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How to make regions RTD success stories?

Good practice models and regional RTD

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1. Introduction[1]

This report is part of the work undertaken to realise Work Package 2 within the CRIPREDE project. The work package's main objective is to identify current regional policies fostering innovation and technology transfer as well as 'good practice' policy and influencing factors for an RTD exemplar region.[2] WP 2 also aims at selecting 'good practice' regions against which participating regions are to be benchmarked. Furthermore it wants to review the current policies fostering RTD excellence in participating regions in order to assess their strengths and weaknesses in contributing to an RTD exemplar region.

The paper draws on models and theories of regional development, documented experience and literature on policies aimed at research and technology development (RTD) in order to identify criteria for assessing current good practice models and to identify strengths and weaknesses of current regional RTD. This has been done through both a desk-top study of relevant material, documents, and literature and through selected interviews with experts within identified good practice regions.

The report is structured as follows: Chapter 2 presents an overall conceptual framework for identifying good practices on RTD and regional development, outlining dimensions of RTD, factors and processes influencing regional RTD and current policy initiatives. In chapter 3 the paper discusses theoretically and empirically derived territorial innovation models, while chapter 4 identifies good practice regions, based on the results from previous chapters, and presents evidence on selected good practice regions. Chapter 5 concludes by introducing a matrix of factors and processes derived both from the literature review and the documented evidence from good practice regions and by indicating challenges for realising good practices in regions as well as fostering RTD at a regional level.

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[2] As outlined in the description of work of the CRIPREDE project, originally we aimed at identifying and analysing 'best' practice regions. But during working on WP2 we decided to change the term 'best practice' into 'good practice' regions for several reasons. Firstly, regions that perform well depend on regional conditions so that their applicability elsewhere is discussible. Moreover, they also might have a kind of a 'life cycle' which means that what is working nowadays must not be a best practice region tomorrow anymore. Therefore, and to underline the restricted generalisation possibilities of best practice regions we prefer the term 'good practice'.

2. Conceptual Framework for Identifying Good Practices on RTD and Regional Development

This chapter introduces a conceptual framework for identifying good practices on RTD at a regional level. Based on a literature review, the following sections synthesize evidence regarding the dimensions of RTD and factors which have been identified in previous studies as important influences for a region and its actors to become more RTD-oriented, innovative and entrepreneurial.

2.1. Dimensions of RTD

2.1.1. Firm Size, R&D and Innovation[3]

Schumpeter (1934) was the first to consider large firms as the main engines of technological progress (Schumpeter Mark II hypothesis), although simultaneously emphasizing the role of dynamic entrepreneurs and enterprises, regardless of firm size, for economic development (Schumpeter Mark I hypothesis). Following Schumpeter, there has been much debate in the literature about the relative contribution of firms of different sizes to innovation (e.g., Symeonidis 1996). Proponents of Schumpeter Mark II hypothesis explain the importance of larger firms for R&D because of economies of scale and scope in the innovation process, while those advocating Schumpeter Mark I hypothesis refer to the flexibility of small firms as being advantageous for innovation processes.

However, the empirical evidence regarding the link between firm size, R&D and innovation is not conclusive. Small firms are said to participate less in 'formal' R&D activities which is reflected in statistical data showing a lower number of patents or lower expenses for R&D personnel, although this is not necessarily a sign of smaller firms being less innovative. Most industries show decreasing returns to scale, i.e., the smaller the firm the higher its innovation intensity and vice versa. For example, based on an analysis of the size distribution of innovating firms in the UK between 1945 and 1983, Pavitt et al. (1987) concluded that small firms are more likely to introduce new innovations than larger firms because they have less commitment to existing practices and products than larger enterprises, thus emphasising the flexibility of a small firm size. Based on US data, Acs and Audretsch (1990) provided further empirical support for the disproportionate contribution of SMEs to innovation. Innovative SMEs can also be important in developing radically new innovation through their contribution to main-

[3] This section draws on ideas published by Smallbone et al. (2002).

taining technological diversity, since large firms typically innovate incrementally within existing technological trajectories.

At the same time, there are other studies which apparently confirm the Schumpeter Mark II hypothesis. Evidence from the second Community Innovation Survey (CIS) suggests that across all sectors SMEs made fewer innovations (in terms of introducing technologically new or improved products or processes) between 1994 and 1996 than large enterprises (Craggs and Jones 1998): Across Europe the proportion of innovating firms by size class varied from 73% of large firms, 49% of medium sized firms to 37% of small firms. Moreover, the gap widens when only 'novel' or 'radical' innovations are considered, where larger firms are more likely to introduce novel innovations than SMEs. Additionally, larger firms also are more likely to cooperate in order to innovate, with 49% of those in the largest size group cooperating compared to 28% of medium-sized and only 19% of small firms (Günther 2005). Another study demonstrated that the largest enterprises have consistently been a disproportionately important source of innovation in the manufacturing sector in the UK (Tether et al. 1997).

Whilst this debate will continue, not least because studies typically use a variety of definitions of what constitutes innovation as well as different databases to examine it, the point to stress is that both large and small firms play important roles in innovation and R&D. Viewed across all sectors and types of innovation there is no optimal firm size from the point of view of innovation, although there might be one for in-house 'formal' R&D, and dynamic complementarities exist between large and small enterprises (Tether et al. 1997; Rothwell 1983).

This variety across firm size has led some authors to attempt to classify the various roles that small firms play in relation to innovative activities. Rizzoni (1991) for example, has produced a six-fold classification based on the role of small manufacturing firms with respect to technological innovation, in which the sectoral dimension is very important. These roles ranged on the one hand from 'static' small firms in the sense of being largely uninvolved with innovation and showing a degree of conservatism and inefficiency, and 'traditional' small firms which play a more active role in the diffusion of innovation, to 'new technology' based small firms at the other extreme, where small firms play an important role in the introduction of significant new technologies. Rizzoni's taxonomy, which emphasizes the heterogeneity of small firms with regard to their involvement in R&D, can be used to identify the various roles that small firms can play in technological change.

2.1.2. Technology Regimes and Spatial Innovation Systems[4]

The context in which RTD and innovation activities take place also helps to explain the heterogeneity that exists between firms of different size with respect to their involvement in and levels of R&D as well as regional differences. This refers to the sectoral context that reflects the underlying technological base (e.g., Nelson and Winter 1982), as well as to the regional (e.g., Mothe and Paquet 1998b, Moulaert and Nussbaumer 2005) and national innovation systems (e.g., Breschi and Malerba 1997, Nelson 1992, Nooteboom 2000, Mothe and Paquet 1998a, 1998b).[5]

With regard to the sectoral context, Nelson and Winter (1982) introduced the notion of *technological regimes*, differentiating between entrepreneurial and routine regimes. The former are characterised by a variety of new and untried technologies whilst the latter mainly occur in later stages of sector development. Consequently, routine technology regimes are typically dominated by mature technologies favouring larger firms which have resources for their own R&D. Here, Nelson (1992: 361) emphasizes the importance of analysing institutional R&D infrastructure in its respective sectoral context, by pointing out that strong research at universities does not necessarily imply positive spillover effects to industrial R&D, but that this strongly depends on the respective industry.

In this context, Pavitt (1984) distinguishes between four categories of firms and sectors, illustrating in more detail the relationship between sector and R&D needs. Firms in supply-dominated sectors such as clothing or furniture mainly obtain technologies and innovations from other firms whilst in scale-intensive sectors (such as food industry) firms concentrate on process innovations. Specialised suppliers such as engineering or software industry frequently carry out product innovations, often together with customers. And finally, science-based producers (e.g., chemical industry or biotechnology) cover the whole range of innovative activities, basically requiring in-house R&D and thus being dominated by larger firm size.

Rizzoni (1994), in extending the concept of various roles for small firms, applied a taxonomy based on technologies and the maturity of industry, in order to define what constitutes innovation in various sectors. For example, incremental improvements of design could be innovations in sectors with broadly standardised customers demand such as textile industry or furniture production; in the ‘New Economy’ innovations would contain the introduction of new software products and services or the development of new customer segments. Moreover, we can distinguish various degrees of innovation

[4] Oinas and Malecki (1999: 10) introduced the term ‘spatial innovation system’ which they define as ‘re-gional innovation systems plus their interconnections”.

which allow a more detailed analysis of innovation processes in SMEs and the underlying need for R&D, compared to a dichotomous differentiation into innovators and non-innovators (North and Smallbone 2000). SMEs move along a continuum of innovations. One example for a lower degree of innovation would be the introduction of imitative products which however are new for the enterprise. Examples for a higher degree of innovation would be products and services which are new for the market or industry as happened for example during the transition towards market economies in Eastern Europe (Smallbone et al. 2002).

Besides technological regimes at sector level, the dominating *spatial innovation regimes* play an important role for the level of R&D and RTD[6] at regional level. These concepts are based on the fact that innovations appear to be dependent on their environment which includes for example the scientific and institutional infrastructure of regions and localities as well as the institutional density of the territory.[7] An ideal-type innovation regime is entrepreneurial in contrast to routine innovation regimes, fostering the application of new and untested technologies and going hand in hand with a higher R&D level. It is characterised by open structures and a variety of technological concepts; and pioneer firms play a dominating role (Nelson and Winter 1982, Audretsch and Fritsch 2000). Entrepreneurial innovation regimes encourage innovative smaller firms because these regimes support flexible organisations, and flexibility is said to be one of the advantages of SMEs.

Spatial R&D and innovation clusters reflect the formal institutional settings and the inherent division of labour between enterprises and institutions, in short: the overarching innovation systems. The main characteristics of any such system are its enterprises, public research institutions and transfer organisations, the educational system, the legal and institutional framework and public policy (Fritsch and Lukas 1999). Patel and Pavitt (1994: 12) define a national innovation system in an even broader way as ‘the national institutions, their incentive structure and their competencies, that determine the rate and the direction of technological learning ... in a country’, thus incorporating the ‘soft’ factors which also are said to constitute an innovative milieu, an industrial district or a cluster (cf. chapter 3). Similar definitions are to be found with regard to regional innovation systems

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[5] There is no single comprehensive definition in literature of what constitutes a national (or regional) innovation system.

[6] RTD is seen as part of chain R&D – Innovation – Entrepreneurship – Market / Regional performance.

[7] The general idea of a ‘national system’ which creates competitive advantages can be traced back to Friedrich List who in 1841 published his book on ‘National Systems of Political Economy” (de la Mothe and Paquet 1998: 103). His ideas became the basis for the so-called ‘*Schutzzoll*’ politics in Germany in the 19th and early 20th century (*Schutzzölle* are protective import duties, imposed in order to foster indigenous industries). In the 20th century, Michael Porter implicitly drew on List’s concept in developing his idea of comparative advantages of nations.

(RIS). For example, Autio (1998) sees RIS as ‘essentially social systems, composed of interacting sub-systems’, where interaction creates knowledge flows which in turn drive the evolution of RIS (cf. also Koschatzky 1998).[8]

Drawing on the concept of systems of innovation and technological regimes, cross national, interregional and sectoral differences in R&D activities then could be explained as a result of the predominant innovation systems at various levels as well as the specific development paths of industry and enterprises (Breschi 2000). For example, research seems to indicate that the German innovation system favours high-tech incremental innovations, whilst the USA system would support radical innovations (Becker and Vitols 1997, Meyer-Krahmer 1998). In general, territorial systems of innovations emphasize that firms are part of a wider network of public and private sector institutions, which are – implicitly and explicitly – involved in RTD. Besides this network, key features of such a territorial innovation system are linkages and knowledge flows between institutions as well as learning (Mothe and Paquet 1998b: 105).

However, for a region to be able to profit from any territorial innovation system, it is necessary to overcome what Oughton et al. (2002) label the ‘regional innovation paradox’: In regions lagging behind in RTD, enterprises often are not used to articulate R&D needs, which leads to a low level of R&D, partly due to a lack of trust and cooperation between actors at regional level. This frequently results in regions having a very fragmented innovation system, which leads to them being trapped in a vicious circle of low demand for R&D and poor matched public funding.

2.1.3. The Development Paths of High-Technology Industry

A common question to be found in the RTD and innovation literature is related to the development of high-tech industries and sectors, although one might criticise those studies for using an exclusive high-technology orientation as the most important indicator for the innovativeness of firms and regions. Several studies illustrate processes of regional clustering, analysing in some detail how initial conditions within a region are reinforced, what triggered cluster processes and how innovative clusters of firms emerged. The underlying question is whether there exists an ideal path of RTD development. Although some authors refuse this idea, for example, Conti (2005) points out that depending on local conditions, institutional assets and actors’ perceptions there will be a multitude of development paths, the following examples nevertheless offer

[8] Oughton et al. (2002) refer to the triple helix model of innovation, which emphasizes government-industry-university relations, as being related to the RIS concept.

deeper insights into some of the elements which could foster the emergence of agglomerations of high-technology industries or industries with a high R&D orientation.

Drawing on the example of the biotechnology industry in Oxfordshire, Lawton-Smith (2005) outlines *how initial conditions were reinforced by the interactions of local and non-local factors and actors*, thus introducing an interaction-based clustering process (Wolter 2004)[9]. Initially, high-tech industries and clusters need triggers to set them off onto technology specific trajectories. The author identifies the following factors for regional RTD and clusters of high tech firms to happen (Lawton Smith 2004):

- Concentration of scientific research: Cluster processes are not spontaneous, but they arise e.g., through the investment decisions taken on the kinds of research undertaken in specific institutions. Of particular importance in this regard for the development of high-tech industries are the quality and intensity of science in the universities in a region such as the number of people engaged in science and research, the overall quality of human capital and the numbers of star scientists employed in regional institutions and universities. High quality scientific research institutions in turn will foster regional RTD through knowledge inflows, as these institutions are integrated into the international scientific community.
- Location becomes increasingly important as the local highly skilled labour market expands, thus contributing to regional capabilities and knowledge. This is facilitated by labour mobility within the region, allowing for knowledge spillover between firms, an element which has been recognised by proponents of collective learning as an important ingredient for regional development (e.g, Camagni 1991, Lawson 1997). Interestingly and similar to Florida (2004), Lawton-Smith (2005) also emphasises the need for a skilled labour force on both high and intermediary levels, as both levels of qualification are needed for companies and consequently industries to be innovative and creative.
- Additionally, networking reinforces knowledge spillovers and transfer, giving rise to informal, collective learning and milieu effects, although the author points out that networks are not a sufficient condition in making regions innovative.
- Finally, the extent and effectiveness of local governance, namely the coordination and institutionalisation at local level is important.

Feldman et al. (2005) concentrate on the role *entrepreneurship plays in triggering the emergence of high-tech agglomerations*. In contrast to the development of territories such as the Silicon Valley, Route 128 or the Research Triangle Park in North Caro-

[9] Wolter (2004) distinguishes two dominant explanations for clustering tendencies, namely resource-based ones, emphasizing the access to resources, and interaction based concepts.

lina, where ‘strong directed efforts’ (Feldman et al. 2005: 132) of public-private actors played an important role for cluster emergence, their study illustrates a different path. In the first phase of cluster emergence (the so-called emergent phase), entrepreneurship is triggered by exogenous events. In the second phase, entrepreneurship, organisations and institutional arrangements co-evolve, reinforcing themselves, while in the third stage both industry and cluster mature.

Although this study can be criticised for glorifying and overemphasizing the role of entrepreneurs, the results nevertheless are important insofar as they link entrepreneurship to RTD in a regional context, thus drawing attention to an often neglected factor of regional R&D development. Moreover, the authors point out a process of co-evolvement as an important element of regional RTD development where ‘entrepreneurship facilitates the realization of innovation as firms are formed to commercialize and advance new ideas’ (Feldman et al. 2002: 139, cf. also Stam 2005).

The next section will take a closer look at factors and processes underlying RTD in a regional context.

2.2. Factors and Processes influencing RTD in a Regional Context

Besides resource endowments, which include natural resources, markets and customer bases, the physical and overall institutional infrastructure arrangements within a region, research has identified a variety of factors influencing RTD in a regional context. These include, for example, a well-educated labour force and professional labour markets (Simmie et al. 2003), attractive and ‘fashionable’ places to live with high social and cultural amenity and a high reputation, which help in attracting knowledge workers and leading-edge high technology industries (e.g., Florida 2004, 2005a), places which are visible internationally and talked about (Hospers 2005), sufficient scale of activity to produce localisation benefits in particular technologies and regional sectoral diversity in order to create flexibility and maximise ‘fungeability’ of knowledge (e.g., Antonelli 2003), well-established universities (e.g., Lawton-Smith 2003, 2005), global technology leadership in some regions (e.g., Feldman 1994, Saxenian 1994), and international linkages of small and large enterprises alike, including the international migration of highly skilled personnel (e.g., Fromhold-Eisebith 2002a, 2002b). Moreover, the same literature also refers to some of the processes that generate RTD, and the concepts used to ‘explain’ patterns of uneven regional development such as embeddedness, ‘institutional thickness’, cumulative causation, agglomeration economies, localisation economies, fungeability, labour market dynamics, quality of life and environmental amenity, and the role of regional and local governance.

We have condensed these factors and processes into the following major categories, namely knowledge and processes of learning (cf. chapter 2.2.1), the role of networks (2.2.2) and key actors (2.2.3) as well as the concept of place, proximity and embeddedness (2.2.4). These factors and processes are discussed in more detail within the following sections.

2.2.1. Knowledge and Learning

In a R&D context, *knowledge* refers to scientific knowledge, but also to those capabilities and skills needed in commercialising inventions, in transferring scientific research results into operational concepts, and in adapting research results to an enterprise context. As such, knowledge is an input needed for regional RTD, while learning refers to the process underlying the transfer of tacit and non-codified knowledge into explicit and codified knowledge. Regarding technical knowledge, Antonelli (2000) raised the question of whether this could be regarded as a collective good, pointing out that this type of knowledge is to a certain extent industry- and firm-specific, as such also region-specific, and thus difficult and costly to use in other contexts. This obviously renders technical knowledge an important contribution to regional RTD advantages. Malecki (1997: 89) takes this one step further by indicating a need for a technical culture as one element needed for a favourable RTD environment. In this regard, universities, science parks and the like may influence the level of RTD because they contribute to the stock of regional knowledge which in turn constitutes the technical culture of an area.

