2008
Linkages & entrepreneurship		
2.2.1 SMEs innovating in-house as % of SMEs	Eurostat	2004, 2006, 2008
2.2.2 Innovative SMEs collaborating with others as % of SMEs	Eurostat	2004, 2006, 2008
2.2.3 Public-private co-publications per million population	CWTS / Thomson Reuters	2004 – 2008
Intellectual assets		

2.3.1 PCT patents applications per billion GDP (in PPS€)	Eurostat	2004 – 2008
2.3.2 PCT patent applications in societal challenges per billion GDP (in PPS€) (climate change mitigation; health)	OECD / Eurostat	2004 – 2008
2.3.3 Community trademarks per billion GDP (in PPS€)	OHIM / Eurostat	2006 – 2010
2.3.4 Community designs per billion GDP (in PPS€)	OHIM / Eurostat	2006 – 2010
OUTPUTS		
Innovators		
3.1.1 SMEs introducing product or process innovations as % of SMEs	Eurostat	2004, 2006, 2008
3.1.2 SMEs introducing marketing or organisational innovations as % of SMEs	Eurostat	2004, 2006, 2008
3.1.3 High-growth innovative firms	N/A	N/A
Economic effects		
3.2.1 Employment in knowledge-intensive activities (manufacturing and services) as % of total employment	Eurostat	2008 – 2010
3.2.2 Medium and high-tech product exports as % total product exports	UN / Eurostat	2006 – 2010
3.2.3 Knowledge-intensive services exports as % total service exports	UN / Eurostat	2005 – 2009
3.2.4 Sales of new to market and new to firm innovations as % of turnover	Eurostat	2004, 2006, 2008
3.2.5 License and patent revenues from abroad as % of GDP		

Method: The Summary Innovation Index in the EIS – A composite indicator for national innovation performance

The overall innovation performance of each country has been summarized in a composite indicator (the Summary Innovation Index). The methodology used for calculating this composite innovation indicator will now be explained in detail.

Step 1: Identifying and replacing outliers

Positive outliers are identified as those relative scores which are higher than the mean plus 2 times the standard deviation (This approach follows Chauvenet's criterion for determining spurious observations).. Negative outliers are identified as those relative scores which are smaller than the mean minus 2 times the standard

deviation. These outliers are replaced by the respective maximum and minimum values observed over all the years and all countries.

Step 2: Setting reference years

For each indicator a reference year is identified based on data availability for all countries (for all countries data availability is at least 75%). For most indicators this reference year will be lagging 1 or 2 years behind the year to which the IUS refers. Thus for the IUS 2011 the reference year will be 2009 or 2010 for most indicators (cf. Table 1).

Step 3: Imputing for missing values

Reference year data are then used for "2011", etc. If data for a year-in-between is not available we substitute with the value for the previous. If data are not available at the beginning of the time series, we replace missing values with the latest available year. The following examples clarify this step and show how 'missing' data are imputed. If for none of the years data is available no data will be imputed.

Table 5: Imputing missing data

Example 1 (latest year missing)	"2011"	"2010"	"2009"	"2008"	"2007"
Available relative to EU27 score	N/A	150	120	110	105
Use most recent year	**150**	150	120	110	105
Example 2 (year-in-between missing)	"2011"	"2010"	"2009"	"2008"	"2007"
Available relative to EU27 score	150	N/A	120	110	105
Substitute with previous year	150	**120**	120	110	105
Example 3 (beginning-of-period missing)	"2011"	"2010"	"2009"	"2008"	"2007"
Available relative to EU27 score	150	130	120	N/A	N/A
Substitute with latest available year	150	130	120	**120**	**120**

Step 4: Determining Maximum and Minimum scores

The Maximum score is the highest relative score found for the whole time period within all countries excluding positive outliers. Similarly, the Minimum score is the lowest relative score found for the whole time period within all countries excluding negative outliers.

Step 5: Transforming data if data are highly skewed

Most of the indicators are fractional indicators with values between 0% and 100%. Some indicators are unbound indicators, where values are not limited to an upper threshold. These indicators can be highly volatile and can have skewed data distributions (where most countries show low performance levels and a few countries show exceptionally high performance levels). For the following indicators skewness is above 1 and data have been transformed using a square root transformation: Non-EU doctorate students, Venture capital, Public-private co-publications, PCT patents, PCT patents in societal challenges and License and patent revenues from abroad.

Step 6: Calculating re-scaled scores

Re-scaled scores of the relative scores for all years are calculated by first subtracting the Minimum score and then dividing by the difference between the Maximum and Minimum score. The maximum re-scaled score is thus equal to 1 and the minimum re-scaled score is equal to 0. For positive and negative outliers where the value of the relative score is above the Maximum score or below the Minimum score, the re-scaled score is thus set equal to 1 respectively 0.

Step 7: Calculating composite innovation indexes

For each year a composite Summary Innovation Index is calculated as the unweighted average of the re-scaled scores for all indicators.