However, such institutions alone do not guarantee a regional high-tech centre: 'Again, several studies have shown that it does not suffice for a science park to be simply there because geographical proximity alone does not suffice. Something else is needed.' (Malecki 1997: 90). Moreover, access to technical knowledge can be restricted due to its tacit and idiosyncratic nature (Antonelli 2000: 537). Consequently, regions can lag behind and experience problems in raising the level of R&D because scientific and technical knowledge does not exist on a regional level, or effective mechanisms to spread technical knowledge throughout a region are not in place: 'What is needed for location to play a major role in enhancing technological communication' is a variety of communication channels (Antonelli 2000: 543).

This also refers to one of the key processes influencing regional R&D development, namely *learning*, which research frequently highlights as playing an important role for regions to be(come) RTD-oriented, innovative and entrepreneurial: 'Current thinking suggests that the technological vitality of regions revolves around their learning efficiency' (Oinas and Malecki 1999: 14). Research started paying more attention to learning processes, once the ‘intrinsic learning nature of technological change’ (Camagni 1991: 124) became clear and it was understood that technology development and innovation are non-linear processes – a fact which Camagni (1991: 123) labelled the ‘emergence of the new ‘evolutionary’ paradigm in the study of technological change’. Learning is a cumulative process to embed new knowledge into rules, routines and existing norms, which guide behaviour (Lazaric and Monnier 1995: ix, cited in Mothe and Paquet 1998: 7). Learning processes need triggers and thresholds, as organisations and individuals tend to stick to routines and known behaviour as long as they feel comfortable with the results (Nelson and Winter 1982).

Some regions, such as for example the Cambridge region (Keeble et al. 1999, also cf. chapter 4) appear to favour RTD, because they facilitate the exchange of ideas and the development of social relations as well as more formalised co-operation, thus creating an environment conducive for learning processes. Recent research picked up this topic in discussing *collective learning* which is understood as the learning process between different agents (enterprises, public research institutions, etc.), rather than organisational or individual learning. Collective learning includes the regional accumulation of knowledge which is freely shared and transferred among the participants through social interactions (Capello 1999). In this regard, Mothe and Paquet (1998) indicate the importance of communities of practices, defined as elements of proximity, trust, solidaristic values, as one antecedent for learning and innovation, identifying as threshold for learning processes the degree of dissonance at a regional level.

Collective learning is said to be closely linked to proximity, as it is based on conversations and interactions among stakeholders within a particular context, which has lead some authors to introduce the concept of the ‘learning region’ as a region where external knowledge flows are effectively disseminated and integrated into a region’s internal systems of information diffusion (e.g., Morgan 1997, Stam and Wever 1999). As Lawson (1997: 21) pointed out the discussion around collective learning is ‘an attempt to trace out the mechanisms by which proximity influence innovative behaviour’. Learning is in many ways a collective process because of repeated interactions between individuals within and across organisations (Malmberg, Sölvell and Zander 1996).

However, there is an ongoing debate regarding the existence of ‘learning regions’. Some research also suggests that the spatial dimension of learning processes is not confirmed (Stam and Wever 1999). Oinas and Malecki (1999: 14) summarise the problem with the learning region concept in the following way: ‘The collective aspect of learning sometimes comes up somewhat naively in the enthusiast usage of the ‘learning region’ metaphor: as (…) if ‘learning regions’ were happy collectively learning communities where no sign of friction nor domination is to be found – too heavenly to be descriptions from the earth.' They instead suggest applying the concept of 'regional learning'.

The mainstream academic debate of today recognises that collective learning emphasises joint problem solving, without necessarily implying that regions as such can learn. Therefore, the discussion on learning regions started to focus more and more on how learning in regions can occur. Research has identified three key mechanisms of such regional learning: labour mobility, the creation of spin-offs and dense networks, for example, between firms, customers and suppliers (e.g., Camagni 1991, Florida 1995, Harrison 1994, Malmberg et al. 1996).

- Labour mobility can enhance technology development through diffusion of information and skills, as employees transfer both their tacit and firm-specific knowledge to new jobs. A similar mechanism happens with spin-offs which could foster knowledge transfer through bringing knowledge and experiences from previous working places to the new firm. Finally, firm-customer and firm-supplier linkages contribute to interorganisational knowledge transfer, especially in those cases where these relationships are long-standing ones.

With regard to RTD, this draws attention to both the environment which is needed for technical and scientific knowledge to be existent and to be transferred and transformed effectively, and the role of networking in that regard.

2.2.2. Networks

As stated in the introduction to this chapter, studies over and over again have emphasized the role a broad and dense institutional infrastructure, both in quantitative and qualitative terms, can play for regional RTD development. Such an infrastructure includes universities, public and private R&D institutions, a sufficient supply of highly qualified labour and a generally good infrastructure of business support institutions. However, although infrastructure can create the context for an innovative region, infrastructure alone is not a sufficient condition for R&D and innovation to occur. Interactions between different institutions are needed to trigger R&D and innovation processes, with networking and cooperation providing the 'glue' for innovative activities on firm and regional level.

Networks are understood as 'a configuration of firms, owner-managers, support agencies, voluntary associations and other bodies through which small firms connect to the wider economy' (Curran et al. 1995), whilst networking refers to the activities of the participants, which sustain the network. This includes all potential external relationships such as customer-supplier relations as network activity.

In R&D-oriented regions, Schätzl (1999: 103) distinguishes three dominant network configurations, namely science-led, industry-led and policy-led ones. In *science-led* regional networks, universities or research institutions triggered regional development with a particular role for R&D. Examples include Silicon Valley, Route 128 or Cambridge in the UK. In *industry-led networks* RTD-intensive large firms are the innovative hub, with close links to university research. Examples are the Finnish telecommunication concern Nokia or the German automobile company VW in Wolfsburg. Finally, *policy-led networks* are to be observed in Silicon Glen in Scotland, or in regions where policy-makers initiated successful science parks.

Research has debated which network forms are the most successful in fostering RTD within a region. Science-led networks are said to be seldom successful in the long run (e.g., Malecki 1997), although examples such as the Silicon Valley or Cambridge appear to tell a different story. Sternberg (1999) has analysed innovation networks, concluding that they can foster 'sclerotic milieus' (p. 91) and that they are difficult to integrate into a regional milieu if build top-down. Moreover, some authors stress the possible negative effects of networks and networking such as an increase in transaction costs, because of the resources needed to build and sustain networks which renders networking difficult for smaller firms, the danger of free-riders who will reduce collective advantages of networking, the trade-off between exclusivity of networks and excluding regional actors as well as problems arising with power asymmetries within networks (e.g., Sternberg 1999, Welter et al. 2004, Welter and Trettin 2005).

Which factors influence network emergence and development at regional level? Trust is the 'lubricant' without which network activities would not be possible (Anderson and Jack 2002). Regional and sectoral factors facilitate trust building in those cases where they allow individuals to draw on common rules and conventions (Welter 2005). This is a fact which is also widely known from the literature on Italian districts (e.g., Dei Ottati 2005), where the local 'code of fair behaviour' creates a specific trust milieu within a region and for the district's firms. Although trust might be considered higher in strong network ties (such as family or friends), it is the use of weak ties within a network, which most studies have found to be related to business growth (e.g., Birley et al. 1991, Brüderl and Preisendörfer 1998, Chell and Baines 1998, Jenssen 2001, Liao and Welsch 2005).[10] For example, in their study of UK owner-managers, Chell and Baines

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[10] Although most empirical studies confirm a link between networking and positive business development, the empirical evidence is not conclusive whether strong ties or weak ties matter the most. In their review on network studies, Hoang and Antoncic (2003) conclude that the respective outcome seems to depend on the operationalization of network variables to a large extent.

(1998) concluded that especially weak ties influence business growth, as they help the entrepreneur to access non-redundant ideas and resources.

With regard to R&D and innovation activities in a regional context, this appears to signal a more important role for weak ties within or even beyond a region, as those transport new ideas and information regarding new technologies. However, a successful network needs both strong and weak ties: A diverse set of persons working in different contexts allows for loose couplings and infrequent contacts, thus adding diversity within networks and providing access to various sources of knowledge, information, and opportunities to meet new people. Thus, weak ties 'represent local bridges to disparate segments of the social network that are otherwise unconnected' (Elfring and Hulsink 2003: 411).

On the other hand, strong ties tend to bind individuals with similar or complementary interests in longer-term and intense relationships, thus adding to the identity of networks, while simultaneously providing shortcuts to information and knowledge (Elfring and Hulsink 2003). Uzzi (1997) pointed out that strong ties contribute to 'economies of time' as they add to an individual's capability to quickly capitalize on market opportunities. This might be of particular value in commercialising R&D results and gaining (technical) advantages. However, there is a trade-off between strong ties, overembeddedness and the danger of being locked-in in networks which in turn might stifle economic performance.

In summarising the issues as emerging from our literature review we conclude that networks foster the emergence of embeddedness of regions and systems as one important ingredient for RTD, although there is a trade-off between embeddedness and openness of systems. Networks are simultaneously an input needed for embeddedness to occur as well as an output of proximity and embeddedness.

2.2.3. Regional Actors

Few studies have researched the emergence of networks (e.g., Human and Provan 2000, Neergaard 1998, Sarasvathy and Dew 2003, Schutjens and Stam 2003, Welter and Trettin 2005).[11] Sarasvathy and Dew (2003) suggest a simple threefold typology: Networks either emerge spontaneously and through random chance (also Neergaard 1998); they may form in 'some path dependent fashion' (Sarasvathy and Dew 2003, p. 13), or they result from deliberate actions of an existing network. All authors however agree that networks are initiated and driven by persons.

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[11] The following paragraphs draw on Welter and Trettin (2005).

Here, recent research studies emphasize the *role(s) network promoters play in network emergence and development* (Axelsson and Larsson 2002, Koch 2003, Koch et al. 2006). In a study on network structures in Gnosjö, a Swedish industrial district, Axelsson and Larsson (2002) identified typical forms of networks, all of which are based on the different roles network actors play: The ‘locomotive-driven network’ is one which is initiated and dominated by one actor, while a ‘joint umbrella’ describes a network structure which is driven by members and their joint interests. For networks to be successful, three key actors need to be in place: the ‘architect’ brings in a vision for the network and is capable of structuring the network along these lines; the ‘lead operator’ fulfils a bonding function within the network; and the ‘caretaker’ focuses on developing and improving the network (Axelsson and Larsson 2002: 98).

Koch et al. (2006) show that actors within networks often act as process and relationship promoters, demonstrating that different promoter roles and network positions go hand in hand. For example, relationship promoters often had a full time job and a central position within the network. In this context, the works on the creative milieu suggest that high communicators play an important role for network development at regional level. High communicators are individuals at the decision making level in several public and private organizations. They play a central role in transmitting information, speeding up decision-making, and fostering inter-organizational linkages (Fromhold-Eisebith 1995: 38). Such key individuals contribute to the development of ‘institutional thickness’ or embeddedness by bringing in local knowledge and the ability to access and link local capacity at different levels (Malecki 1997, p. 91 with reference to Amin and Thrift 1994).

Many studies dealing with regional and/or technological development emphasise a need for *key actors* which goes far beyond networks. Key actors are variously labelled ‘gate actors’ (Bellini and Landabaso 2005), ‘high communicators’ (Fromhold-Eisebith 1999, 2001), ‘sponsors’ (Flynn 1993, cited in Malecki 1997: 92), ‘executive champions’ (Abetti 1992, cited in Malecki 1997: 92), ‘promoters’ (Koch et al. 2006, Welter et al. 2004), ‘clusterpreneurs’ (Stoerring and Christensen 2004). Lawton-Smith (2005) illustrates the effect key actors can have on local capacity building drawing on the example of star scientists who link locally based scientific institutions to the international academic community. She emphasizes that this is a key means by which firms are linked to global research systems, thus providing localised and simultaneously international linkages and networks. This in turn sets off learning processes, as it fosters technology transfer into firms, consequently influencing development on firm and regional level.

In this regard, key actors help with RTD insofar as they enhance or build local capacity. However, most literature on regional development so far has ignored the role of the ‘individual change-agent’ (Feldman et al. 2005) in developing networks. As said before, key actors also drive networks, either acting as network hubs (e.g., a focal firm) or network promoters (i.e., those persons building and / or sustaining networks), helping networks to legitimate themselves.

To sum up, with regard to regional R&D, key actors are an important factor for a regional milieu to emerge and to be sustained over time. Overall, such key actors can foster a regional R&D milieu in contributing to the development of strong ties, but they also can contribute to lock-in effects in networks in case these strong ties dominate, as is illustrated by Watts et al. (2006) for the example of the Sheffield metal-working cluster. The theme emerging here is analysed in more detail in the following section dealing with the influence of place and proximity on RTD.

2.2.4. Place, (Spatial) Proximity and Embeddedness

A popular theme in the regional RTD literature is concerned with identifying the influences of *place and spatial proximity* on RTD. Studies show for example that corporate investments in R&D, measured by corporate patenting by region within ICT industries in regions in the UK, Germany and Italy, are highly agglomerated (Santangelo 2002), demonstrating the extent to which this results in cumulative processes in core regions at the expense of peripheries. Data from this study clearly shows that the pattern of patenting is much more concentrated than the distribution of the industry in general. Santangelo (2002) explains this in terms of customary factors such as strong educational tradition (e.g., well-established universities), the presence of world leaders in specialised niches, sector-specific localisation economies and general effects of agglomeration, public support for training and technical initiatives, but he also points to cumulative causation and path-dependent effects.

This first of all refers to the *influence of place on RTD in central compared to peripheral regions*. In drawing on a case study of high-technology spin-offs in the North East of England, Benneworth (2004) illustrates how traditions, in particular the strong sense of underdevelopment experienced in peripheries, might help in concentrating firms in such regions. The author shows how high-technology firms in the electronics sector used the regional strengths of North East England and drew on universities in building up their companies, thus simultaneously fostering RTD in a peripheral region. These results obviously question the mainstream hypothesis that peripherality is a disadvantage for regional RTD, instead drawing attention to the influence of tradition and identity building.

Another issue which is important here is the *link of place and spatial proximity to knowledge, learning and RTD*: '(…) geographical proximity is important to the innovation process because of the nature of the knowledge in question. In particular an increasing focus is placed on the importance of uncodified information.' (Lawson 1997: 20). In short: tacit knowledge in regions gains importance, in particular where it is bound to the region in the sense that it 'sticks'. This is related to the process of ubiquitification (Maskell and Malmberg 1999, Maskell et al. 1998): Once region-specific factors are available worldwide, something which is encouraged by globalisation, regions loose their comparative advantages based on genuine regional factors (Maskell et al. 1998, Piscitello and Sgobbi 2004).

In such situations, spatial proximity and the local embeddedness of personal interactions play an important role in creating competitive advantages of both firms and regions (e.g, Lechner and Dowling 2003, Liao and Welsch 2005, Maskell and Malmberg 1999, Schamp and Lo 2003). Regions still can generate comparative advantages based on tacit regional knowledge, which is embedded in regional innovation systems and milieus (Sternberg 1999). A regional interaction based approach gains importance over a resource-based approach in developing regional advantages: 'As an industry evolves, the creation of specific forms of knowledge and the pressures and incentives to upgrade firm capabilities often becomes vital to its continued success. *Advantages that are developed through the interaction of individuals, firms, and institutions often supersede those based on specific territorial details*.' (Enright 2003: 109, emphasis added by authors of this report).

In stressing the importance of proximity in combination with the overall socio-cultural context as one important factor fostering territorial development, Mothe and Paquet (1998b: 109) refer to Putnam's work on the civic communities in Italy and Saxenian's studies on Boston and the Silicon Valley (1994). Moreover, they conclude that proximity is not a solely spatial concept (Mothe and Paquet 1998a: 9): Besides territorial dimensions, it also includes organisational, ideological, institutional and social dimensions. Proximity alone does not suffice for interaction to emerge and take place, synergy is needed as well (Malecki 1997: 90).

One element fostering synergies is *embeddedness*[12], which is required for 'sticky' tacit knowledge to become a regional advantage. Unpacking the relation between embeddedness and RTD, we have to take into account mutually reinforcing relationships: Embeddedness has been stressed as one characteristic of successful regional milieus, with it being both antecedent for a regional innovative milieu to emerge and an output of an innovative milieu. For RTD and a regional innovative milieu to emerge three different kinds of embeddedness are required:

- spatial embeddedness, which is a result of spatial proximity. For example, recent research on virtual networks confirms that ICT usage, although facilitating networking of entrepreneurs, cannot substitute for personal face-to-face contacts (Welter et al. 2006).
- technological embeddedness, which refers to technical knowledge and the resulting technical culture as one important factor in creating synergy effects out of spatial proximity (Oinas and Malecki 1999). As explained above, this also needs spatial proximity and is embedded in the location decision of firms.
- social embeddedness, which refers to the embeddedness of firms and organizations in the social structure of a particular region such as networks, social groups etc. For example, Wigren (2003) illustrates this for an industrial district in Sweden, namely Gnosjö, where business and social spheres are heavily intertwined, fostering the development of a particular identity, often referred to as the 'spirit of Gnosjö'.