Annex 7: Strong clusters in innovative regions, Stockholm School of Eco. (2011)

Table 6: Strong Clusters in Innovative Regions

The table lists the 100 3-star clusters that are located in the regions that have the highest innovation rank in RIS.			
Austria			
Region	Sector	Specialisation	Employees
Tirol	Tourism and hospitality	7,75	31 965
Wien	Financial services	2,54	57 873
Wien	**Telecom**	**2,64**	**21 505**
Wien	Transportation and logistics	3,08	63 808
Belgium			
Region	Sector	Specialisation	Employees
Brabant Wallon	Pharmaceuticals	21,96	9 013
Brussels	Financial services	4,16	77 200
West-Vlaanderen	Textiles	7,26	15 767
Czech Republic			
Region	Sector	Specialisation	Employees
Jihozapad	Building fixtures, equipment and services	2,68	18 127
Severovychod	Automotive	3,36	30 191
Severovychod	Building fixtures, equipment and services	2,30	18 884
Severovychod	Textiles	5,44	21 847
Stredni Cechy	Automotive	4,07	28 842
Finland			
Region	Sector	Specialisation	Employees
Etelä-Suomi/Åland	**Telecom**	**2,96**	**27 921**
Länsi-Suomi	Paper products	6,10	17 063
France			
Region	Sector	Specialisation	Employees
Bretagne	Processed food	3,01	64 183
Franche-Comté	Automotive	5,41	21 483
Île de France	Financial services	2,37	341 065
Lorraine	Automotive	2,40	17 878
Midi-Pyrénées	Aerospace	17,55	26 818
Pays de la Loire	Processed food	2,24	57 929
Germany			
Region	Sector	Specialisation	Employees
Arnsberg	Metal manufacturing	4,89	114 532
Arnsberg	Production technology	3,31	35 101
Berlin	Education and knowledge creation	2,37	40 459
Darmstadt	Financial services	2,69	122 165
Detmold	Building fixtures, equipment and services	2,33	18 651

Detmold	Metal manufacturing	2,35	32 947
Detmold	Production technology	3,75	23 767
Düsseldorf	Metal manufacturing	2,47	88 940
Freiburg	Metal manufacturing	3,07	44 880
Freiburg	Production technology	4,56	30 170
Hamburg	Distribution	2,27	21 718
Karlsruhe	Automotive	3,15	39 293
Karlsruhe	**IT**	**3,29**	**28 836**
Karlsruhe	Production technology	4,31	39 011
Kassel	Automotive	3,82	18 420
Mittelfranken	**IT**	**6,03**	**33 814**
Mittelfranken	Production technology	3,70	21 403
Münster	Production technology	3,04	20 878
Niederbayern	Automotive	3,85	16 986
Niedersachsen	Automotive	4,02	124 680
Oberbayern	Automotive	3,95	84 360
Oberbayern	**IT**	**3,35**	**50 338**
Oberfranken	Plastics	5,74	9 659
Schwaben	Production technology	5,17	27 550
Stuttgart	Automotive	5,97	115 385
Stuttgart	Metal manufacturing	2,05	63 664
Stuttgart	Production technology	5,59	78 500
Tübingen	Production technology	7,32	40 789
Unterfranken	Automotive	3,39	17 949
Unterfranken	Production technology	6,13	23 615
Ireland			
Region	Sector	Specialisation	Employees
Ireland	**IT**	**3,43**	**28 498**
Ireland	Tourism and hospitality	2,86	44 427
Italy			
Region	Sector	Specialisation	Employees
Emilia-Romagna	Production technology	3,75	59 026
Friuli-Venezia Giulia	Furniture	7,56	17 210
Lazio	Transportation and logistics	2,02	94 540
Lombardia	Metal manufacturing	2,55	196 188
Marche	Footwear	27,48	31 741
Marche	Metal manufacturing	2,46	27 764
Piemonte	Automotive	3,21	61 098

Piemonte	Metal manufacturing	2,43	74 199
Veneto	Metal manufacturing	2,26	84 596
Lithuania			
Region	Sector	Specialisation	Employees
Lietuva	Building fixtures, equipment and services	2,40	23 035
Lietuva	Construction	2,36	78 304
Lietuva	Processed food	2,00	40 603
Poland			
Region	Sector	Specialisation	Employees
Lodzkie	Apparel	7,69	32 453
Lodzkie	Textiles	6,71	19 606
Mazowieckie	Education and knowledge creation	2,64	48 799
Mazowieckie	**Telecom**	**2,38**	**31 787**
Portugal			
Region	Sector	Specialisation	Employees
Centro	Building fixtures, equipment and services	2,74	23 987
Centro	Construction	2,44	73 592
Lisboa	Business services	2,92	143 322
Slovenia			
Region	Sector	Specialisation	Employees
Slovenija	Metal manufacturing	3,34	45 191
Spain			
Region	Sector	Specialisation	Employees
Castilla y León	Farming and animal husbandry	3,53	30 044
Galicia	Farming and animal husbandry	3,60	33 791
Galicia	Maritime	13,13	40 100
País Vasco	Metal manufacturing	3,15	60 301
Valencia	Distribution	2,29	54 166
Sweden			
Region	Sector	Specialisation	Employees
Norra Mellansverige	Paper products	7,71	11 665
Stockholm	Business services	2,91	67 485
Stockholm	**IT**	**4,23**	**25 206**
Stockholm	**Telecom**	**3,17**	**24 002**
Västsverige	Automotive	6,35	41 397
United Kingdom			
Region	Sector	Specialisation	Employees
Beds and Herts	Business services	2,31	60 947
Berks, Bucks and Oxon	Business services	2,44	95 295
Berks, Bucks and Oxon	Education and knowledge creation	3,32	58 363
Berks, Bucks and Oxon	**IT**	**3,01**	**30 184**

E Anglia	Education and knowledge creation	2,36	36 276
E Scotland	Education and knowledge creation	2,39	34 416
E Scotland	Financial services	2,05	59 747
Hants and Isle of Wight	Business services	2,10	62 199
Inner London	Business services	2,59	219 044
Inner London	Education and knowledge creation	2,35	89 444
Inner London	Financial services	3,04	233 734
Inner London	Media and publishing	2,80	76 111
NE Scotland	Oil and gas	25,22	11 792
Outer London	Business services	2,07	122 757
Outer London	Transportation and logistics	2,04	100 707
Surrey, E and W Sussex	Business services	2,02	81 724
W Midlands	Automotive	2,30	35 419
W Yorks	Education and knowledge creation	2,01	31 638

Annex 8: Network analysis methods, Malerba F. et al. (2010)

Source: Malerba F., Vonortas N., Corrocher N., Cusmano L. (2010) Trends and Evolution of the EU ICT Research and Deployment Landscape. Final Report. Bocconi University.

"Following the methodologies of our previous studies, we identify organizations working as Network Hubs. A hub is defined as a node with a large number of connections or, alternatively, as a node that is highly influential by playing the role of network connector, i.e. one which connects nodes that would otherwise remain unconnected. Hubs have an extremely important role in networks as they contribute towards the effective and fast diffusion of knowledge even to the most peripheral nodes of the network. More formally, the notion of network hub can be captured by two indicators:

- degree centrality,
- betweenness centrality.

Degree centrality is defined as the number of lines incident with a node. In the context of this study where nodes represent organizations, degree centrality is therefore defined as the number of other organizations with which the focal organization has a relational tie.

Betweenness centrality is a measure of the influence a node has over the spread of information and knowledge through the network. The basic idea is that a node, which lies on the information path linking two other nodes, is able to exercise a control over the flow of knowledge within the network. Formally, it is defined as the fraction of shortest paths (i.e. the minimum number of lines connecting two nodes) between node pairs that pass through the node of interest. Removing a node with a high betweenness centrality significantly reduces the overall connectivity of the network.

We have calculated degree centrality and betweenness centrality for all organizations and have created a synthetic index by considering jointly the ranking of organizations according to the two indicators. Hubs have been defined as the top 2 per cent of the organizations according to this joint ranking.[134] [135]

Additional information about the connecting role played by network participants is related to the concepts of bi-connected component and articulation point. A bi-connected component is a relatively homogeneous sub-group, in which no entity plays an essential role for the communication among actors. In fact, a bi-connected component is defined as a network subset that does not contain any "articulation point", that is, a subset whose connectivity is robust to the removal of single nodes.[136]

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[134] The two per cent cut-off is obviously arbitrary but this arbitrariness in the cut-off value is hard to avoid in similar exercises. However, we considered different values (both higher and lower than two per cent) in order to check for robustness. The main results are robust to these alternatives, since they are based on the role of some organizations that are found to act as Hubs independently of the chosen value. Alternatively, Hubs could have been defined on the basis of threshold values for centrality. This becomes impractical, however, because of the need to compare across different types of networks of different sizes.

[135] A full list of network hubs is provided in the Technical Annex of the report for each of the networks under investigation.

[136] A generic vertex in of the network is an articulation point if there are two other vertices, j and k, so that every path between them also includes vertex i. Removing the articulation point means "disconnecting" the network, breaking it into smaller components.

Annex 9: Country rankings, ITIF (July 2011)

Ranking of countries in "The Atlantic Century II: Benchmarking EU & U.S. Innovation and Competitiveness"

Overall Rank	Change Rank (1999-2011)
1. Singapore	1. China
2. Finland	2. South Korea
3. Sweden	3. Cyprus
4. United States	4. Slovenia
5. South Korea	5. Estonia
6. United Kingdom	6. Czech Republic
7. Canada	7. Latvia
8. Denmark	8. Singapore
9. NAFTA*	9. EU-10**
10. Netherlands	10. Portugal
11. Japan	11. Hungary
12. Australia	12. Lithuania
13. Belgium	13. India
14. France	14. Austria
15. Ireland	15. Chile
16. Germany	16. Greece
17. Austria	17. Japan
18. EU-15**	18. Slovakia
19. EU-25**	19. Finland
20. Czech Republic	20. Denmark
21. Estonia	21. Australia
22. Hungary	22. Indonesia
23. Spain	23. Ireland
24. Slovenia	24. United Kingdom
25. Portugal	25. Brazil
26. Slovakia	26. Mexico
27. EU-10**	27. Poland

28. Latvia	28. EU-25**
29. Russia	29. Netherlands
30. Italy	30. Turkey
31. Malaysia	31. Spain
32. Lithuania	32. Argentina
33. Chile	33. Russia
34. China	34. Canada
35. Cyprus	35. Malaysia
36. Poland	36. EU-15**
37. Greece	37. France
38. Brazil	38. Germany
39. Turkey	39. Sweden
40. Mexico	40. Belgium
41. South Africa	41. NAFTA*
42. Argentina	42. South Africa
43. India	43. United States
44. Indonesia	44. Italy

* North American Free Trade Agreement region: Canada, Mexico and the United States.

Annex 10: EIS 2009 indicators – definitions and data availability

Source: Regional Innovation Scoreboard 2009 – Methodology report

- **Population with tertiary education per 100 population aged 25-64**

Numerator: Number of persons in age class with some form of post-secondary education (ISCED 5 and 6).

Denominator: The reference population is all age classes between 25 and 64 years inclusive.

Rationale: This is a general indicator of the supply of advanced skills. It is not limited to science and technical fields because the adoption of innovations in many areas, in particular in the service sectors, depends on a wide range of skills. Furthermore, it includes the entire working age population, because future economic growth could require drawing on the non-active fraction of the population. International comparisons of educational levels however are difficult due to large discrepancies in educational systems, access, and the level of attainment that is required to receive a tertiary degree. Differences among countries should be interpreted with caution.

Data source: Eurostat – Data Navigation Tree: Database / General and regional statistics / Regional statistics / Regional science and technology statistics (reg_sct) /

Human Resources in Science and Technology (HRST) (reg_hrst) / Annual data on HRST and sub-groups (NUTS level 0, 1 and 3) (hrst_st_rcat)

Data availability: Good: available for most regions for 2004 and 2006.