While the embeddedness concept frequently is understood to exclusively refer to localised spatial processes, research on successful regions illustrates the importance of widening this concept to include a dimension of international embeddedness as well. For example, Fromhold-Eisebith (2002a, 2002b) suggests a model of 'migration induced' regional development which is based on international networking relations between internally embedded technology regions. Highly qualified individuals migrating abroad and re-migrating to their territory of origin trigger regional development processes in both countries, which result in creating a 'transnational community', combining local and international embeddedness. Moreover, such remigrants often contribute to a particular regional identity in their home-countries. Similarly, Taylor (2005), in his critique on clusters, advocates against the 'fetishing of proximity', pointing out that there is 'good reason to be circumspect about the benefits of proximity in local knowledge networks' and 'that the role of 'proximity' in clusters needs to be interpreted with

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[12] Embeddedness is a concept widely used in entrepreneurship research. Granovetter (1985) used this concept to explain how economic actions are grounded in social connections and milieus.

great care', implicitly indicating that clusters need to be open to global connections as well.

Similarly focused on labour mobility, migration patterns and their effects on embeddedness and regional development, recent studies by Richard Florida (2004, 2005a, 2005b) suggest a particular important role for place and spatial proximity in attracting human capital and fostering technological regional development, which becomes visible in spatial patterns of a so-called '*geography of talent*'. The author identifies a triangular relationship between his three 't', namely talent (human capital), tolerance and high technology growth: Talent is attracted to places with high levels of opportunity, low entry barriers (i.e., good entrepreneurial environments) and high diversity of social groups. For example, this is reflected in the general attractiveness of a region and measured by the 'gay' or the 'bohemian' index, which represents the tolerance of different lifestyles within a region (Florida 2004). High technology industries are to be found in regions with high levels of talent, although the direction of the causal relationships needs future research.

However, this 'geography of talent' indicates that a region might experience problems in raising the level of R&D because the antecedents needed for knowledge to develop do not exist in that region. The question raised here is connected to the role of policy in creating antecedents for 'talent' to flock into regions, thus fostering RTD.

2.3. Policy Initiatives to foster Regional RTD

There exists a multitude of different policies and concepts aimed at fostering the development of research and technology. Approaches range from science and technology policies to innovation policies and promoting a supportive environment, often in the context of regional development, which refers, e.g., to cluster policies or fostering regional innovation systems. In this chapter, we briefly sketch relevant policy approaches before asking which role policies could and should play for regional RTD.

2.3.1. Policy Approaches: A Brief Overview

Science policy is concerned with the development of science and the training of scientists, while *technology policy* refers to the use of scientific knowledge in the development of technology, often with an emphasis on moving into 'higher technology' areas of production. Instruments include, for example, the establishment of science parks, subsidies to foster R&D personnel in smaller firms and the exchange of scientific personnel between universities and firms, programmes for scientific cooperation and measures for commercialisation of scientific results.

These policy areas focus to a large extent on formal, scientific knowledge and technological innovations. They also treat the research and technology development process as a rather linear process, based on Schumpeter's distinction of stages of invention, innovation and imitation. This questions the effectiveness and wide-spread applicability of such concepts, especially for smaller firms, where research has shown the innovation process to be non-linear and open-ended (e.g., Collinson 2000, Freel 1998), a lower use of scientific information from (semi-) public research institutions as well as a lower involvement in scientific cooperation mainly due to their smaller absorptive capacity in systematically monitoring and applying external research (Cohen and Levinthal 1990).

Moreover, science and technology policies often have been criticised for their explicit focus on sectors, industries or technologies, justified by most governments with market failures (Lageman et al. 1995). Evaluations indeed show mixed results. For example, in Germany programmes aimed at fostering high-technology start-ups have had a limited outreach, supporting around ten new companies per year, which is attributed to their narrow focus on high-technology fields instead of applying a broader view to innovative enterprises. Another example concerns science parks which often were not able to recruit sufficient firms or they have been recruiting the 'wrong' firms, i.e., non-innovating companies (Pratt 1997).

On the other hand, Karlsson and Andersson (2005), in their study on Sweden, indicate that the spatial pattern of industrial R&D is sensitive to the location of university R&D, thus implicitly confirming the importance of policy approaches aimed at fostering technology transfer. In summarising a number of studies on university technology transfer efforts, Phan and Siegel (2006) consider the following lessons to be taken from these studies: For technology transfer to be successful, the institutional, organisational and individual contexts need to be taken into account. The authors moreover point to the fact that universities need to think strategically about this process, as their review demonstrates that university administrators appear to be more often concerned with protecting intellectual property rights and appropriating the rewards of technology transfer than being concerned about creating an appropriate context for technology transfer to take place.

As a more recent approach, designed to cope with the shortcomings of science and technology policy, *innovation policy* sets out to create enabling structures for research and development, looking beyond the single firm for other means of how to best support RTD. Innovation policy focuses on interaction between firms and with the institutional infrastructure, such as R&D and higher education institutions. This approach was developed during the 1980s in Western Europe, mainly at national and EU level. In the context of globalisation and increasing international competition, its aim is to strengthen the innovation capability and competitiveness of European industries. Although a broadly defined innovation policy is a relatively new policy area, it basically goes back to older concepts of industrial policy aiming at raising the competitiveness of national industries.

Originally, innovation policy has been defined by Lundvall and Borrás (1997) as a policy 'that explicitly aims at promoting the development, spread and efficient use of new products, services and processes in markets or inside private and public organizations'. Nowadays, a main objective of innovation policy is to foster and speed-up learning and innovation processes within firms as well as between firms and their environment (Nauwelaers et al. 1999). With this, innovation policy has wider objectives than those of science policy and technology policy, but incorporates elements of both policy areas.

This reflects the view that the strengthening of innovation activities represents a main answer to the requirements on firms, nations and regions from the globalisation process by enhancing learning abilities of workers, firms and 'systems'. This philosophy also is the basis for the more recent concept of *territorial innovation systems*, which emphasizes the role that regional and national environments play in influencing RTD and innovation in firms. One focus of policy attention in this regard has been on regional clusters of innovative enterprises and the role of the external environment in fostering innovation (Lawson 1997). For example, regional clusters of innovative firms could result from attempts to reduce the uncertainty of any innovation process through networking where spatial proximity is one important requirement for trust between companies to develop. A '...timely exchange of information and accumulation of knowledge' (Feldmann 1994: 27) also partly explains regional clusters of innovative firms. They are a means to facilitate access to information and knowledge transfer, which would involve being near to universities and scientific research institutions.

More recently, in connection with the recent trend on creativity and its relation to regional RTD, one study started arguing for regional RTD policies to be oriented more towards the different types of knowledge in innovative industries (Hogni Kalso, Vang and Asheim 2005). Drawing on Florida's general framework of technology, tolerance and talent, the authors divide the knowledge base into synthetic, analytical and symbolic knowledge, each of which they furthermore discuss in relation to specific policy actions. Albeit being overcritical of Florida's works, their policy framework offers valuable insight into how regions might go about fostering RTD.[13]

- Synthetic knowledge consists of a combination of tacit and partly codified, but existing knowledge, as is typical for industries with incremental innovative activities such as plant engineering or specialised advanced industrial machinery. In such cases, development activities are more important compared to research actions; knowledge often is created based on experience, learning by doing and incrementally improving existing routines. Regions relying on such industries and knowledge base are walking a tight rope between fostering the embeddedness needed for tacit knowledge to be codified externally and immigration of 'talents' to profit from new ideas. Policy-makers can promote regional development best through upgrading existing skills within the region.
- Analytical knowledge is abstract and mainly codified knowledge. This refers to industries which are heavily dependent on scientific knowledge such as biotechnology, information technology and others. Here, research activities are more important compared to development. In such a context, regional policy-makers are well advised to attempt attracting 'talent' from other regions, because this can have an important effect on the R&D potential in the region: 'Bringing in new researchers schooled in different traditions or with different mindsets facilitates innovation.' (Hogni Kalso et al. 2005: 12). This implies, for example, funding in order to establish renowned research institutions and to attract 'star scientists', but also creating an attractive environment for living.

2.3.2. Is There a Role for Policy?

The question remains whether and in which ways regional agglomerations and regional RTD can be supported by policy-makers. Many are sceptical about the potential of government policies in such a context (Malecki 1997), pointing out that government policies rarely can substitute for a missing technical culture and lacking networks of firms.

Cooke (1996) identifies four 'i' as being important for building innovation networks, none of which is readily accessible for policy support: identification, regional intelligence, institutions, where he points out redundancy in the form of 'fail-safe network circuitry' as common element in innovative regions, and integration, i.e., institutions forming a network and

[13] Symbolic knowledge is of less interest in the context of RTD, as this refers the so-called genuine 'creative industries' such as film, theatre, publishing, advertisements etc.

not a 'jungle'. For example, a recent study on place marketing in the Oresund region illustrates the difficulties involved in creating identification within regions, as such efforts aimed at regional identities and regional images need to be based on a 'bottom-up' approach of internal marketing, i.e., creating commitment and identity within the place first (Hospers 2004).

Another study on knowledge-intensive industrial agglomerations, although emphasizing the role of policy interventions in the process of agglomeration formation, concludes that 'efforts to directly transpose a development model from an established district are likely to be ineffective' (O'Gorman and Kautonen 2004: 459). The authors use the software agglomeration in Dublin and the IT-sector in Tampere as examples to demonstrate how the agglomeration process is contingent on local resources and processes. In terms of RTD, they convincingly illustrate how policy-makers' favourite recipe for attracting new knowledge-intensive businesses, namely an increase in R&D activities within universities, are not sufficient to create the conditions necessary for new agglomerations to emerge. This leads them to suspect that the role of policy interventions might have been over-emphasized in successful cases, as evidence also shows that policies are more effective in supporting existing industries and in exploiting established technological trajectories instead of fostering or contributing to the emergence of new technological fields (O'Gorman and Kautonen 2004: 476).

Their conclusions are echoed by Bellini and Landabaso (2005) who outline some general rules policy makers need to follow in supporting regional agglomerations, which are also applicable to issues of regional RTD: First, they indicate that as a 'golden rule' policy cannot create regional innovation systems because of their complexity, but policy can create the antecedents needed for cluster development, for example by investing in human technical capital and knowledge. Secondly, policy can contribute by supporting the global connectedness of local development, thus ensuring a continuing openness of the regional system in order to avoid 'lock-in' situations. Finally, the authors emphasize that policy is responsible for timely recognition of 'spontaneous' phenomena which may evolve into regional agglomerations (which resembles the 'good antennae' identified by Cooke 1996: 168), although this might be a far too optimistic viewpoint regarding the possibilities of policy makers.

In this regard, Hospers (2005) outlines three dangers of policies explicitly geared towards developing high-tech clusters. Firstly, the question arises of whether regional governments are capable of assessing the future economic potential of particular regional agglomerations, because any misjudgement could result in government failures. Secondly, local governments need to accept that regional policies are not about simply copying 'good practices' in high-tech development, but 'real competitive advantage comes from making a difference' (Hospers 2005: 453). Thirdly, in supporting high-tech agglomerations local governments might be prone to ignore whether preconditions for such clusters are present in the region in question. Here, low-tech cluster policies could be a viable option for many regions striving to make a difference to regional development, as 'traditional' sectors normally are well embedded in the region, having been the basis for a region's past success, although most low-tech regional policy has a tendency to be aimed at subsidizing 'loosers' instead of creating a vision for restructuring a region's R&D potential (Hospers 2005: 454).

3. Territorial Innovation Models

In this chapter, we look at territorial innovation models, i.e., popular concepts for analysing and classifying regional development paths with an emphasis on RTD, innovation and entrepreneurship in a wider meaning. In drawing on Moulaert and Nussbaumer (2005: 91), territorial innovation models (TIM) are used as 'a generic name for models of regional innovation in which *regional and local institutional dynamics* play a significant role'.[14] In particular, this chapter discusses how different concepts attempt to explain comparative advantages of regions in economic development and in their innovativeness and level of R&D.

3.1. Industrial Districts and Localised Production Systems

The industrial district model emphasizes the role played by cooperation, mutual trust and 'industrial atmosphere' in the innovation process. It is based on a number of empirical studies of the so-called 'Third Italy', covering successful regions in Northern Italy, which have shown a particular regional dynamic (e.g., Alberti 2003, Becattini 1990, 1991, Brusco 1986, 1990, Dei Ottati 1991, 1996a, 1996b, 2003, 2004, 2005, Harrison 1994, Nuti 1004).[15] The 'Third Italy' is understood as a model of diffuse industrialization based on a particular mode of development and a specific mix of town and country

[14] We do not follow the classification of the authors who distinguish between three families of TIM (districts / innovative milieus, regional innovation systems, and new industrial spaces / clusters). In our understanding, regional (or national) innovation systems are an overarching concept, including the different ideas developed around industrial districts, clusters, innovative milieus and technopoles, in particular focusing on those elements and processes as introduced in chapter 2, namely knowledge and learning, networks and key actors, and proximity and embeddedness.

[15] The term 'Third Italy' is said to have been coined by the Italian sociologist Arnaldo Bagnasco in the mid-1970s; and it was popularized during the 1980s by Michael Piore and Charles Sabel, two MIT sociologist. Bianchi (1998) presents an excellent and critical overview on the development of the 'Third Italy', including an extensive reference list to authors and studies.

grounded in a cooperative family industrial culture. Each industrial district specialises on a particular area and is characterised by concentrations of small businesses. Furthermore, it is characterised by a high level of interfirm cooperation, a high division of labour, relations of trust and reciprocity, but also competition between actors (Lorenz 1992, Dei Ottati 2005). Examples of well-known industrial districts in Italy include the textile industry in Prato, furniture making in Poggibonsi, ceramic products in Sassuolo, machinery products in Modena, shoes in Montegranaro, the silk industry in Como, or – outside Italy – the automobile production or the knitwear industry in Baden-Württemberg (Staber 2001) and many others.[16]

An industrial district (or a localized production system) is both a territorial and social entity. Looking at socio-cultural factors, the success of this model is explained by factors such as the degree of social cohesion within the territory, the homogeneity of cultural behaviour, a strong sense of belonging to a local community and the family embeddedness of small firms (Andréosso-O'Callaghan 2000: 73). In economic terms, the concentration of small firms with a similar specialisation and skills is one of the major success factors producing positive externalities such as economies of scale and scope.

Proponents of the industrial district model often tend to see the concept through rose-tinted lenses, overlooking critical factors. Only few studies explicitly name the dark sides of the particular mixture of economic and social factors which constitute an industrial district (e.g., Harrison 1994, Malmberg 1996), in particular lock-in effects which might accompany social embeddedness, and negative path-dependencies regarding technology development. The original industrial district model rightly has been criticized for being too focused on local developments within the particular territory, neglecting external relations and the openness of systems (Colletis-Wahl/Pecqueur 2001: 451). In this regard, the concept of localised production systems differentiate itself from the model of diffuse industrialisation underlying the industrial district model by including all forms of regulation and by giving up the focus on small firms. In this, the localised production system can be considered a generalisation of the industrial district model (Moulaert and Sekia 2003), albeit the constituting principles resemble those of an industrial district (Colletis-Wahl and Pecqueur 2001):

- a group of firms formed around industrial specialisation, however, without focussing in particular on small firm size,

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[16] For new evidence on several Italian industrial districts cf. Cainelli and Zoboli (2004). The district model also is popular in analysing territorial agglomerations in developing and emerging market economies, for example in the context of India (Das 1998), or Mexico compared to Italy (Rabelotti 1997), generally for South Eastern countries and Latin America Schmitz (2000).

- a locality characterised by dense market and non-market interrelations which produce positive externalities,
- a dense network of traded and non-traded interdependencies amongst firms, formed around a common goal of achieving positive externalities and fostered by long-term oriented joint production modes.

Research frequently has studied the emergence of industrial districts and localised production systems in an attempt to identify possibilities to transfer these models to other regions and countries. As the development of industrial districts is grounded in place and time, with industry- and location-specific factors influencing the emergence of territorial agglomerations, Pyke and Sengenberger (1992) conclude that it is less the systems as such which can be transferred but more single elements which constitute the industrial district model.

In the context of regional RTD and innovation, an interesting debate also concerns the genuine R&D and innovation potential of industrial districts and localised production systems. In the late 1990s, Piore and Sabel (1989) considered the flexible specialisation to be observed in industrial districts as the emerging mode of regulation, which was going to replace Fordism, and which could be the basis for the renewal of regional economies. For example, this happened in Prato where the traditional textile industry was able to survive and to adapt to changing global circumstances (Dei Ottati 2005). Staber (2001) reports a similar phenomenon from the knitwear industry in Baden-Württemberg in South-Western Germany.

Supporters of the industrial district model thus suggested that the territorial agglomeration of an industrial district is said to facilitate innovation, thus emphasising the innovative capacities of small firms belonging to the same industry and local space. As Asheim (1995) pointed out, the 'industrial atmosphere' of districts with its trust-based relationships would favour imitation, adaptation and diffusion of innovations amongst SMEs, although at the same time limiting innovative activities to incremental innovations. It is in this context that Brusco already in 1990 pointed out that 'industrial districts eventually face the problem of how to acquire the new technological capabilities which are necessary to revive the process of creative growth.' (Brusco 1990: 17).

Critics of the industrial district model have drawn attention to its disadvantages regarding R&D and innovation as compared to other territorial innovation models, using the negative path-dependencies around technology development to be observed in Italian districts such as old machinery and outdated production processes as one explanation. Not surprisingly, proponents of the milieu-concept consider the industrial district as a special case of a milieu, due to its socio-cultural embeddedness, but with a low learning dynamic relative to innovative milieus (Maillat 1995), which in turn restricts its RTD and innovation capacity.

While this perspective would discard any innovation potential of industrial districts or localised production systems, Bianchi (1998) argues for a more balanced view. He stresses the 'embarrassment' of localised production systems when confronted with radical changes as observed during the 1990s in terms of globalisation and international pressure on local economies as well as the post-industrial transition process. For industrial districts to successfully cope with at least some of these fundamental changes, R&D is one of the components needed, although this might have been widely absent in the original local industrial system (Bianchi 1998: 102). In summing up, the issues for RTD and regional development to be taken from the industrial district concept centre around their (in-)ability to draw on R&D and to foster technological change.

3.2. Clusters

The concept of clusters, originating from Porter's diamond (Porter 1998, 2000), has strong overlaps with the industrial district model; in literature it is often used interchangeable and mixed up. Clusters are described as regional concentrations of enterprises *across different sizes* and their support infrastructure; this could be in one industry and along the value chain (vertical cluster) or horizontally with enterprises competing in the same sector.[17] Spatial concentration is explained by drawing on agglomeration effects and relationships between firms, in particular the intra-regional interaction of competitors, producers and consumers. For enterprises, clusters have several advantages (Maskell 2001, Malmberg and Maskell 2002): Firms are able to draw on a pool of qualified labour; they can obtain a good overview of customers' needs; competition within clusters pushes their innovation capacities; they share costs of infrastructure; spatial proximity reduces transaction costs and problems with free riders might be reduced because of mutual control mechanisms. Recently, Lorenzen and Maskell (2004) indicated that clusters do not exist solely due to economic benefits, but also because they are a more efficient 'nexus of knowledge creation' compared to the traditional firm, allowing for simultaneous exploration and exploitation of knowledge.

[17] One of the recent reports in the Observatory of European SMEs series (EC, 2002) discussed regional clusters in Europe.

Clusters centre on commercial firms and end-users, suppliers and other business partners, with other institutions influencing the way clusters function. Examples include universities, which produce specialised knowledge and trained personnel, industry associations offering specialised services or financing institutions such as venture capital fonds and business angels. Cluster research differentiates between miscellaneous forms of clusters, with consequences for RTD as these forms might influence the existence of R&D, as well as the diffusion of technologies and innovations: hub-and-spoke, value chain, knowledge-based and technology / spin-off clusters (DeMartino, McHardy Reid and Zyglidopoulos 2006).

- Hub-and-spoke clusters are characterised by power asymmetries with larger firms controlling the technological and innovative pace of the whole industry. Prominent examples include clusters in the automotive (Ford, GM in Detroit, Mercedes in Stuttgart) or aerospace industry (Boeing in Seattle). While this need not be negative in itself, it might hamper the full innovative potential of smaller firms to be realised in such cases where they have to follow the technological pace set by the hub firm.
- Value chain clusters are characterised by buyer-supplier relationships along the value chain. Power relations are more balanced; competitive strengths of these clusters are external economies of scope and scale with industrial districts being one sub-category of this cluster form. Commercial relationships are at the forefront of this cluster form, and R&D plays a lesser role in influencing cluster development.
- In knowledge-based clusters knowledge sharing and mutual knowledge creation is a competitive strength. This could be facilitated by joint R&D, but it is not a precondition for knowledge-based clusters to occur.
- Technology / spin-off clusters often are promoted through government policies or university initiatives. In a way, they resemble the hub-and-spoke model with the university or government agency being the catalyst for locational processes, although other authors have voiced some concern about the possibilities of external agencies in fostering such agglomerations (O'Gorman and Kautonen 2004, Phan and Siegel 2006). Another common model of spin-off clusters results from smaller firms being span out from larger companies. Regarding RTD, these clusters tend to be linked by a common technology rather by commercial interactions; and firms share a need for a uniquely skilled labour force, regardless of their business structure.

Each cluster might take a variety of generic structural forms, based on either power asymmetries, commercial relationships or interactions with non-commercial actors such as municipalities or universities; and none of these forms are mutually exclusive. Which factors render a cluster a successful territorial (innovation) model? In generalising the results of cluster research, Bathelt (2004, cf. also Beyer 2005) distinguishes between different dimensions of clusters: horizontal, vertical, institutional, external and power. The horizontal dimension covers issues of competition and variation, which the author considers crucial in understanding the cluster phenomenon. In general, firms competing in the same sectors might have few incentives to cooperate, but spatial proximity allows them to closely watch competitors in order to increase their own competitiveness through product differentiation, process optimizing and decreases in costs. The vertical cluster dimension captures traded interdependencies, which renders firms with complementary products and services more competitive through cooperation, and of untraded interdependencies (Storper 1995) such as the effects of embeddedness and localised learning.

The institutional dimension is concerned with elements of 'reproductivity and local buzz' (Bathelt 2004: 153) and it is of particular interest regarding RTD, as it reflects the 'soft factors' influencing cluster development. Similar to industrial districts and innovative milieus, it is the social fabric of a region which plays a particular important role in explaining economic regional development and success. Cluster researchers assume a mutual relationship between institutions and cluster structure, where regional specialisation and agglomeration are fostered by a territorially bounded system of norms, values, codes of conducts.[18] This 'industrial atmosphere' could in turn also foster a rapid diffusion of new technologies and innovation within the cluster. A local culture with cluster-specific norms, values and institutions facilitates the transfer of 'tacit knowledge', thus positively influencing the innovation capacity of a cluster: Co-location and the possibility for face-to-face contacts within a cluster generate 'local buzz', which refers to the constant flow of information and communication exposing firms to new information without actors consciously having to search for relevant information (Bathelt 2004).

The external dimension refers to the need for clusters to be integrated into external markets and technology systems in order to realise the growth potential of regional agglomerations. This indicates an important mechanism for RTD and innovation in a regional context, namely drawing on (technological) resources externally to a region, but it also hints at a possible dilemma: Trade-offs might occur between the need for embeddedness, which could lead to lock-ins, and the requirement of openness. Clusters

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[18] Interestingly, the industrial district literature also recognises co-evolving processes in this regard, with such systems of norms and local values being one of the success factors for districts, but also districts contributing to its development. See for example Dei Ottati (2005) for a description of the role of trust and its interdependencies in the district of Prato, or Wigren (2003) for her dense exploration of co-evolving social and business relationships in the Gnosjö district.

have to be sufficiently open to allow for renewal and technological development, but they also have to be sufficiently closed to allow for the institutional dimension to develop.

Finally, Bathelt (2004) mentions the relational power dimension as important element of clusters, reflecting the potential of a cluster to join its actors in mutual beneficial activities. However, again there is a trade-off involved, one between power asymmetries and blind confidence, with the latter picking up a recent discussion in trust-related research, indicating that trust-based relations have a dark side, which most research has tended to overlook (Welter and Smallbone 2006). With regard to RTD, blind confidence might contribute to lock firms in inefficient technological trajectories and increasing the risk of collective failure at cluster level (Bathelt 2004: 155). This has consequences on cluster development, as technological trajectories within clusters influence the development of the cluster, regardless of market chances and opportunities (Menzel and Fornahl 2005).

In taking the trade-off argument further, this could pose a problem insofar, as the main problem for regional development could become one of lack of diversity in technologies, thus further reinforcing existing lock-ins and resulting in a lack of creativity needed to foster cluster development. Examples are the development of the Ruhr Area in Germany, which became locked in to technologically inefficient and heavily subsidised steel and coal industries since the early 1980s, all of which prevented an effective structural change (Grabher 1993); or Route 128 in the Boston Area (Bathelt 2001, Saxenian 1994). Lessons to be learned from the cluster concept relate to the ability of clusters to overcome lock-in situations, with particular attention to the role R&D has played and could play in this context.

3.3. Technopoles and Innovative Milieus

'What constitutes the specific nature of the *technopole* is (…) the density and longevity of immaterial relations formed between its constitutent entities.' (Gaffard 1990: 433, cited in Colletis-Wahl and Pecqueur 2001). This definition once more demonstrates the difficulties involved in distinguishing between different territorial innovation models, as criticised by several authors (for an overview cf. Moulaert and Sekia 2003). We nevertheless briefly describe the concept of technopoles as this is often applied to describe successful model regions in RTD and high-tech development.

The technopole concept is a popular policy model in France. Technopoles are municipalities (smaller than metropolises) where a distinct technology focus can be identified; concentrating on fostering high-tech sectors. The explanation for spatial concentration and success result either from locational strategies of high-tech firms, which themselves follow technological trajectories, or they are a result of a top-down regional development strategy defining technological trajectories (Colletis-Wahl and Pecqueur 2001), as for example in the case of Montpellier. In reality, most technopoles appear to follow a mixed strategy where initial government programmes might trigger locational strategies of firms or, more rarely, an initial agglomeration of firms might trigger additional government support. A distinctive element of the technopole concept, with consequences for our understanding of RTD, is that it considers technological and territorial strategies in parallel.

Andréosso-O'Callaghan (2000: 73) sees local innovation systems as a basis for the emergence of technopoles, which could originate out of territorial catalysts fostering a local innovation system such as technological parks. This happens 'once co-operation structures between the different units have given rise to the emergence of recognizable specific competencies, and once it has proved able to attract new productive organizations (the territory effect).' (Andréosso-O'Callaghan 2000: 73)

In contrast to innovative milieus and other territorial concepts, less importance is given to interaction between actors within the technopole. Therefore, technopoles often have been characterised as places where learning occurs without interaction, while in industrial districts there is an emphasis on interaction, but learning is neglected (Oinas and Malecki 1999). Technopoles put more emphasis on linkages between science, technology and innovation in a linear way, with these linkages representing global technological expertise (O'Gorman and Kautonen 2004). Consequently, policy support is focused on instruments such as science and technology commercialisation programmes, venture capital initiatives, or consulting in intellectual property rights and internationalisation. With regard to regional RTD, the technopole concept might contribute valuable lessons about the effectiveness and appropriateness of different policy measures, although it neglects the embeddedness of RTD processes within the region.

This differs for the concept of the *innovative milieu*. The term 'innovative milieu' was coined by GREMI (Groupe de recherché européen sur les milieux innovateurs, e.g., Aydalot 1986, Camagni 1995, Maillat 1992, Maillat, Crevoisier and Lecoq 1994) and adapted by others, e.g. to creative milieu (e.g., Fromhold-Eisebith 2000). More and more research studies have emphasised the local and regional embeddedness of RTD and innovation, indicating trust, tacit regional knowledge, learning processes and informal interactions as important elements for regional technology-driven development. For example, a study on Munich as a high technology region in Germany indicated that this local environment is characterised by extensive inter- and intraregional linkages as well as by comprehensive co-operation between large and small firms (Sternberg and Tamasy 1999).

In this context, innovative milieus are characterised as '...a set of relationships that occur within a given geographical area that bring unity to a production system, economic actors, and an industrial culture, that generate a localized dynamic process of collective learning and act as an uncertainty-reducing mechanism in the innovation process' (Camagni 1995: 320), in short: as a milieu of networked actors. While this is similar to both concepts presented in previous sections, in contrast to models of industrial districts and localised production systems, the concept of the innovative milieu emphasizes a non-linear innovation process and brings learning to the forefront of regional RTD. The milieu is seen as an incubator for innovations and the creativity needed to renew and develop regions.

There are especially two processes which need to be in place for an innovative milieu, namely learning and interaction (Maillat 1995), with interactions triggering and producing collective learning processes. This collective and 'socialised' process allows for cost reductions within firms, thus enhancing their (technological) efficiency (Camagni 1991). Overall, milieus reduce uncertainty for firms by 'tacitly or explicitly organising the functional and informational interdependence of local actors and informally performing the SSSTTC functions (search, signalling, selection, transcoding, transformer, control)' (Camagni, 1991: 132). Fromhold-Eisebith (2000) considers three elements as essential for a milieu (or in particular a creative milieu) to develop: a dense regional fabric of interpersonal relationships for information exchange, a highly social and informal character of these linkages inducing learning processes and innovations and a common image and sense of belonging to this particular region or this particular group of actors. These linkages have to be both information-intensive and based on trust; they are built to a large extent by informal and personal relationships and face-to-face contacts (Fromhold-Eisebith 1999).

Similar to technopoles, milieus can emerge through external innovative interventions, although those need to be integrated into the local society and economy (Camagni 1995, Ritsilä 1999). Such interventions set off local synergies, which in turn foster high-tech production and innovation within the region. With particular reference to creative milieus, research also pointed to a 'depression trigger hypothesis' (Fromhold-Eisebith 2000), where economic problems within a region trigger the creativity of networks and actors in searching for new solutions, thus causing a milieu to emerge.

Issues emerging from the literature on milieus, with particular relevance for regional RTD, are the following: Most studies stress the link between spatial proximity and creativity as requirements for regional development, while simultaneously emphasizing that local embeddedness needs to be supported by good external linkages, in order to foster new input and know-how flows into the region. Such openness is of particular importance during periods of rapid technological change or intense global competition (DeMartino, McHardy Reid and Zyglidopoulous 2006): ‘Without external interaction, the local production system could suffer from intellectual ‘lock-in’ hindering the region’s ability to successfully adapt to new changing environments and hasten their decline’. (Audretsch 2000, cited in DeMartino et al. 2006: 7). This also implies that regional actors need to have high cognitive and functional competencies in their respective areas in order to successfully recognise future trends and critical situations.

3.4. From Industrial Districts to Innovative Milieus: Is there an optimal Path for Regional RTD?

Do these models of territorial development offer ‘solutions’ regarding an ideal-type way of how RTD should proceed? In summarising conditions for the evolution of regional agglomerations, Enright (2003: 109) points out that ‘reasons for the initial location of a cluster in a particular place might be different from those that foster its subsequent growth and development’. Triggers fostering the emergence of regional clusters are manifold. They include natural conditions (examples are Carrara with its marble and stonecutter cluster, Western Japan with the silk industry and the proximity to China or the Hollywood motion picture industry, where climate and cheap labour played a triggering role); pools of specific expertise, which often is to be observed in technology dominated clusters such as the optics industry in Rochester (US) and Wetzlar (Germany), the electronics or biotech industry around Boston (US) or Aachen (Germany); specific local demand such as in the Bologna packaging machinery industry in Italy, the textile machinery industry in Switzerland, or the factory automation industry around Turin in Northern Italy; location near market cities as is the case with Prato’s textile industry (near Florence) or the Solingen cutlery industry near Cologne (Germany); and the development out of related industries.

To summarize the discussion set out in this chapter and linking it back to chapter 2, territorial innovation models indicate some general requirements for regional RTD to occur, although the details obviously differ across concepts. These include the ways in which relationships between public and private actors develop, the role for private and public actors with particular emphasis on the importance of leadership, thus highlighting the role of social processes which have to complement technological leadership, all of which assist processes of localised learning needed to set off innovation processes.

While there appears to be no model which fits all nor an ideal pathway for regions to excel in RTD, it is obviously important to foster the emergence of a regional innovation system, which is aptly defined as the 'degree of institutionalization of formal and informal interaction' between various organizations including knowledge institutions, firms, local government, professional service providers and others (Lawton-Smith 2003: 900). In this understanding, regional innovation systems consist of a set of non-written, tacit rules based on trust, mutual exchange and reliability (Cooke 1998); in short: they comprise of the overall governance of regional agglomerations (Moulaert and Sekia 2003).

4. What makes Regions (more) successful in RTD? Some Examples from Around the World

This chapter presents examples of good practice regions throughout Europe and beyond. We start in section 4.1 with introducing our selection criteria, while section 4.2 presents some facts and figures on RTD in a regional European context. This is followed by snapshots of our selected good practice regions, synthesizing results both from literature and expert interviews (for a list of interviewed experts see appendix I).

4.1. Criteria for identifying Good Practice Regions

Table 1 presents a matrix developed on the synthesis of literature in chapter 2 and 3 to identify possible good practice regions.

- Vertically, criteria I-IV identify regions in relation to the dominant *territorial innovation model* (chapter 3), although as said above, this classification has to take into account overlaps between the different models. With this classification, we attempt to capture the diversity of factors influencing RTD in a regional context as well as the dynamics to be observed across different territorial models.
- Horizontally, criterion 1 classifies regions according to the *age of their industry*. Here, we draw on the sectoral variant of the product-life-cycle theory which states that young industries, i.e., industries in an early phase of their life-cycle, will be more innovative compared to old industries. Consequently, regional development might benefit from a sectoral structure where younger industries dominate. With this classification, we attempt to capture the role of the sectoral context.
- Criterion 2 distinguishes between regions according to the *R&D orientation* of their industries. This classification takes up an argument developed by Audretsch and Feldman (1996), namely that there exists a link between life cycles of industries and clusters of firms. In early stages of the industry life cycle, tacit knowledge plays

an important role for firm development, and spatial clustering allows firms to realise and draw on knowledge spillovers. With this classification, we aim at capturing the regional RTD context.

Table 1: Criteria for identifying good practice regions in RTD

	Concepts of regional agglomeration			
	I. Industrial District	II. Cluster	III. Innovative Milieus	IV. Technopoles
		1. Age of industry		
1.1. old	I.1.1. districts in Emilia-Romagna, Prato, Solingen, Tuttlingen	II.1.1. Sheffield, Tuttlingen, Jena	III.1.1. Tuttlingen, Jena	IV.1.1. n/a
1.2. young	I.1.2. n/a	II.1.2. Erlangen, Oresund, Cambridge, Oxford, North Jutland	III.1.2. Bangalore, Bremen, Cambridge, Oxford, Silicon Valley, Route 128 / Boston	IV.1.2. Montpellier, Sophia Antopolis
		2. R&D orientation of industry		
2.1. lower	I.2.1. districts in Emilia-Romagna, Prato, Solingen	II.2.1. Sheffield	III.2.1. n/a	IV.2.1. n/a
2.2. higher	I.2.2. Tuttlingen	II.2.2. Erlangen, Tuttlingen, North Jutland, Jena	III.2.2. Bangalore, Bremen, Route 128 / Boston, Cambridge, Oxford, Silicon Valley	IV.2.2. Montpellier, Sophia Antopolis

Source: Authors. – n/a: not applicable

The following regions, covering different countries and areas[19], have been selected for a more detailed study. We aimed at including a variety of regions from around the world, albeit with a particular focus on Europe. We also attempted to include lesser-known regions, although this was rendered difficult as there needed to be sufficient material available for us to analyse good practices within these regions:[20]

- In the category 'industrial district' we have selected *Prato* (Tuscany, near Florence*)* as an example for a regional successful model, where old industries (textile) with low R&D orientation dominate.