- **Participation in life-long learning per 100 population aged 25-64**

Numerator: Number of persons involved in life-long learning. Life-long learning is defined as participation in any type of education or training course during the four weeks prior to the survey. The information collected relates to all education or training whether or not relevant to the respondent's current or possible future job. It includes initial education, further education, continuing or further training, training within the company, apprenticeship, on-the-job training, seminars, distance learning, evening classes, self-learning etc. It includes also courses followed for general interest and may cover all forms of education and training as language, data processing, management, art/culture, and health/medicine courses.

Denominator: The reference population is all age classes between 25 and 64 years inclusive.

Rationale: A central characteristic of a knowledge economy is continual technical development and innovation. Individuals need to continually learn new ideas and skills or to participate in life-long learning. All types of learning are valuable, since it prepares people for “learning to learn”. The ability to learn can then be applied to new tasks with social and economic benefits.

Data source: Eurostat – Data Navigation Tree: Database / General and regional statistics / Regional statistics / Regional labour market statistics (reg_lmk) / Regional socio-demographic labour force statistics – LFS series (reg_lfsd) / Life-long learning – participation of adults aged 25-64 in education and training, at NUTS levels 1 and 2 (1000) (ref_lfsd2plll)

Data availability: Good: Available for most regions for 2004 and 2006.

• Public R&D expenditures (% of GDP)

Numerator: All R&D expenditures in the government sector (GOVERD) and the higher education sector (HERD). Both GOVERD and HERD according to the Frascati-manual definitions, in national currency and current prices.

Denominator: Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.

Rationale: R&D expenditure represents one of the major drivers of economic growth in a knowledge-based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.

Data source: Eurostat – Data Navigation Tree: Database / General and regional statistics / Regional statistics / Regional science and technology statistics (reg_sct) / R&D expenditure and personnel (reg_rd) / Total intramural R&D expenditure (GERD) by sectors of performance and region (RD_E_gerdreg)

Data availability: Good: available for most regions for 2004 and 2006.

• Broadband access

Numerator: Number of households with broadband access.

Denominator: Total number of households.

Rationale: Realising Europe's full e-potential depends on creating the conditions for electronic commerce and the Internet to flourish. This indicator captures the relative use of this e-potential by the number of households that have access to broadband.

Data source: Eurostat

Data availability: Good: available for most regions for 2004 and 2006.

• Business R&D expenditures (% of GDP)

Numerator: All R&D expenditures in the business sector (BERD), according to the Frascati Manual definitions, in national currency and current prices.

Denominator: Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.

Rationale: The indicator captures the formal creation of new knowledge within firms. It is particularly important in the science-based sector (pharmaceuticals, chemicals

and some areas of electronics) where most new knowledge is created in or near R&D laboratories.

Data source: Eurostat – Data Navigation Tree: Database / General and regional statistics / Regional statistics / Regional science and technology statistics (reg_sct) / R&D expenditure and personnel (reg_rd) / Total intramural R&D expenditure (GERD) by sectors of performance and region (RD_E_gerdreg)

Data availability: Good: Available for most regions for 2004 and 2006.

• Non-R&D innovation expenditures (% of total turnover)

Numerator: Sum of total innovation expenditure for SMEs only, in national currency and current prices excluding intramural and extramural R&D expenditures. (Community Innovation Survey: CIS-4 question 5.2, sum of variables RMACX and ROEKX)

Denominator: Total turnover for SMEs only (both innovators and non-innovators), in national currency and current prices. (Community Innovation Survey: CIS-4 question 11.1, variable TURN04)

Rationale: This indicator measures non-R&D innovation expenditure as percentage of total turnover. Several of the components of innovation expenditure, such as investment in equipment and machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas. Compared to the EIS 2007 the indicator no longer captures intramural and extramural R&D expenditures and thus no longer overlaps with the indicator on business R&D expenditures.

Data source: Eurostat (Community Innovation Survey)

Data availability: Poor: data are not available for all countries and for some countries data is not available for both 2004 and 2006.

• SMEs innovating in-house (% of all SMEs)

Numerator: Sum of SMEs with in-house innovation activities. Innovative firms are defined as those firms which have introduced new products or process either 1) inhouse or 2) in combination with other firms. This indicator does not include new products or processes developed by other firms. Data are taken from CIS4 question 2.2 and 3.2, i.e. whose SMEs which are either:

- A product innovator who, to the question "Who developed these product innovations", answered Yes to at least one of the following categories of CIS4 question 2.2: "Mainly your enterprise or enterprise group" or "Your enterprise together with other enterprises or institutions".
- A process innovator who, to the question "Who developed these process innovations", answered Yes to at least one of the following categories of CIS4 question 3.2: "Mainly your enterprise or enterprise group" or "Your enterprise together with other enterprises or institutions".

Denominator: Total number of SMEs (both innovators and non-innovators).

Rationale: This indicator measures the degree to which SMEs, that have introduced any new or significantly improved products or production processes during the period

2002-2004, have innovated in-house. The indicator is limited to SMEs because almost all large firms innovate and because countries with an industrial structure weighted to larger firms would tend to do better.

Data source: Eurostat (Community Innovation Survey)

Data availability: Poor: data are not available for all countries and for some countries data is not available for both 2004 and 2006.

• Innovative SMEs co-operating with others (% of all SMEs)

Numerator: Sum of SMEs with innovation co-operation activities. Firms with cooperation activities are those that had any co-operation agreements on innovation activities with other enterprises or institutions in the three years of the survey period (i.e. those SMEs who replied Yes to CIS-4 question 6.2).

Denominator: Total number of SMEs (both innovators and non-innovators).

Rationale: This indicator measures the degree to which SMEs are involved in innovation co-operation. Complex innovations, in particular in ICT, often depend on the ability to draw on diverse sources of information and knowledge, or to collaborate on the development of an innovation. This indicator measures the flow of knowledge between public research institutions and firms and between firms and other firms. The indicator is limited to SMEs because almost all large firms are involved in innovation co-operation.