[19] Attempts to include regions in the new member states or from other post Soviet countries were not successful. Although we contacted colleagues in the new and upcoming member states, none of them was able to identify possible 'good practice' regions. Moreover, we have not been able to identify much relevant literature dealing with regional innovation models in a (post) transition context. One might assume that, given the previous focus on formal R&D in Soviet countries, regional innovation systems and innovative milieus are only slowly emerging across Central and Eastern Europe. This is the focus of an ongoing research project at ISI-Fraunhofer Institute in Karlsruhe, Germany, dealing with '***R***egional ***I***nnovation Systems & ***S***trategies in ***E***uropean *C*andidate ***CO***untries (RISSECCO)'

[20] We acknowledge that concepts such as industrial districts and clusters are blurred, as they have no clear boundaries and a considerable overlap. This is not surprising, as the concepts discussed before have originated from academic discourses which change over time. Moreover, most concepts are primarily based on empirical observations and studies.

- As representatives for the category ‘cluster’, albeit with strong overlaps into the category ‘innovative milieu’, we have selected *Tuttlingen* (Baden-Württemberg, Germany), *Oresund* in Denmark / Sweden and *North Jutland* in Northern Denmark. The industry in Tuttlingen could be characterised as old, but with a relatively high R&D orientation and actually could also be classified as an industrial district because of its SME-structured economy and vertically organised added value; the industry in Oresund is younger. Oresund also has been included because of the cross-border nature of its cluster. The region North Jutland is still in the process of developing local clusters.
- Four regions represent the concept of ‘innovative milieu’, again with overlaps into the cluster category. This refers to Bangalore (India), selected because of its ‘newness’ and location in an newly industrialized country, Bremen, selected because of the successful transformation from an area reliant on heavy industry (shipbuilding) to a more R&D based milieu, Oxford (UK), which has been included because of the university environment, and Boston/Route 128, which has been chosen for its demonstrated potential to overcome a crisis.
- Montpellier in South France stands for the French technopole concept, selected to analyse the value of this particular concept for fostering RTD.

4.2. Good Practice Regions

4.2.1. Bangalore: ‘Silicon Valley of India’ – A Latecomer’s Strategy

Some research concentrated on explaining new patterns of innovation-oriented regional development in upcoming regions from newly industrialized countries. One prominent example refers to the ‘making’ of a creative milieu in a newly-industrialized country, namely in Bangalore, India. Here, the interaction between different R&D actors creates synergies and self-reinforcing processes of innovation: The embeddedness of firms in local information systems is important to remain innovative, ‘since they encourage continuing learning processes of the resident companies in an evolutionary, self-sustaining way, combining knowledge external as well as internal to the region.’ (Fromhold-Eisebith, 1999: 234).

Bangalore, known as the ‘Garden City’ of India, is the capital of the Indian state of Karnataka situated in the southeast (cf. Figure 1). It is the 3rd-largest city in India. The metropolitan area has a population of 6.1 million. It was chosen for further analysis because it is a region from a developing country, a latecomer and a quick starter regarding regional development, all of which might be interesting for regions in newly emerging market economies, but also for old-industrialised regions searching for new ways of overcoming structural problems.

Figure 1: Map of India and the state Karnataka

Bangalore is home to many education and research institutes like the renowned 'Indian Institute of Science' (already built in 1909) or the 'Bangalore University' with 250,000 students as well as a number of public research institutes covering various areas such as IT, artificial intelligence, production technologies, aircraft- / aerospace (Fromhold-Eisebith and Eisebith 1999). These education and science establishments have promoted 'a research and learning culture in the city' (Balasubramanyam and Balasubramanyam 2003: 351), which obviously is one of the elements in assisting Bangalore's industrial development.

Bangalore covers the following main economic sectors: Manufacturing industries (it is home to the headquarters of state owned heavy industries such as Hindustan Aeronautics, National Aerospace Laboratories, Bharat Electronics, Indian Telephone Industry, Hindustan Machine Tools), space technology (Indian Space Research Organisation) and IT (esp. international computer hardware and software enterprises that have operations in Bangalore). The enterprise structure consists of many branches of MNCs (e.g. Texas Instruments, Infosys Technologies Ltd.). In total, Bangalore is the most important centre of civil and military aircraft and aerospace industry and IT in India. The IT firms in Bangalore employ about 35% of India's pool of 1 million IT professionals.

Responsible for the success are, amongst others, some general conditions and resources available in Bangalore. At first, Bangalore has a geographical position which is not only strategically important (distance to Pakistan) but also beneficial for worldwide economic connections (e.g., time zone). The natural factors such as climate and its reputation as a garden city are of advantage when it comes to life quality. Concerning human resources Bangalore (and India as a whole) has comparative low labour costs, of course. Not only price for labour is an advantage but also the quality of the workforce: The Indians are seen as ambitious and capable people who are international mobile with high qualifications. Many local universities and research centres foster knowledge spillovers into industry and close research-industry cooperation.

In a historical context, the US major enterprise Texas Instruments that 'discovered' Bangalore as a location is of great importance. It was the first to establish a subsidiary with a satellite link in 1986. This initiated the settlement of other American and European MNCs (Balasubramanyam and Balasubramanyam 2003). Not to forget the colonial British heritage that, for example, influenced legal norms, constitution, education system and media and provides stability and reliable circumstances for foreign enterprises even nowadays.

Additionally, the regional identity plays an important role. A large number of highly-qualified Indians went abroad and worked and were trained in the USA, esp. in Silicon Valley. Amongst this group there exists a strong feeling of togetherness and they formed a 'transnational community'. Many of them remigrated to Bangalore to manage local branches of MNCs or create their own businesses. Here, India's 'Non-resident Indian's' (NRI) politics helped attracting these people back to their native country. Because of their common background and similar experiences they share an 'esprit de corps' that helps building a creative milieu in Bangalore (Fromhold-Eisebith 2000).

This is supported by the 'academic flair' of Bangalore as a university city. Bangalore's software cluster owes 'its origins and growth to increased cross-border flows of labour, a development associated with globalization, consisting mostly of migrants returning to India and the so called to-and-fro type of brain drain' (Balasubramanyam and Balasubramanyam 2003: 362). The latter is an important element for Bangalore's future. As Saxenian (2004: 180) puts it: 'There is a small but growing technical community linking India and Silicon Valley – one that could play an important role in upgrading the Indian software industry in the future.' This refers to the often heard criticism that Bangalore's success is only a result of the foreign investment because of low cost advantages and has not a real impact on economic development and local entrepreneurship. There is a need for a larger vision beyond competing only on the cost advantage (Saxenian 2002) or, in other words, a change of mind from 'chasing billions' to 'shooting for greater innovation' (Fromhold-Eisebith and Eisebith 2003: 93).

Moreover, some key persons fostered the regional development: The political leaders of the Indian state Karnataka in which Bangalore is situated played a pivotal role in the development of IT and business process outsourcing. In itself, policy and governance were and are of great importance for Bangalore's development. India's political orientation in the past, the self reliance policy which was designed to help building up indigeneous competencies and which consisted of heavy central government investment in strategic goods, was followed by liberalisation (market opening). While the first helped to settle technology orientated public enterprises in Bangalore, the latter made the settlement of foreign MNCs possible. The public support worked well for several reasons: For instance, a lot of investments were made in infrastructure (e.g., data networks) that supported the settlement of foreign enterprises. In Bangalore subsidies were given on an enterprise level (e.g., free trade area and establishment of the 'Software Technology Park') so that the support reached the beneficiaries directly (Balasubramanyam and Balasubramanyam 2003). Furthermore, the government supported close relations for knowledge transfer between various actors.

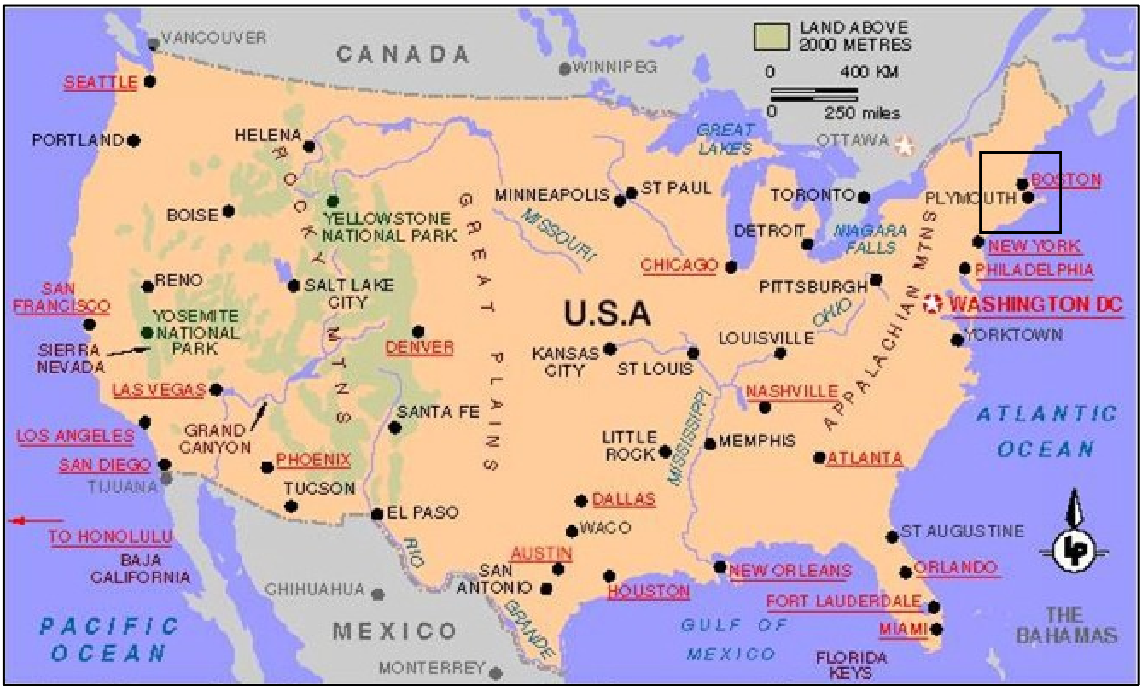
Although the headline of this chapter 'Silicon Valley of India' is widely not seen as an appropriate labelling for Bangalore (e.g., Fromhold-Eisebith and Eisebith 1999) because the region is still in no way that innovative and entrepreneurial as its American eponym, we think that Bangalore is nevertheless worth looking at. It can be seen as a 'good practice' region because of the strong influence and intensive support of policy and governance and especially the awareness and sensibility of the government for regional requirements. Moreover, the remigration of high qualified Indian people seems to be an interesting strategy for regions that suffer from inhabitants moving to other cities.

4.2.2. Boston Route 128: Ups and Downs in a World Known Model Region

Route 128 is also known as the 'Yankee Division Highway', a partial beltway around Boston, MA in the United States. Boston is the biggest city in New England, the main city of Massachusetts (cf. Figure 2).

Route 128 is no newcomer to prosperity or industrial action (Herbig and Golden 1993). Between 1975 and 1980 225,000 new manufacturing jobs were created, mostly in high-technology industries, as a result the unemployment rate in Boston was almost negligible by 1986. This so called 'Massachusetts Miracle' (Rosegrant and Lampe 1992: 2) ended in the late 1980s when a severe crisis begun because of the decline of the minicomputer industry and a reduction in military budgets, both on which the local industries were highly dependent. The crisis could arise because of lock-in effects - the industries were unable to give up old structures and replacing them by new ones. The enterprises were mainly very focused and centralised, vertically high integrated systems locked into an inefficient technological trajectory (Bathelt 2001). Because of missing interfirm linkages and inflexibility originating from the firms' separate and self-sufficient organisational structures their adaptation to external changes was hindered ‘by isolating the process of technological change within corporate boundaries’ (Saxenian 1994: 161).

Figure 2: Map of the USA



But Boston was able to change by, amongst others, shifting from declining to growing sectors, technological diversification and individual restructuring (Bathelt 2001, Best 2003). This change makes Boston an interesting example for our study, in particular for old industry regions wanting to foster regional structural change.

‘By 2000, Boston was a center for information technology, financial services, and biotechnology, and ranked as the eighth richest metropolitan area in the US’ (Porter et al. 2005: 287).Today for example, Boston is one of the leading locations for biotechnology in the world (pharmaceutical and medical applications) showing many linkages to international locations (Haeussler 2005; Porter et al. 2005). In this context, Bathelt et al. (2004: 42) are talking of ‘global pipelines’ (which means that firms are not only embedded in regional innovation networks but also in supra-regional or even worldwide social networks) that ‘offer particular (…) advantages for firms engaged in innovation and knowledge creation.’ These kind of open networks are very contrary to the earlier self-sufficient attitude of Boston’s firms. From this example one can see how the enterprises changed while responding to the market challenges.

Again, there are many different reasons why Boston could overcome the crisis and regain its strength. In the first place, its resources in terms of the excellent educational infrastructure with first-class universities (e.g., Harvard, MIT) are the basis for the highly skilled workforce available in the area. Boston is one of the most educated areas in the USA (Porter et al. 2005) which fosters innovation and regional development: 'The Boston area's extensive research and educational infrastructure is the key to the region's ability to innovate.' (Rosegrant and Lampe 1992: 182).

Besides that, the availability of building space, good surface and air transportation as well as the attractiveness of socio-cultural amenities and a specific lifestyle (managers and engineers remain throughout their career in the region) and the reputation as a technology region are main advantages assisting both Boston's structural change and its current favourable economic situation.

Boston is a region strongly linked to knowledge and science. Although scientific competition could lead to cutthroat behaviour, instead in Boston it created a 'virtuous cycle': Especially the biotechnologies conduct an 'open science' which means that research is published and openly debated, so that it can be utilised by others (Porter et al. 2005: 288).

Furthermore, Boston profited from external effects: The technological development worldwide (increasing importance of sectors like biotechnology, internet services etc.; dislocation of emphasis from hardware to services) was a benefit for Boston that 'was ideally poised to take advantage of the rise in returns to skill that so marked the last quarter of the twentieth century.' (Glaeser 2005: 151).

Contrary to regions such as North Jutland or Bremen, policy and governance is of no greater importance for regional development. Route 128's innovations have been driven by individuals, not organisations. Individual entrepreneurs fostered the development by founding new companies and introducing new technologies and products (Rosegrant and Lampe 1992). There is obviously no single dominant key person or organisation in Boston responsible for the success (or better to say the returning success), but the diversity of organisations in itself encourages experimentation and flexibility (Porter et al. 2005).

Another factor worth looking at is Boston's regional identity which has an additional impact on local entrepreneurship and innovation. In general, Boston's regional culture is characterised by technological awareness and optimism, a valuable basis for regional economic development. Moreover, the several crisis situations Boston had to face throughout its history had an influence on the people's attitude towards entrepreneurship. 'Reinvention depends critically on how people respond to crisis by innovating, not fleeing.' (Glaeser 2005: 152). Therefore, the 'tradition' of successful overcoming crisis situations influenced the regional entrepreneurial attitude in a positive way: failure is not seen as an obstacle for starting a new venture.

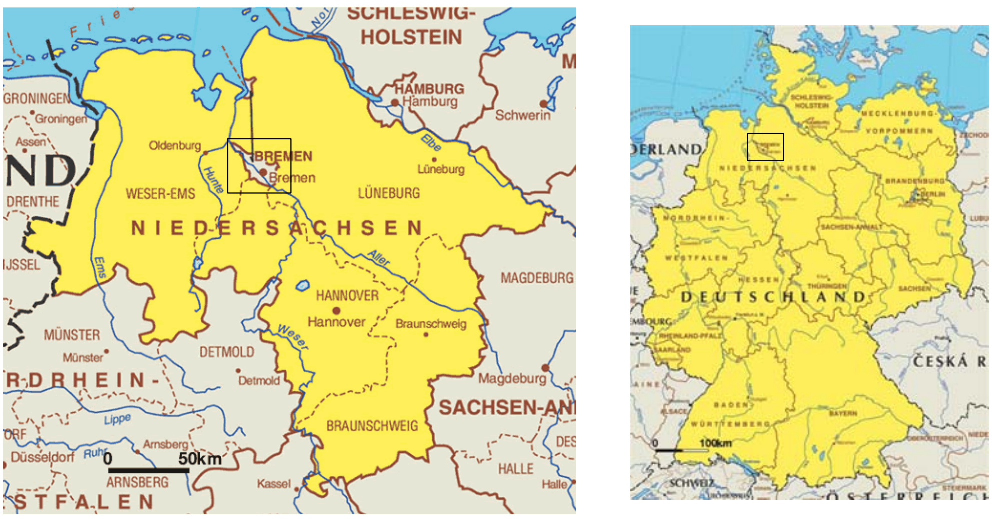
‘Boston’s continuing survival is the result of repeatedly successful responses to adverse shocks.’ (Glaeser 2005: 151). The collapse of the microcomputer market in the beginning of the 1990s was not the only crisis situations Boston came across in its history. For example, after World War II they had to face the decline of the textile industry; and after Vietnam War the decline of the public spending for armaments meant a severe challenge for the local industries as well. These market or structural changes can be seen as main external triggers for change and the search for and the acceptation of new market opportunities and the change of technological focus (lately, emergence of biotechnology and internet services).

Summing up, Boston is especially seen as a ‘good practice’ because ‘...,high technology industries have proven that they are capable of readjusting and rejuvenating their product and process structures in such a way that further innovation and growth is stimulated.’ (Bathelt 1999: 2).