Data source: Eurostat (Community Innovation Survey)

Data availability: Poor: data are not available for all countries and for some countries data is not available for both 2004 and 2006.

• EPO patents per million population

Numerator: Number of patents applied for at the European Patent Office (EPO), by year of filing. The national distribution of the patent applications is assigned according to the address of the inventor.

Denominator: Total population as defined in the European System of Accounts (ESA 1995).

Rationale: The capacity of firms to develop new products will determine their competitive advantage. One indicator of the rate of new product innovation is the number of patents. This indicator measures the number of patent applications at the European Patent Office.

Data source: Eurostat – Data Navigation Tree: Database / General and regional statistics / Regional statistics / Regional science and technology statistics (reg_sct) /

European patent applications to EPO (reg_pat) / Patent applications to the EPO by priority year at the regional level (pat_ep_rtot)

Data availability: Good: available for most regions for 2004 and 2006.

• Technological (product or process) innovators (% of all SMEs)

Numerator: The number of SMEs who introduced a new product or a new process to one of their markets.

Data are taken from CIS-4 questions 2.1 and 3.1, i.e. those SMEs which have either introduced:

- A product innovation, i.e. have introduced either "New or significantly improved goods" or "New or significantly improved services".
- A process innovation, i.e. have introduced either "New or significantly improved methods of manufacturing or producing goods or services", "New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services" or "New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing".

Denominator: Total number of SMEs.

Rationale: Technological innovation as measured by the introduction of new products (goods or services) and processes is key to innovation in manufacturing activities. Higher shares of technological innovators should reflect a higher level of innovation activities.

Data source: Eurostat (Community Innovation Survey)

Data availability: Poor: data are not available for all countries and for some countries data is not available for both 2004 and 2006.

• Non-technological (marketing or organisational) innovators (% of all SMEs)

Numerator: The number of SMEs who introduced a new marketing innovation and/or organisational innovation to one of their markets.

Data are taken from CIS-4 question 10.1, i.e. those SMEs which have either introduced:

- A marketing innovation, i.e. have introduced either "'Significant changes to the design or packaging of a good or service" or "New or significantly changed sales or distribution methods, such as internet sales, franchising, direct sales or distribution licenses".
- An organisational innovation, i.e. have introduced either "New or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within your enterprise", "A major change to the organisation of work within your enterprise, such as changes in the management structure or integrating different departments or activities" or "New or significant changes in your relations with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting.

Denominator: Total number of SMEs.

Rationale: The Community Innovation Survey mainly asks firms about their technical innovation. Many firms, in particular in the services sectors, innovate through other non-technological forms of innovation. Examples of these are organisational

innovations. This indicator tries to capture the extent that SMEs innovate through non-technological innovation.

Data source: Eurostat (Community Innovation Survey)

Data availability: Poor: data are not available for all countries and for some countries data is not available for both 2004 and 2006.

- **Resource efficiency innovators**

This indicator is captured by the following two sub-indicators each contributing for 50% of the overall score for resource efficiency innovators:

- **a) Reduced labour costs resulting from process innovations (% of SMEs)**

Numerator: Sum of innovating SMEs who replied that their product or process innovation had a highly important effect on reducing labour costs per unit of output (CIS-4 question 7.1, variable ELBR).

Denominator: Total number of SMEs.

Rationale: This indicator captures the cost savings from process innovation.

Comment: this indicator will be included jointly with indicator 3.1.3b using a relative weight of 50%.

Data source: Eurostat (Community Innovation Survey)

Data availability: Poor: data are not available for all countries and for some countries data is not available for both 2004 and 2006.

- **b) Reduced use materials and energy resulting from process innovations (% of SMEs)**

Numerator: Sum of innovating SMEs who replied that their product or process innovation had a highly important effect on reducing materials and energy per unit of output (CIS-4 question 7.1, variable EMAT.

Denominator: Total number of SMEs.

Rationale: This indicator captures the energy savings from process innovation.

Comment: this indicator will be included jointly with indicator 3.1.3b using a relative weight of 50%.

Data source: Eurostat (Community Innovation Survey)

Data availability: Poor: data are not available for all countries and for some countries data is not available for both 2004 and 2006.

- **Employment in knowledge-intensive services (% of total workforce)**

Numerator: Number of employed persons in the knowledge-intensive services sectors. These include water transport (NACE 61), air transport (NACE 62), post and telecommunications (NACE64), financial intermediation (NACE 65), insurance and pension funding (NACE 66), activities auxiliary to financial intermediation (NACE 67), real estate activities (NACE 70), renting of machinery and equipment (NACE 71),

computer and related activities (NACE72), research and development (NACE73) and other business activities (NACE 74).

Denominator: The total workforce includes all manufacturing and service sectors.

Rationale: Knowledge-intensive services provide services directly to consumers, such as telecommunications, and provide inputs to the innovative activities of other firms in all sectors of the economy. The latter can increase productivity throughout the economy and support the diffusion of a range of innovations, in particular those based on ICT.

Data source: Eurostat (High-tech industry and knowledge-intensive services:

Economic, Science & Technology and Employment statistics)

Data availability: Good: available for most regions for 2004 and 2006.

- **Employment in medium-high and high-tech manufacturing (% of total workforce)**

Numerator: Number of employed persons in the medium-high and high-tech manufacturing sectors. These include chemicals (NACE24), machinery (NACE29), office equipment (NACE30), electrical equipment (NACE31), telecommunications and related equipment (NACE32), precision instruments (NACE33), automobiles (NACE34) and aerospace and other transport (NACE35).