4.2.3. Bremen: From Shipbuilding to High-Tech Region?

Bremen is a city as well as a federal state in Northern Germany situated within the larger federal state Lower Saxony. The free hanseatic city is located along the river Weser about 100 kilometres southwest of Hamburg (see Figure 3). The federal state Bremen is Germany‘s second biggest export location after Hamburg. The city Bremen is one of two towns belonging to the federal state of Bremen (the other being Bremerhaven) and one of eleven European metropolitan regions in Germany. There are 546,000 inhabitants in the city and 664,000 in the federal state.

Figure 3: Map of Germany and its federal states Lower Saxony and Bremen



In the 1970s and 1980s Bremen was affected by a distinctive structural change following the downfall of the shipbuilding and steel industries (Koschatzky and Stahlecker 2005). Therefore, Bremen is an interesting case study because it went through a structural change from a typical harbour and shipbuilding location relying on heavy industries to a more future orientated business location.

Bremen's employment is divided into two main sectors: 29.9% of the workforce is employed in industry and 69.3% in services. One of the main industry sectors is the automotive industry; here Bremen hosts the 2nd largest DaimlerChrysler plant with ca. 15,500 employees and 300 automotive industry suppliers. Furthermore, Bremen is one of the leading centres of the German aerospace and aeronautics industry. It employs 40% of all German employees in this sector (e.g., Airbus 380, Space-Lab, Columbus Space Laboratory). Bremen is also Germany's 'Brand Capital' in food and semi-luxurious products. It is home to important brands 'made in Bremen' like Beck & Co., Kraft Foods, Milka, Jacobs, Kelloggs, Tchibo, Kaffee HAG, Hachez, Frosta, Vitakraft, or Nordsee.

If one wants to assess the success of Bremen in terms of regional development and RTD, there arises an ambivalent picture. Talking of key data, on the one hand the inhabitants' income situation in Bremen is relatively good, for instance. Also, just to mention another example, the ability of the local university to attract research funds is extraordinary compared to other universities. Both indicators seem to hint at wealth and the existence of innovation abilities (see also Table 2 for more data referring to Bremen's success). But on the other hand the unemployment rate ranks clearly above the German average, which is still pointing at structural deficits and depicting a different image of Bremen. The fact that the knowledge intensive business service (KIBS) sector, seen by many as the main driver of technical change and economic progress, is still comparably less developed and dynamic in Bremen (Koch and Stahlecker 2004) seems to underline that the restructuring there has not finished yet. Nevertheless, as several indicators pointed at a clear improvement in many respects over the last years, this brought us to take a closer look at the 'innovative milieu' of Bremen and its possible success factors.

Table 2: Some key data on Bremen concerning innovation

Regional importance of the 14 lead and growth sectors = specialisation in national comparison	**1,20** (1,0)
Number of employees in the 14 lead and growth sectors	**93.500**
Share of the 14 lead and growth sectors in all employees	**40,4 %** (33,7%)
Index of employee development in the 14 lead and growth sectors 2000-2004	**102,8** (100)
Change of employment in the 14 lead and growth sectors absolute (2000-2004)	**2.550**
Number of sectors in which the district / town is ranked among the Top 25 in Germany	**6**
Top 25-positioning in the sectors: automotive engineering; medical technology / measurement and control technology / optics; other vehicle construction; logistics; IT; services for enterprises	
In brackets: Reference value Germany Source: PROGNOS Zukunftsatlas 2006	

First, there are the general conditions and resources to look at. Bremen, the 'short way city', (BIG Bremen – Die Wirtschaftsförderer 2006) has the advantage of being a relatively small region with the offer of all transportation links needed for business (airport, harbour etc.) within a short distance. Concerning science, there are several higher education institutes with about 35,000 students. The University of Bremen is the largest amongst them educating 22,000 students. Furthermore, there are renowned non-university based research institutes like a Max-Planck-Institute or a Fraunhofer Institute. These scientific establishments are the basis for an excellent workforce potential.

The technology park 'University of Bremen', founded at the end of the 1980s, contains the university, the technology and incubation centre 'BITZ' as well as numerous companies.

A main issue in Bremen contributing to the emergence of an innovative milieu are policies and governance.[21] Extensive (financial) support was given to facilitate the structural change. A lot of the money came out of external sources like EU funding or the so called federal financial compensation mechanism[22] within Germany. The public influence can be measured: The region's R&D expenditures reached 2.13% of GDP (2.55% in Germany) in 2003 with a relatively high share of public R&D expenditures. In Bremen, private and public expenditures are nearly identical while in Germany expenses from public sources amount only to one third. This hints at a publicly dominated

[21] What has to be kept in mind when talking of policies and governance as influencing factors for regional RTD is that Bremen's 'Senat' is an elected government that has its own legal and financial rights because of the status as a federal state. Therefore, of course, the Bremen 'region' has, despite is spatial smallness, special governance possibilities not comparable with other regions that constitute on a real regional or even local level.

[22] This 'Länderfinanzausgleich' is a mechanism whereby 'richer' states such as Bavaria have to pay some of their state budget to 'poorer' states such as Bremen.

science sector while the industry's R&D initiatives have to be regarded as comparably weak (Koschatzky and Stahlecker 2005).

However, Bremen's government is supporting the regional development not only with financial subsidies. On a strategic level, the programme 'InnoVision 2010 – Bremer Innovationsoffensive', established in 2002, is the main policy framework for future decisions. With this framework Bremen is putting a main emphasis on developing new innovation fields like T.I.M.E. (telecommunications, information technology, multimedia and entertainment), health care services and environmental economics etc. The business start-up initiative 'B.E.G.IN' is aiming at increasing the number of firm foundations in this context.

The strategic framework is supported by operative institutions like, for instance, the 'Bremer Innovation Agency', a 'one-stop-shop' business development support agency responsible for all innovation promotion programmes. Overall, the institutional arrangements are characterised by a limited amount of intermediary actors, few redundancies and clear competencies (Koch and Stahlecker 2004).

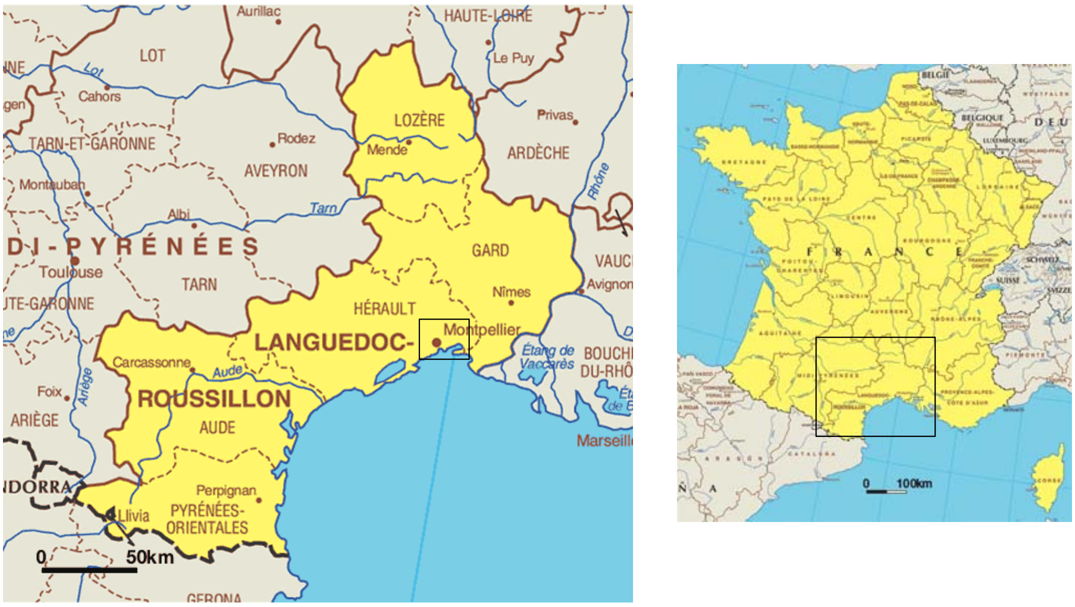
Bremen's example shows that massive political support can have some impact on the regional development. Here, Bremen is seen as a 'good practice' because the region was able to amend the economic development path according to external changes. However, one has to wait whether the impulses for innovation will switch over from the political level to the firm level – this obviously has not been yet accomplished sufficiently in Bremen.

4.2.4. Montpellier: From 'somnolent' agriculture region to booming 'technopole'

Montpellier is a city in the south of France, located at the Mediterranean coast. It is the capital of the region Languedoc-Roussillon and administrative capital of the Hérault department (cf. Figure 4). There are 225,000 inhabitants in the city and 397,000 in the agglomeration (Lasch 2006).

Montpellier is worth looking at because its success was made possible by the implementation of the 'technopole' concept fostered by regional politics. It is also of interest because it has no (historical) industrial background - Languedoc-Roussillon is the least industrialized region in France. Therefore, the technopole concept clearly focuses on the service sector. Moreover, Montpellier is a latecomer: prior to the 1960s Languedoc-Roussillon was a 'somnolent agricultural region' (Hansen 1999: 102).

Figure 4: Map of France and the department Languedoc-Roussillon



The success is evident: In less than 20 years Montpellier has risen to the rank of 7th largest French city: it is the fastest growing city in France with an annual population growth rate of 1.5. 43% of the inhabitants are younger than 30 years (Lasch 2006). Since 1985 34,000 jobs have been created. Today, ca. 33,200 enterprises, mainly SMEs, are settled in the urban community and Montpellier has one of the highest firm birth rates in France (Lasch 2003). Moreover, Montpellier is ranked the 3rd largest city in terms of congress hosting and France's third leading urban area (not including Paris) for strategic jobs (i.e. those with ‘strong potential for using gray matter’) following Grenoble and Toulouse. Finally, not to forget: Montpellier is debt-free.

General conditions and resources responsible for Montpellier’s success are, for example, the availability of high qualified people and a traditionally specific know-how (e.g., pharmacy, agronomy). This is because Montpellier has been a university city since the 13th century with 3 universities and several technical and graduate colleges. Furthermore, Montpellier has no restructuring burdens because of the lacking industrial background and a weaker influence of trade unions compared to traditional industry regions. Within France, Montpellier has one of the lowest overall costs of employment, salary levels are at least 10% below the French national average.

There are some external factors that triggered the development from an agricultural to a scientific region. The settlement of an IBM plant in 1965 can be seen as a major initial impetus for a new phase of economic development as part of a ‘third industrial revolution’ (Kolmer 1997: 127). Additionally, the development of the population had in important impact on the local economy: In the 1960s, the repatriation of Algerian-French people 'who were typically industrious and often possessed ressources' brought, besides a remarkable increase of population and workforce, 'a new spirit of enterprise to the city' (Hansen 1999: 94). Apart from that, the increase of students and high qualified working population ('cadres') made a shift from a traditional conservative dominated society to a modern, dynamic and visionary one possible. This changed also the electoral behavior from right to left (Lasch 2006).

The latter enabled the change of the local government. In 1977, Georges Frêche became socialist mayor. He and his (intellectual) staff can be seen as visionaries and key persons for Montpellier's development. They initiated the technopole concept accompanied by a creative urban planning that aimed at a continuous enhancement of the quality of life and attractiveness of the city (presence of urban and environmental amenities). That included early buying and compulsory purchase of properties which enabled spatial expansion.

The technopole concept emphasizes four technical areas ('pôles'). The selection criteria for the strategic sectors to be followed were existing capacities (e.g., universities, research institutes), existing economic starting-points and future prospects. The pôles are: 'Euromédicine' for medicine, pharmacy and biotechnology, 'Agropolis' for tropical and Mediterranean agronomy, 'Antenna' to support the development of telecommunications and audiovisual techniques and 'Informatique' for microelectronics, data processing, etc. A fifth pôle is 'Héliopolis' which concentrates on tourism and cultural activities. In contrast to the others it is not related to any spatial area or business park, but represents a kind of urban marketing concept aiming at building up and communicate Montpellier's image (Kolmer 1997).

The technopole concept is supported by a special infrastructure, e.g., the public-private association 'Montpellier L.R. Technopole', an economic development agency founded in 1986, responsible for the development and promotion of the 'pôles' (Voyer 1998). 13 business parks, 6 incubator and technology parks (the flagships are 'Cap Alpha' for biotechnology, 'Cap Omega' for ICT and 'Cap Gamma' for pharmacy) and the start-up-centre CEEI (centre européen d'entreprises et d'innovation) also support the economic development. Since 1987, more than 300 enterprises have been accompanied by the CEEI within the Montpellier agglomeration with an above-(national) average probability of surviving.

A major strength of Montpellier is its communication and outreach strategy. Image campaigns successfully stress the combination of life quality, business infrastructure and environment as key arguments for investing and living in Montpellier. This is accompanied by special support services for firms planning to localise in Montpellier (Lasch 2006).

Another success factor for the economic development is the regional identity, which can be characterised by a traditional sense of rivalry with the capital Paris and a strong sense of regional culture. This helps to concentrate on local needs and local economic development (Hansen 1999).

What should not be forgotten is that success often also has a 'dark side'. In the case of Montpellier the focus on the tertiary sector and the dynamic, small-structured economy encourage a high unemployment rate because of the absence of low wage jobs and SMEs only providing very few additional jobs. In addition, the massive expansion of the city evoked heavy traffic, a lot of construction sites, high prices for real estate and high cost of living in general.

Nevertheless, we classify Montpellier as 'good practice' because the region succeeded in creating a long-term vision for the city resp. the agglomeration and in forcefully realising it. Already since 1977 the settling policy aimed at future orientated enterprises (Schmude 1990) accompanied by a strategic urban development, a gradual expansion based on an existing concept. 'What the Montpellier experience illustrates is what a dedicated 'champion', in this case, Monsieur Frêche, can accomplish through a clear vision, motivation and tenacity' (Voyer 1998: 96).

Furthermore, Montpellier offers a successful urban marketing strategy picturing the city as a future orientated economic metropolis. Remarkable in every sense are the 'concerted local efforts and a comprehensive and consistent development strategy' (Hansen 1999: 102). Finally, the technopole concept builds on traditional strengths of the region, for example in using Montpellier's century old tradition in pharmaceutics or agriculture, thus illustrating one more an important ingredient of making a regional RTD work.

4.2.5. North Jutland: A Digital and Wireless Periphery

North Jutland is a county on the Jutland peninsula in Northern Denmark, the largest county in Denmark. It stretches from Mariager Fjord in the south to 'Grenen' in the north (cf. Figure 5). The county seat is Aalborg, the 4th largest city of Denmark. North Jutland consists of 27 municipalities, its area size mounts up to more than 6,100 square kilometres with approx. 495,000 inhabitants. It is a comparatively new and artificial administrative region (Dalborg and Halkier 1998).

Figure 5: Map of North Denmark

North Jutland is a peripheral region successfully having made the transition towards a more high-tech oriented region. Moreover, North Jutland is an interesting region due to the fact that it is an 'assisted area': For decades, the region was covered by central government regional incentive schemes. Since the mid 1980s it implemented 13 major EU-programmes (especially because of the region's structural problems). The evaluation reports state that the overall effects of these programmes were positive for the region (Pedersen and Dalum 2004).

North Jutland is traditionally characterized as a peripheral region with an unemployment rate among the highest in Denmark. The economy is dominated by SMEs with a heterogeneous economic structure. There is still a fairly large share of low-tech industries such as primary industries, agriculture and fishery while the service sector is relatively small. In North Jutland, the educational level is lower than the average of whole Denmark, although, Aalborg University is home to 12,500 students and employs more than 1,700 people (Stoerring and Christensen 2004; Pedersen and Dalum 2004).

During the 1980s and 1990s the region went through a structural change with employment moving from traditional sectors to service and high-tech sectors like mechanical engineering and electronics (Pedersen and Dalum 2004).

In this regard, two clusters are of interest in North Jutland. Firstly, there is the ICT cluster 'NorCOM', an ICT cluster that was originally triggered by a private firm initiative. A club (NorCOM) was founded in 1997 by 20 firms, the Aalborg University and the university based 'NOVI' science park that is concentrated on the ICT sector. Radiocommunications technology is the common knowledge base for the cluster. It can be traced back to 1947 when the consumer electronics firm 'SP Radio' was founded. The cluster is focused on production and development of mobile communications equipment, cordless systems, modem and fax equipment for wire and wireless systems as well as various equipments for maritime communications and navigation (Dalum et al. 1999; Stoerring and Dalum 2006).

The second cluster is an emerging medical technology cluster ('Biomedico'). This is an active, mainly policy-driven cluster initiative that started in 2000, in an attempt to repeat the success of the ICT cluster (Stoerring 2005). Biomedico was initiated by the official institutions 'Aalborg Commercial Council' and 'The Industrial Liaisons Office' at Aalborg University, later other actors joined them. The so called 'clusterpreneurs' are the key persons in initiating and fostering the cluster – representatives of university, policy, and industry (Stoerring and Christensen 2004). It was formalised in 2003 by the initiators when the 'BioMed Community' was established. In February 2003 a 'firm club' was created to support companies from North Denmark and establish synergies.

Now, what made the transistion from a agricultural periphery to an at least emerging technology region happen? Aalborg University is of great advantage for North Jutland. Established in 1974, today it has 13,000 students and 1,700 employees (Pedersen and Dalum 2004). It has a priority area in ICT sector, but has also build up substantial activities within life sciences in the last years. The university delivering engineers and basic research is seen as a core asset of the region (Stoerring and Dalum 2006). The strong university research capacity is combined with a long tradition and specific character of the cooperation between university and industry. 'The principles of project-based learning, often with the solution of real-life technical problems as part of the students' project work, have created skills highly demanded in product development intensive firms' (Dalum et al. 1999: 184). All this helped in fostering cluster development, and it illustrates as a particular strength of the regional development in North Jutland, that the region build on its core assets, namely ICT (NorCOM) and the emerging life sciences at university for Biomedico.