Denominator: The total workforce includes all manufacturing and service sectors.

Rationale: The share of employment in high technology manufacturing sectors is an indicator of the manufacturing economy that is based on continual innovation through creative, inventive activity. The use of total employment gives a better indicator than using the share of manufacturing employment alone, since the latter will be affected by the hollowing out of manufacturing in some countries.

Data source: Eurostat (High-tech industry and knowledge-intensive services:

Economic, Science & Technology and Employment statistics)

Data availability: Good: available for most regions for 2004 and 2006.

- **Sales of new-to-market products (% of total turnover)**

Numerator: Sum of total turnover of new or significantly improved products for SMEs only. (Community Innovation Survey, CIS-4 question 2.3, variable TURNMAR)

Denominator: Total turnover for SMEs only (both innovators and non-innovators), in national currency and current prices. (Community Innovation Survey: CIS-4 question 11.1, variable TURN04)

Rationale: This indicator measures the turnover of new or significantly improved products, which are also new to the market, as a percentage of total turnover. The product must be new to the firm, which in many cases will also include innovations that are world-firsts. The main disadvantage is that there is some ambiguity in what constitutes a 'new to market' innovation. Smaller firms or firms from less

developedcountries could be more likely to include innovations that have already been introduced onto the market elsewhere.

Data source: Eurostat (Community Innovation Survey)

Data availability: Poor: data are not available for all countries and for some countries data is not available for both 2004 and 2006.

• Sales of new-to-firm products (% of total turnover)

Numerator: Sum of total turnover of new or significantly improved products to the firm but not to the market for SMEs only. (Community Innovation Survey, CIS-4 question 2.3, variable TURNIN)

Denominator: Total turnover for SMEs only (both innovators and non-innovators), in national currency and current prices. (Community Innovation Survey: CIS-4 question 11.1, variable TURN04)

Rationale: This indicator measures the turnover of new or significantly improved products to the firm as a percentage of total turnover. These products are not new to the market. Sales of new to the firm but not new to the market products are a proxy of the use or implementation of elsewhere already introduced products (or technologies). This indicator is a proxy for the degree of diffusion of state-of-the-art technologies.

Data source: Eurostat (Community Innovation Survey)

Data availability: Poor: data are not available for all countries and for some countries data is not available for both 2004 and 2006.

Annex 11: ENIAC JTI

Source: http://www.eniac.eu/web/index.php

What is a JTI?

A Joint Technology Initiative is a public-private partnership using the 'Joint Undertaking' model. The European Commission has identified JTIs as a new strategy of implementing the 7th Framework Programme (FP7) to support, in a limited number of cases, large scale initiatives that could not be implemented efficiently, using the other R&D funding mechanisms. A JTI focuses on one specific industrial area, has a well defined objective, addresses a market failure and is funded by a combination of private and public investments.

Why a JTI on nanoelectronics?

Information and communication technologies (ICT) are of increasing economic and social importance, underpinning productivity, innovation and growth. They are key to the EU's ambitions under the Lisbon strategy to become the world's most dynamic knowledge-based society and economy.

Today electronics is the leader amongst manufacturing industries. All services and most industrial products rely on electronics to some extent. In the electronics sector, the semiconductor industry (manufacturing 'chips') underpins a pyramid of value, through its pervasive nature, making it a key enabler of innovation, growth and jobs. The shift from the past era of microelectronics (1 millionth of a metre) to nanoelectronics (1 billionth of a metre) will make electronics even more pervasive and strategic than it is today.

The European Technology Platform dealing with nanoelectronics is called ENIAC. It is a large scale, application-driven initiative mobilising all European efforts in this innovation- and technology-intensive nanoelectronics sector. The main goal of the nanoelectronics JTI will be to carry out pre-competitive collaborative research and development (R&D) addressing two objectives which are a substantial part of the Strategic Research Agenda of the ENIAC Technology Platform: enhancing the further integration and miniaturisation of devices and increasing their functionalities. It may also realize other activities related to industrial strategies, including encouraging innovation, standardisation, international cooperation, education and training, and promoting SMEs.

Background documents

- Council Regulation 72/2008 (including statutes of the ENIAC Joint Undertaking)
- ENIAC SRA 2007

The founding members of the ENIAC Joint Undertaking were the Community, Belgium, Germany, Estonia,

Ireland, Greece, Spain, France, Italy, the Netherlands, Poland, Portugal, Sweden, the United Kingdom, and

AENEAS, an association representing companies and other R & D organisations active in the field of nanoelectronics in Europe. The ENIAC Joint Undertaking should be open to new members.

(Extract from: Council Regulation: ftp://ftp.cordis.europa.eu/pub/fp7/docs/councilreg_eniac.pdf)

ENIAC Joint Technology Initiative

http://cordis.europa.eu/fp7/ict/nanoelectronics/eniac_en.html

The ENIAC Joint Technology Initiative (JTI) is a European public-private partnership on nanoelectronics. It was officially launched as a Joint Undertaking (JU) in Brussels on February 7th 2008. The ENIAC JTI is officially called ENIAC Joint Undertaking and is not to be confused with the ENIAC European Technology Platform, with which it cooperates closely. The office of the JU is located in Brussels.

ENIAC combines for the first time funding efforts of industry, some EU Member States (and associated states) and the European Commission to implement research activities in the field of nanoelectronics. Although other European initiatives, like the European Technology Platforms or the regular calls in the

Framework Programmes have established cooperation between these three actors before, none of them bring all together at the same time, systematically to implement a focused research programme.

Over its lifespan of 10 years, the JU is expected to bring together 3 billion euros of which more than half will be provided by industry and other research actors. The EC targets to contribute 450 M€ funding out of the 7th Framework and Member States at least another 800 M€. The association AENEAS represents industry and other research partners such as institutes and universities in the JU.

ENIAC Technology Platform

http://www.aeneas-office.eu/web/index.php

The European Nanoelectronics Initiative Advisory Council (ENIAC) is the European Technology Platform for nanoelectronics. The most important objective of ENIAC is to reinforce the position of Europe as a leading global player in micro- and nanoelectronics.

European Technology Platforms focus on strategic issues where achieving Europe's future growth, competitiveness and sustainability depends upon major technological advances. They bring together stakeholders, led by industry, to define medium to long term research and technological development objectives and lay down markers for achieving them. The achievement of these objectives will significantly improve the daily lives of the European citizen in many areas. These platforms are seen as a crucial component in future European research policy and already play a major role in the Seventh Framework Programme (FP7) for research.

Platforms have an impact on the development of national and regional research programmes and policies, creating the conditions for a stronger and more coherent European Research Area and making Europe a more attractive place for research investment and for innovation.

The ARTEMIS JTI

ARTEMIS is implemented as a Joint Undertaking (JU) which is a public-private partnership between:

- The European Commission
- Member States
- ARTEMIS Industry Association, the non-profit Industrial Association.

ARTEMISIA is the ARTEMIS Industrial Association which represents the research community including Industry (large, small and medium sized companies), universities and research institutes. The ARTEMIS JU is an organisation based in Brussels, which was legally established in February 2008 and became autonomous in October 2009. It is managed by an Executive Director.

ARTEMIS aims to tackle the research and structural challenges faced by European industry by defining and implementing a coherent Research Agenda for Embedded Computing Systems. The ARTEMIS JU will manage and co-ordinate research activities through open calls for proposals through a 10-year, € 2.5 billion research programme on Embedded Computing Systems. The programme is open to organisations in European Union Member States and Associated Countries. Selected projects will be co-financed by the Joint Undertaking and the Member States that have joined ARTEMIS.

Mission statement: Define and implement the Research Agenda for the development of key technologies in the field of Embedded Computing Systems, by creating a sustainable public-private partnership and leveraging and increasing private and public investment in the sector of embedded systems in Europe.

Annex 12: Regional typology (UNU-MERIT, 2010)

Source: Wintjes R., Hollanders H. (2010). The regional impact of technological change in 2020

Regional typology

High-tech regions

DE11 Stuttgart; DE12 Karlsruhe; DE13 Freiburg; DE14 Tübingen; DE21 Oberbayern; DE23 Oberpfalz; DE25 Mittelfranken; DE26 Unterfranken; DE71 Darmstadt; DE91 Braunschweig; DEB3 Rheinhessen-Pfalz; NL41 Noord-Brabant; FI19 Länsi-Suomi; FI1A Pohjois-Suomi; SE12 Östra Mellansverige; SE22 Sydsverige; SE23 Västsverige.

Skilled technology regions

DE22 Niederbayern; DE24 Oberfranken; DE27 Schwaben; DE5 Bremen; DE72 Gießen;DE73 Kassel; DE92 Hannover; DE93 Lüneburg; DE94 Weser-Ems; DEA1 Düsseldorf; DEA3 Münster; DEA4 Detmold; DEA5 Arnsberg; DEB1 Koblenz; DEB2 Trier; DEC Saarland; DED1 Chemnitz; DEF Schleswig-Holstein; DEG Thüringen; FR42 Alsace; FR43 Franche-Comté; ITC1 Piemonte; ITC4 Lombardia; ITD3 Veneto; ITD4 Friuli-Venezia Giulia; ITD5 Emilia-Romagna; ITE2 Umbria; ITE3 Marche; ITF1 Abruzzo; AT11 Burgenland (A); AT12 Niederösterreich; AT21 Kärnten; AT22 Steiermark; AT31 Oberösterreich; AT32 Salzburg; AT33 Tirol; AT34 Vorarlberg; SI Slovenia.

Skilled industrial Eastern EU regions

BG32 Severen tsentralen; BG34 Yugoiztochen; BG42 Yuzhen tsentralen; CZ02 Strední Cechy; CZ03 Jihozápad; CZ04 Severozápad; CZ05 Severovýchod; CZ06 Jihovýchod; CZ07 Strední Morava; CZ08 Moravskoslezsko; EE Estonia; LV Latvia; LT Lithuania; HU21 Közép-Dunántúl; HU22 Nyugat-Dunántúl; HU23 Dél-Dunántúl; HU31 Észak-Magyarország; HU32 Észak-Alföld; HU33 Dél-Alföld; PL11 Lódzkie; PL21 Malopolskie; PL22 Slaskie; PL31 Lubelskie; PL32 Podkarpackie; PL33 Swietokrzyskie; PL34 Podlaskie; PL41 Wielkopolskie; PL42 Zachodniopomorskie; PL43 Lubuskie; PL51 Dolnoslaskie; PL52 Opolskie; PL61 Kujawsko-Pomorskie; PL62 Warminsko-Mazurskie; PL63 Pomorskie; RO11 Nord-Vest; RO12 Centru; RO21 Nord-Est; RO22 Sud-Est; RO31 Sud – Muntenia; RO41 Sud-Vest Oltenia; RO42 Vest; SK02 Západné Slovensko; SK03 Stredné Slovensko; SK04 Východné Slovensko.

Metropolitan knowledge intensive services regions

BE1 Région de Bruxelles-Capitale/Brussels Hoofdstedelijk Gewest; BE24 Prov. Vlaams Brabant; BE31 Prov. Brabant Wallon; DK Denmark; DE3 Berlin; DE6 Hamburg; DEA2 Köln; DED2 Dresden; FR1 Île de France; FR62 Midi-Pyrénées; LU Luxembourg (Grand-

Duché); NL11 Groningen; NL31 Utrecht; NL32 Noord-Holland; NL33 Zuid-Holland; AT13 Wien; FI18 Etelä-Suomi; SE11 Stockholm; UKH2 Bedfordshire, Hertfordshire; UKI1 Inner London; UKI2 Outer London; UKJ1 Berkshire, Bucks and Oxfordshire; UKJ2 Surrey, East and West Sussex.