The regional culture resp. identity shows a local entrepreneurial spirit among researchers who are very open to creating their own businesses. Additionally, building up and maintaining social networks have a long tradition in the region (Stoerring and Christensen 2004). Moreover, a widespread awareness of the importance of further developing the technological system can be found (Dalum et al. 1999; Stoerring and Dalum 2006), all of which for example is reflected in the strong university-industry co-operations to be seen in the region and in the cluster initiatives.

Concerning policies and governance as success factors for regional development the North Jutland example also gives some indication. Here, a coherent policy framework supports the economic development. The installation of bridging institutions and (financial) support schemes on an European and national level contribute to the region's success (Dalum et al. 1999). For instance, over 40 organisations are involved in economic development activities and business support (Damborg and Halkier 1998).

In terms of regional RTD, the cluster initiatives are an interesting element of regional development. The two clusters presented here raise the question whether a 'bottom up' approach like the NorCOM cluster where enterprises / spin-offs originally were the main actors or a kind of ‘top down’ approach Biomedico represents with institutions promoting it, is the more promising cluster concept. The answer to this cannot be given at the moment as Biomedico is still a very young emerging cluster.

4.2.6. Oresund: Medicon Valley across Borders

The Oresund is a European transnational region located at the Oresund, the straits that separates the Danish island Zealand from the South Swedish province Scania and connects the North Sea to the Baltic Sea (cf. Figure 6). The Oresund consists of seven counties and 132 municipalities and the area size amounts to approx. 21,000 square kilometres. The region includes the big cities Copenhagen in Denmark and Malmo in Sweden.

Figure 6: Map of the Oresund

Overall, the region has 3.5 million inhabitants, 2/3 live in the Danish and 1/3 in the Swedish part. It is the most densely populated agglomeration in Scandinavia (Hospers 2004). The infrastructure allows access to the region by air (Copenhagen international airport) and sea (ports in Copenhagen-Malmo, Trelleborg and Helsingborg). Since July 2000 the Danish and the Swedish sides of the region are connected by the Oresund Bridge, the largest infrastructure project since the Channel Tunnel.

We have chosen Oresund as a region worth looking at because it is a cross-border region (Euregion), thus allowing us to look at how regional development progresses in a cross-border situation, which factors are favourable, which factors might hinder it. This may be of particular value for smaller countries such as Latvia where cross-border regional development is of particular importance. From 2002 to 2008 Oresund also receives huge financial support by the European Interreg IIIA programme for cross-border integration (Hospers 2004). The EU selected the Oresund region as ‘best practice’ for Euregional cooperation.

Oresund is a hub for high-tech companies and research organisations. The sectors which are especially strong are pharmaceuticals and biotechnology, ITC, food, environment, logistics and design. The branding 'Medicon Valley' refers to a successful biotechnology cluster in the Oresund region. It is one of the world's leading biotech clusters containing a high concentration of pharmaceutical companies. Since 1997 the region is jointly branded as 'Medicon Valley' to reflect the region's life science strongholds (Medicon Valley 2006).

Oresund's workforce mounts up to an average of 1.8 million people. More than 105,000 people are employed within the ICT sector and the medicinal industry employs 52% of all people employed in this sector in the whole Denmark and Sweden. In the region, more than 170,000 companies, mostly SMEs, can be counted. Nevertheless, the industrial structure in general can be described as low-tech because R&D extensive manufacturing is still larger than its R&D intensive counterparts (Maskell and Törnquist 1999). The only exceptions to this are the Nordic pharmaceutical firms and some others with large R&D investments and good collaboration with universities (OECD 2001).

Oresund is home to one of the worlds' best biotechnology clusters. It is 'uniquely positioned to attract industrial and financial investments in the biomedical area' (Boston Consulting Group 2002). It is the most important investment region in Scandinavia and ranked number three in Europe when it comes to the number of investment projects (Oresund Region 2006).

A main issue for the region is knowledge and learning, which helped making this region successful in terms of knowledge transfer between research and education institutions and industry: 6 research parks, 11 university hospitals, 14 cooperating universities ('Oresund University') are populated by 140,000 students, 10,000 scientists and 6,500 PhDs providing active cooperation with 800 other universities worldwide. Strong basic academic research and a long tradition for clinical research as well as a good cooperation climate between research and economy help fostering knowledge spillovers (Boston Consulting Group 2002).

The engagement of private actors (e.g., 'Big Pharma' is represented with approx. 70 enterprises in Medicon Valley) is a main element fostering economic development (Toedtling et al. 2006), but effective collaboration between local parties has its positive influences, too: politicians from both sides of the border have been working together trying to break down barriers and stimulating integration in the Oresund Region. They try to achieve this through cross border institution building ('The Oresund Committee', 'Oresund Science Region': e.g., Oresund IT Academy, Medicon Valley Academy). The latter, a joint non-profit-making organisation for the bio-medical firms in the Oresund area, acts as an intermediate between universities, enterprises, and authorities aiming for promoting the medical sector (Sornn-Friese and Sorensen 2005).

Although the Oresund region follows a clear-cut branding strategy, the region building has not yet finished as well, which is shown for example in the fact, that even the definition of the region has not yet been accomplished (OECD 2001): Cross border differences in laws and institutions (e.g. in taxation rules, labour law, traffic regulations, opening hours) hinder the regional development in this regard. Therefore, a cross border 'Oresund feeling' does not really exist, but '…borderlanders (..) still feel Danish or Swedish rather than residents of a new Euregion' (Hospers 2005: 277). Maybe this could lead to an 'Oresund paradox': although the branding strategy is worldwide accepted as best practice it is not grounded in the region itself and a regional (cross border) identity is still missing. In this regard, the Oresund region has not yet fulfilled the expectations in terms of cross-border linkage formation (Sornn-Friese and Sorensen 2005). Creating a regional identity seems to be the biggest challenge for the Oresund region for the years to come. 'It will presumably take decades to devise functioning institutions, and generations to create the sense of belonging and social fabric that underlies the development of all societies.' (Maskell and Törnquist 1999: 80).

In terms of 'good practices' the Oresund region definitely succeeded in creating a branding and image that is working well in the outside world. Moreover, the region is home to the largest concentration of highly educated people in Northern Europe, a fact which helps in explaining its success in developing a cross border cluster. Although integration problems do still exist one has to admit that the Oresund has grown 'into a modern and dynamic diversified economy' (Hospers 2004).

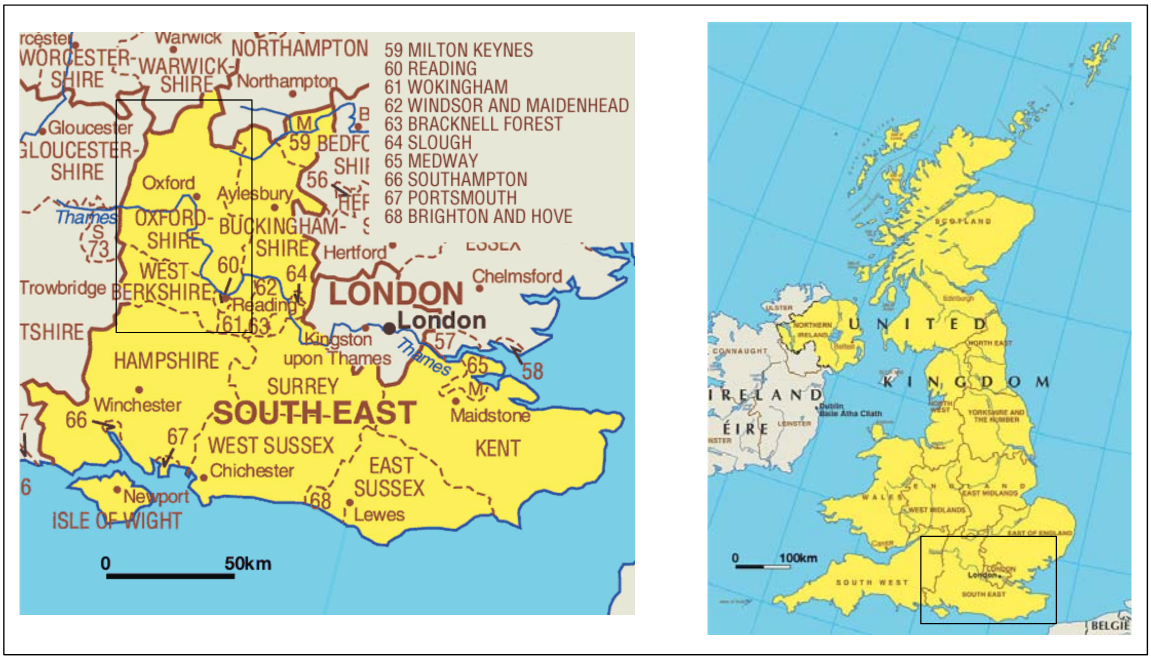
4.2.7. Oxfordshire: From Rural Area to High-tech Economy

The county Oxfordshire, consisting of five districts, is located in the south east of England to the west of London (cf. Figure 7) Oxfordshire covers an area of 1,000 square miles with a population of 619,000 whereof approx. 22% live in the city of Oxford. It is the most rural county in the South East region with over half the people in the county living in settlements of less than 10,000 people. Therefore, it has the lowest population density in the South East region (Oxfordshire County Council 2006).

Oxfordshire can be seen as a 'good practice' region because it has undergone a 'dramatic transformation in its economy in the last 40 years' from 'being a rural county with a historic university and a car industry' to a county now having 'the fastest rate of employment growth in high-tech sectors in the UK.' (Lawton Smith et al. 2005: 455).

This high-tech economy is rooted in its industrial past when motor car and component manufacturing, food industries and blankets were the leading sectors. Today, the key industries include cryogenics, instrumentation and motorsport (Lawton Smith et al. 2005). In the latter, Oxfordshire claims world leadership as it is home to two Formula 1 teams, Williams and Renault. Furthermore, Oxfordshire has the largest concentration of printing and publishing companies in the UK outside London (Oxfordshire County Council 2005).

Figure 7: Map of the UK and the South East region



Of great interest for our analysis is the high-tech sector in which Oxfordshire showed extraordinary growth rates over the past years. In general, the technology-based sectors (e.g., cryogenics, bioscience, precision instruments, medical and optical equipment, motor racing industry) are characterised by diversity rather than by specialisation in a particular field (Lawton Smith et al. 1998). Especially, the biotech sector forms a small but significant part of the high-tech economy in Oxfordshire (Lawton Smith 2004). The high-tech orientation shows itself also in the employment structure: Oxfordshire has a comparably very high proportion of employment (4.9%) in R&D activities (Oxfordshire County Council 2005).

Knowledge and science is of great importance for Oxfordshire's economy. The resident workforce is amongst the most highly qualified in the country. Over 33,000 people (11% of the workforce) are employed in the education sector. Oxfordshire is home to four universities: Amongst them, the most famous is Oxford University, dating back to the 13th century and hosting 17,000 students. The only 10 years old Oxford Brookes University is home to 18,000 students. All guarantee a constant flow of high qualified people (Oxfordshire County Council 2005, 2006). The scientific scene in Oxfordshire is amended by a number of research institutes, national laboratories, hospitals and medical research units (Lawton Smith et al. 1998). 'Oxfordshire's stock of highly skilled and talented people is exceptional by UK standards and it is this that provides the basis for the recent momentum, itself a reinforcing factor.' (Lawton Smith et al. 2005: 455). These academic institutes are not only valuable as education institutes and providers for high qualified employees but also as research establishments with linkages to local industries (e.g., by collaborative projects), attractors for external monies and birth places for spin-offs. Concerning the latter, since the 1990s and 2000s the regional culture (esp. within Oxford University) is characterised by the emergence of an entrepreneurial culture (Lawton Smith et al. 2005).

Concerning key actors Lawton Smith et al. (2005) show that a small group of individuals or as Florida (2004) puts it: a creative class, has a great impact on the regional development. In the case of Oxfordshire amongst these people are entrepreneurs, academics and members of public institutions. 'What we have here is a concentration of the very highly-skilled (talented) individuals who have either created resources or made it more possible for those resources to become more highly available.' (Lawton Smith et al. 2005: 475). Overall, this underlines the importance of efficient networking and the connection to science as basic elements of successful RTD.

Although politicians are amongst the key actors policies and governance are not of the same importance for regional development as in other regions. 'Local government-funded or collectively-organized agencies appear to play a limited rather than a major role in advising or helping local technology-based firms.' (Keeble et al. 1998: 27). Though, one successful example of an institutional arrangement is 'The Oxford Trust', a local charitable organisation that aims at encouraging science and technology enterprise. For example, the Trust has an innovation centre with incubator units and runs business seminars (Lawton Smith et al. 1998).

Overall, Oxfordshire is a good example for a rural region building its economic development on existing strengths and enlarging them according to the environmental changes. Moreover, it illustrates the role universities could play in fostering regional RTD.

4.2.8. Prato: Flourishing Industrial District of Traditional Industry

The province of Prato is located in the Tuscany region of Italy. It consists of 7 communes and its capital is the city of Prato (cf. Figure 8). Overall, there are approx. 241,000 inhabitants.

Figure 8: Map of Italy and its province Prato

Prato[23] is an industrial district based on traditional industries (textile) known as the 'rag capital' (Dei Ottati 2004: 9). It is defined as an industrial district because of Prato being a 'socioeconomic and territorial entity characterized by 'complementary activities' and a set of independent, specialised and small and medium-sized firms operating within a relatively restricted area.' (Bellandi and Romagnoli 1994: 145).

Prato can look back on a long history in textile industries already starting in the Middle Ages.[24] From the beginning of the 1950s until the middle of the 1980s Prato experienced an extraordinary increase of the number of establishments and textile workers based on the foundation of numerous new SMEs and a constant inflow of immigrants as a workforce. Then, it had to face a phase of stagnation and restructuring

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[23] To limit the region analysed to the province of Prato is actually not sufficient: The textile area is quite larger than the province of Prato as there are also municipalities in the provinces of Pistoia and Florence that can be added in. But for 'the greater ease of retrieving data, (…) we will make the Prato industrial district 'ideally' correspond to the province of the same name , even though, (…) the textile area is larger.' (Dei Ottati 2004: 9).

[24] See Dei Ottati 1994 for further information on Prato's history.

because of the worldwide decrease of demand for textile products (Dei Ottati 2004; Bellandi and Romagnoli 1994).But the textile industry was able to survive and to adapt to changing global circumstances (Dei Ottati 2005). Today, Prato's economy is still based mainly on the textile industry despite a marked reduction in terms of establishments and workers compared to the 1980s. In terms of turnover and industrial employment Prato's local system ranks second in Tuscany after the Florentine area and it is one of the leading areas in central Italy. Moreover, Prato's textile industry has a high share of international relations in terms of exports and imports (Dei Ottati 2004).

Today, Prato is home to ca. 8,000 firms whose manufacturing specialisation include, amongst others, yarn for the knitting industry, fabric for the clothing industry, textile for products for furnishing, and knitting goods (Piscitello and Sgobbi 2004). Prato produces a wide range of products made of different fibres and for diverse final uses, produced by various manufacturing processes and for heterogeneous market segments. Over time, the production system within the district has changed: 'Not only is there a greater variety of textile products, but Prato firms are also prolonging their activities in the downstream industries such as clothing and distribution, transforming the district into a huge fashion system, a leader in the world by size and quality of production.' (Dei Ottati 2004: 11). The concentration of small firms with a similar specialisation and skills is seen as one of the major success factors producing positive externalities such as economies of scale and scope.

Another success factor in Prato's history was its ability to rapidly adapt to changes in the international competitive environment (Dei Ottati 2004, 1996b). For instance, as a reaction to the downturn phase in the 1980s, the business models changed: While in the past the enterprises in Prato had a high degree of productive self-sufficiency, nowadays some intermediate production is being subcontracted to or bought from outside the district, often from countries with a lower level of labour costs. Furthermore, the firms reacted to the crisis by upgrading and differentiating their textile products. Additionally, while the employment in the industry sector decreased an expansion of the service sector occurred (Dei Ottati 1996b, 2005). The latter refers to a remarkable birth and fast growth of firms specialised in producer services due to, for example, the outsourcing of activities before and after the production process or the emergence of new needs for, e.g., information technology (Lazzeretti and Storai 2001).

As in every industrial district, the enterprise structure in Prato is characterised by an extensive division of labour. This means the enterprises are highly dependent on one another to be able to carry out their own tasks. Typically, the added value is vertically constructed and organised by subcontracting. On the one hand there are the so-called ‘final(-ordering) firms’ specialised in market analysis, purchasing raw materials, designing of sample collections, sales and marketing of finished products, as well as accomplishing logistic and organisational duties and responsibilities. On the other hand there are the ‘phase firms’, the local suppliers resp. subcontractors, specialised in one of the different textile stages (spinning, weaving etc.). While the former concentrate on product innovations, the latter often develop process innovations (Dei Ottati 2004, 2005; Piscitello and Sgobbi 2004).

As collaboration is of critical importance for Prato’s firms, networks play a fundamental role. The enterprises ‘have to construct a network (…) of business relations with other firms for the most part possessing complimentary specialisations.’ (Dei Ottati 2004: 21). Initially, these relationships are characterised by cautiousness, while later high stability (often relations persist over many years), social proximity and trustworthiness dominates (Dei Ottati 2004, 2005).

As most enterprises in the industrial district Prato are SMEs they are also highly dependent on their employees’ skills in order to guarantee high product quality. Mostly, the firm’s owner is involved in the daily business and therefore not able to control the employees work in detail, therefore personal trust plays a major role in intra-organisational relationships as well. According to this, in Prato’s enterprises an atmosphere of high collaboration and absolute trust can be observed, although lately some erosion of trust can also be noticed, especially concerning the relationship between final firms and local subcontractors (Dei Ottati 2004, 2005).