Public knowledge centres

BG31 Severozapaden; BG33 Severoiztochen; BG41 Yugozapaden; CZ01 Praha; DE4 Brandenburg; DE8 Mecklenburg-Vorpommern; DED3 Leipzig; DEE Sachsen-Anhalt; ITD2 Provincia Autonoma Trento; ITE4 Lazio; HU1 Közép-Magyarország; NL13 Drenthe; NL23 Flevoland; PL12 Mazowieckie; RO32 Bucuresti – Ilfov; SK01 Bratislavský kraj.

Traditional Southern regions

GR11 Anatoliki Makedonia, Thraki; GR12 Kentriki Makedonia; GR13 Dytiki Makedonia; GR14 Thessalia; GR21 Ipeiros; GR22 Ionia Nisia; GR23 Dytiki Ellada; GR24 Sterea Ellada; GR25 Peloponnisos; GR41 Voreio Aigaio; GR42 Notio Aigaio; GR43 Kriti; ES11 Galicia; ES12 Principado de Asturias; ES13 Cantabria; ES23 La Rioja; ES41 Castilla y León; ES42 Castilla-la Mancha; ES43 Extremadura; ES52 Comunidad Valenciana; ES53 Illes Balears; ES61 Andalucia; ES62 Región de Murcia; ES7 Canarias (ES); FR83 Corse; ITF2 Molise; ITF3 Campania; ITF4 Puglia; ITF5 Basilicata; ITF6 Calabria; ITG1 Sicilia; ITG2 Sardegna; CY Cyprus; MT Malta; PT11 Norte; PT15 Algarve; PT16 Centro (PT); PT17 Lisboa; PT18 Alentejo.

Knowledge absorbing regions

BE21 Prov. Antwerpen; BE22 Prov. Limburg (B); BE23 Prov. Oost-Vlaanderen; BE25 Prov. West-Vlaanderen; BE32 Prov. Hainaut; BE33 Prov. Liège; BE34 Prov. Luxembourg (B); BE35 Prov. Namur; IE01 Border, Midlands and Western; IE02 Southern and Eastern; GR3 Attiki; ES21 Pais Vasco;ES22 Comunidad Foral de Navarra;ES24 Aragón;ES3 Comunidad de Madrid;ES51 Cataluña; FR21 Champagne-Ardenne; FR22 Picardie; FR23 Haute-Normandie; FR24 Centre; FR25 Basse-Normandie; FR26 Bourgogne; FR3 Nord - Pas-de-Calais; FR41 Lorraine; FR51 Pays de la Loire; FR52 Bretagne; FR53 Poitou-Charentes; FR61 Aquitaine; FR63 Limousin; FR71 Rhône-Alpes; FR72 Auvergne; FR81 Languedoc-Roussillon; FR82 Provence-Alpes-Côte d'Azur; ITC2 Valle d'Aosta/Vallée d'Aoste; ITC3 Liguria; ITD1 Provincia Autonoma Bolzano-Bozen; ITE1 Toscana; NL12 Friesland (NL); NL21 Overijssel; NL22 Gelderland; NL34 Zeeland; NL42 Limburg (NL); FI13 Itä-Suomi; SE21 Småland med öarna; SE31 Norra Mellansverige; SE32 Mellersta Norrland; SE33 Övre Norrland; UKC1 Tees Valley and Durham; UKC2 Northumberland, Tyne and Wear; UKD1 Cumbria; UKD2 Cheshire; UKD3 Greater Manchester; UKD4 Lancashire; UKD5 Merseyside; UKE1 East Yorkshire and Northern Lincolnshire; UKE2 North Yorkshire; UKE3 South Yorkshire; UKE4 West

Yorkshire; UKF1 Derbyshire and Nottinghamshire; UKF2 Leicestershire, Rutland and Northants; UKF3 Lincolnshire; UKG1 Herefordshire, Worcestershire and Warks; UKG2 Shropshire and Staffordshire; UKG3 West Midlands; UKH1 East Anglia; UKH3 Essex; UKJ3 Hampshire and Isle of Wight; UKJ4 Kent; UKK1 Gloucestershire, Wiltshire and Bristol/Bath area; UKK2 Dorset and Somerset; UKK3 Cornwall and Isles of Scilly; UKK4 Devon; UKL1 West Wales and The Valleys; UKL2 East Wales; UKM Scotland; UKN Northern Ireland

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Abstract

The Commission Communication entitled "A Strategy for ICT R&D and Innovation in Europe: Raising the Game" proposes reinforcing Europe's industrial and technology leadership in ICT. Building on Europe's assets, the Communication anticipates a landscape where, by 2020, "(…) Europe has nurtured an additional five ICT poles of world-class excellence (…)".

This study attempts to identify ICT R&D&I-related agglomeration economies in Europe that would meet world-level excellence, and to identify weak signals that would indicate the dynamics of a changing ICT-related economic geography in Europe. Both of those identification processes are based on quantitative data, built on a set of relevant criteria leading to measurable indicators.

The study is developed around several tasks, the results of which are presented in a series of IPTS working papers. This first Working Paper synthesises the conclusions of the conceptual and empirical literature review that was carried out both at the beginning of the study. It summarises the most prominent concepts discussed in the relevant literature, the methods that were developed and leads to a definition of the European ICT Poles of Excellence that will guide later work.

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