Not only personal relationships together with values and implicit rules matter, but also formal institutions like the local government, trade unions, and trade associations are being helpful by ‘sustaining and reproducing situation of high-trust and social cohesion’ (Dei Ottati 2004: 29), e.g., through regulating local subcontracting.

The example of Prato shows how a region in a traditional economic environment with a rather low R&D level can perform well by benefiting from spatial and social proximity and trust within an industrial district and being assisted by local institutions. ‘In fact, the industrial district firms base their competitive advantage on the plus of flexibility, entrepreneurship and creativity that can be found in the local system, precisely thanks to that fabric of trust relations in which economic transactions are embedded.’ (Dei Ottati 2004: 32 and references cited there).

4.2.9. Tuttlingen: A Global Centre of Medical Technology

Tuttlingen is a city as well as a district in the south of Germany‘s federal state Baden-Wurttemberg. It is located in the region Schwarzwald-Baar-Heuberg and situated at the river Donau (cf. Figure 9). There are about 135,000 inhabitants in the district and 40,000 in the city Tuttlingen. Tuttlingen was first mentioned in the year 797 A.D. and received town charter in 1338.

Figure 9: Map of Germany and the federal state Baden-Wurttemberg

Tuttlingen is the location of a traditional cluster specialised in the surgical instrument industry with two distinct product sub-sectors: traditional surgical instruments and new products such as endoscopes, surgical apparatus and implants. The cluster's enterprise structure is dominated by SMEs with the exception of only some major enterprises (e.g., Aesculap). There are approx. 300 producers of final instruments, 200 subcontractors, and 80 commercial enterprises (the latter were increasingly founded since 1980). The two biggest enterprises within the cluster offer nearly half of all jobs, only 42 enterprises employ more than 20 employees, and more than 200 enterprises do not have any employees at all. Because of the high specialisation and concentration there is also high competition within the cluster (Nadvi and Halder 2005; Halder 2005). But Tuttlingen's producers also benefit from economies of agglomeration in the cluster, e.g., economies of scale and scope, low transaction costs, good reputation in the global market, and linkages worldwide through many local traders and buyers (Halder 2004).

In Tuttlingen, a production value of 610 million EUR per year is counted and nearly two third of the total output is exported to the USA, the EU and Japan. Therefore, the firms are largely independent of the national framework conditions and national demand but, of course, they do strongly depend on international framework conditions (like the US dollar exchange rates) and international demand (Binder and Sautter

2006). Tuttlingen keeps global linkages to e.g., Sialkot / Pakistan or Penang / Malaysia because of international production locations there. On the one hand this means cheaper production cost due to a lower level of labour costs for Tuttlingen's producers. But on the other hand this could foster increasing competition and the danger of loosing specialised know-how to the subcontractors abroad and therefore threaten Tuttlingen's success .

The success of this cluster is evident: 75% of Germany's surgical instrument industry is located in the rural district Tuttlingen. The firms are technology leaders in their special sector worldwide. Therefore, they call themselves '*Weltzentrum der Medizintechnik*' [which means 'glocal centre of medical technology', translation by authors of this report]. The economic success can be measured within the population as well: For instance, since 1990 the population has increased by 12.2% and the region's unemployment rate amounts to under 6.2% which is far below national average. 55.6% of Tuttlingen's employees work in lead and growth sectors compared to only 33.7% in over-all Germany (Prognos 2006; cf. also Table 3).

Regional importance of the 14 lead and growth sectors = specialisation in national comparison	**1.65** (1.0)
Number of employees in the 14 lead and growth sectors	**27,200**
Share of the 14 lead and growth sectors in all employees	**55.6 %** (33.7%)
Index of employee development in the 14 lead and growth sectors 2000-2004	**104.2** (100)
Change of employment in the 14 lead and growth sectors absolute (2000-2004)	**1,100**
Number of sectors in which the district / town is ranked among the Top 25 in Germany	**2**
Top 25-positioning in the sectors: Metal industry; medical technology / measurement and control technology / optics	
In brackets: Reference value Germany Source: PROGNOS Zukunftsatlas 2006	

Table 3: Some key data on Tuttlingen concerning innovation

What is responsible for this success? Firstly, there are some general conditions resp. resources that contribute to it. Tuttlingen has a highly skilled workforce with a special, tacit knowledge and specific mechanical skills that have been built up for many years. This enables the firms to produce high product quality and makes them technology leaders in their specific field. The workforce's technical and mechanical skills help to steadily improve product quality and to satisfy market needs.

A high ability of knowledge absorption is indeed one of the success factors of Tuttlingen. Therefore, the regions aims for fostering cluster orientated education further.

For example, the Business School Tuttlingen offers a special MBA programme 'Medical Devices & Healthcare Management', the Vocational Training Centre (Berufliches Bildungszentrum Tuttlingen – BBT) provides qualification in surgical instrument making, and there exists a Competence Centre for minimal invasive medicine (MITT).

The internationalisation of the cluster is another issue promoting knowledge transfer and fostering innovation 'back home' in Tuttlingen. For instance, external connections from leading enterprises ('pipelines') import new knowledge into the region. This is followed by the so-called 'buzz' in the cluster: the ability of SMEs to copy and improve new products just by seeing and copying them, which illustrates how RTD may progress. 'The example of Tuttlingen shows how cluster advantages foster small firms in times of relatively stagnating technology. Where radical technological innovation is limited, the rapid assimilation of incremental innovation is the key to competitiveness for producers. In this situation, the evolutionary effects of adoption, modification and selection of small improvements, which are accelerated through the cluster dynamic, provide the decisive competitive advantage for the cluster' (Halder 2004: 229).

The regional culture and identity is another point worth looking at. Tuttlingen's people or the Swabians in general are said to have a special inventor's mentality that helps them to improve products incrementally and to create new ones. What is special also for the regional culture is the people's self-reliance and their solitary attitude which create a special entrepreneurial potential. Interestingly, this creates a particular culture of mistrust in the cluster, and the hard competition and mistrust within the cluster are a stimulus for entrepreneurship and innovation ('structural mistrust'). Therefore, multilateral cooperation within the SMEs in the cluster is not working at all – but it is working well on a bilateral basis with a partner outside the cluster (e.g., Sialkot / Pakistan).

On the contrary, strong trust in personal networks is an important point in Tuttlingen. 'The majority of the firms are avoiding direct competition by pursuing a niche strategy and using long-standing personal ties' (Binder and Sautter 2006: 157). This occupation of niches led to a wide-spread variety of products together with the ability not only to supply special and customized products but also to satisfy even smaller demand volumes. This in itself is a success factor for the cluster again.

Summing up, Tuttlingen seems to be a 'good practice' region in terms of competing successfully in a globalised economy. Furthermore, the regional endeavours to foster cluster specific education and knowledge could be a good example for other regions trying to improve their performance in special sectors.

5. Conclusions: What can make a Region (more) RTD-oriented, Innovative and Entrepreneurial?

In this chapter, we conclude by introducing a multidimensional stylized matrix of good practice elements within a region, which is supposed to serve as one basis for the development of a generic and adaptive model (5.1). We end by pointing out major challenges in fostering regional RTD (5.2).

5.1. What makes a Region a 'Good Practice' Region?

The following matrix (cf. Table 4) aims at capturing (i) input factors required for RTD, (ii) processes, (iii) outcomes, and (iv) possible critical points arising throughout regional RTD processes. In this way, we attempt to capture elements of what makes regions successful in growing and developing rather than a whole strategy for creating good practices within regional RTD. The ideas for this matrix result from our review of literature and theoretical concepts, the review of good practice regions and expert interviews as well as from the discussions during the first international project workshop end of June in Deventer, Netherlands.[25] Based on this evidence, there are three main categories of factors influencing RTD, namely resource endowments, institutional infrastructure and knowledge. Within each category, one can distinguish between 'hard' and 'soft' influences. Each group of factors results in factor-specific outcomes, and factor-specific processes are needed to influence the level and existence of regional RTD. We also indicate critical points possibly hindering the influence of these factors on RTD. We recognise overlaps, but also a need to conceptually distinguish between the three main categories of factors and processes influencing RTD. We also recognise a need to simultaneously focus on factors and processes as it is the interplay between both that can foster RTD.

[25] The matrix also was used to derive the questions for the regional assessment exercise (deliverable 2.3).

Table 4: Stylized Matrix of Good Practice Elements in Surveyed Regions

1. Input Factors for RTD

General conditions / resources

Category	Hard Factors	Soft Factors
Territorial resources	Infrastructure, human capital, institutional capital	Regional image and identity
Market resources	Size, customer base, distribution channels	Openness of customer base for new processes, products, services
Industry resources	Age, size of industry base, technology orientation and level of technology use	'Curiosity', i.e., open for new ideas and divergence from routines
Processes	Regional 'antennae' in picking up regional triggers and using them in implementing regional RTD strategy	

Institutional Infrastructure

Category Level	Hard Factors			Soft Factors	
	Macro level	Meso Level	Micro level	Macro Level	Micro Level
Systemic / organisational	Division of tasks and responsibilities between municipalities and other agencies	Dense institutional networks of intermediaries (chambers, business associations, unions, business support agencies)	Dense business networks Good general support infrastructure for entrepreneurship	'Open region'	High level of cooperation and interaction between actors
Individual	High communicators	Network promoters	Star scientists	Open minds	Networking skills
Process	Good governance • political commitment and coherence of institutional infrastructure • integration and openness at individual and institutional level Creation of social capital in the form of trust-based and reciprocal relationships within region				

R&D Oriented Knowledge Base

Category Level	Hard Factors			Soft Factors	
	Macro level	Meso Level	Micro level	Macro Level	Micro Level
Systemic	Existence of (semi-) public research infrastructure, universities	Existence of education and vocational training institutions	Special R&D support and education, instruments for research transfer	Existence of technical culture	Common values such as trust and reciprocity
Individual	Policies for attracting high skilled labour	Policies for upgrading skills	R&D policies, policies for upgrading skills	Attitude towards (new) technologies	Professional skills & social competencies
Process	Shift from individual and spatially dispersed learning to collective learning Creation of technical culture Creation of social capital in the form of trust-based and reciprocal relationships within region				

2. Critical factors

Overembeddedness	Possible indicators
• lock-in effects • negative path-dependencies • inertia	• culture: traditional regional identity, often 'glorifying' industrial past • technological regime and sector structure: lack of or low R&D-orientation, low technical culture and interest • networks and firms within region: closed networks, focusing on intra-regional linkages, neglecting extra-regional and international linkages

Source: Authors, based on literature review and key expert interviews.

RTD is facilitated by *general conditions and resources*. This includes the endogenous resource base within a region, its natural environment determining the quality of life within a region, its industry base and market structures. Our review of good practice regions illustrates different 'hard' conditions triggering RTD (cf. chapter 4) as for example the existence of lead users in an established industry, which played a particular important role in Tuttlingen, or the settlement of major multinational enterprises such as IBM in Montpellier, 'Big pharma' in North Jutland and Texas Instruments in Bangalore. Soft factors such as regional image and identity and the 'openness' of a region are both important inputs as well as outcomes of regional developments. Our empirical examples indicate also one important process in triggering regional RTD, namely that the regions and their key actors need to have excellent regional 'antennae' in picking up and recognising external triggers which they can use to implement a regional RTD strategy, as happened for example in Bangalore or Montpellier.

In terms of institutional infrastructure and the R&D oriented knowledge base, we distinguish systemic and individual levels horizontally, and between macro, meso and micro level vertically. Regarding the *institutional infrastructure*, systemic factors refer to the overall network infrastructure required for RTD within a region, including political institutions on macro level, business intermediaries on meso level and the general business support infrastructure on micro (firm) level. Individually, the institutional infrastructure needs to be complemented by key actors such as high communicators on macro level (political level), network promoters on the meso and star scientists on micro level. Examples from our good practice regions show the diversity of key actors: In Montpellier the main key actor is the socialist mayor George Frêches who rules since 1977; in North Jutland 'clusterpreneurs' foster the development of new regional agglomerations etc. Regional RTD obviously needs individuals with high commitment and a vision for their region.

This is also reflected in the soft factors needed for the institutional RTD infrastructure to evolve, such as the openness of a region, the open minds and curiosity of actors, all of which are reflected in a high level of cooperation between different actors and good networking skills. Processes needed for improving or building such a RTD institutional infrastructure refer to good governance within and amongst networks on different levels as well as the creation of trust-based relationships amongst different institutions and actors.

People also matter with regard to regional knowledge, knowledge transfer and regional learning. In order for a *regional R&D oriented knowledge base* to emerge, a region requires a knowledge infrastructure on systemic level, including research institutions and universities on macro level, educational and vocational training institutions on meso level and specific R&D support and education programmes as well as measures fostering research transfer on the micro level. Individually, knowledge might be attracted to a region by policies aimed at attracting highly skilled labour. This could include remigration policies as in the case of Bangalore, where the Indian government fostered the remigration of those Indians who had previously worked in the Silicon Valley. This also could refer to policies geared at retaining skilled graduates within a region or at educating them as in the example of Tuttlingen, where the business school offers a specialised MBA programme tailor-made for the surgical instrument cluster.

Soft knowledge-based factors include the existence of a technical culture on systemic level and people's attitude towards this as well as their professional and social skills and the existence of values supporting such a culture. All this helps foster learning processes within the region.

5.2. Challenges in Fostering Regional RTD

The matrix presented above illustrates a variety of elements and processes on different levels which can foster regional RTD, and consequently lead to more innovative and entrepreneurial regions. However, our analysis so far also confirms that it is the *interplay of various factors with region-specific resource endowments* which will foster regional development. We need a process-oriented view on RTD. For example, a sole focus on building up stronger local or regional linkages will guarantee nothing. Especially with regard to R&D, inward-looking regions and policies to strengthen local linkages in the absence of an international dimension are likely to fail. Malmberg (2003, p. 151) states that there has been 'too much focus on interaction between firms within geographically defined spaces and numerous rather pointless attempts of trying to assess the degree to which there is actual interaction going on locally'.

It is in this context, that *lock-in effects and negative path-dependencies* could hamper regional development even in cases which one might consider good practice examples. Although there might be a tendency to assess more causal importance to geographical and historical linkages on RTD in a regional context 'for the simple reason that co-relations are more easily detectable in those dimensions' (Mothe and Paquet 1998a: 9), the discussion around good practice models often tends to neglect the 'dark' sides of regional RTD development. Lock-in effects can have several reasons.

Regarding socio-economic influences on regional RTD, lock-in effects are the dark side of embeddedness, arising from networking and closed networks, as was illustrated vividly by Grabher (1993) for the Ruhr Region in Germany. Overembeddedness results in 'atrophied embeddedness' or entropy[26], which reflects the 'progressive deterioration of embedded networks' (De Bruin and De Bruin 2002: 241). The reasons for this phenomenon are manifold: embedded ties could be used increasingly as control mechanisms instead of reflecting trust-based relationships; exclusive and closed networks lead to information isolation, there is an increasing trade-off between stable links and more profitable relations outside the network, the predisposition to render firms in networks highly dependent on each other, the potential problem of reciprocal ties that stronger firms might have to back up weaker firms.

Negative path dependencies[27] also occur with regard to technological development. Path dependency reflects the viewpoint that technological change in a society depends quantitatively and/or qualitatively on its own past (Nelson and Winter 1982). Path dependency has its advantages, but it could also contribute to technological lock-in effects as happened in the case of Route 128 (Bathelt 2001). Technological lock-ins at firm level can usually be explained by switching costs, costs of not learning as fast as competitors, and the genuine uncertainty about the actual benefits of switching (Arthur 1994, Sornn-Friese and Sorensen 2005). High costs of switching encourage individuals to recur to a familiar course of action, which as a rule reflect their previous experiences and tacit knowledge. This in turn tends to reinforce trusted and known codes of conduct, resulting at the individual level in an escalating commitment to viable, but not necessarily the best courses of actions (Whyte 1986). From a macroeconomic point of view, these lock-in effects may foster a sub-optimal resource allocation (Arthur 1994), thus in turn preventing regions from realising their full R&D and growth potential.

Moreover, there is an additional crucial issue related to 'good practices' of regional development: Not only are 'good practices' depending on regional conditions, thus questioning their applicability elsewhere, but they themselves also might have a 'life cycle': What constitutes a good practice region today, might not be a good practice region tomorrow. For example, Tichy (2001, cited in Menzel/Fornahl 2005: 135) identifies a 'cluster-paradoxon' as one reason for negative developments in once successful clusters: While a narrow cluster specialisation increases possible synergy effects between enterprises, this also results in strong technological commonalities of enterprises, thus reducing the probability of radical innovations. This in turn influences the possibility of a cluster to

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[26] Entropy is a concept from natural science. In social science it is used to explain what happens when systems are closed and do not allow for any new input from outside.

adapt to externally changing conditions. In this regard, Taylor (2005) pointed out that regional concepts often do not pay enough attention to the chicken-egg-problem in extracting elements and trajectories of regional growth: 'Are the currently observable relationships in a cluster indicative of the processes that created growth (decline) up to the point they are observed? Are these observable relationships portents of the future that might bring very different outcomes?' The author indicates that there is also evidence showing that embedded relationships may be a relic of the past instead of being a result of clustering tendencies.

5.3. Unsolved Questions in Regional RTD

All this poses additional *challenges to be taken into account by policy-makers*. This first of all concerns the pertinent question of how far policy is able to influence regional development paths, which in turn influences the role policies should and could play. Taking a critical stance towards the general search for 'best practices', Hospers (2005) suggests that there has been too much emphasis on 'trendy' high-tech clusters using so-called 'best-practice' models derived from California, Bavaria, Sophia-Antopolis and Oulu in Finland. These cases, he suggests, have fairly well documented uniqueness and it is questionable whether these unique development paths can be followed by others. Hospers (2005) argues that regional strategies may be more effective if they focus on global-local interactions rather than simply on local linkages (as demonstrated by the examples of Tuttlingen and Bangalore), bridge the gap between high-tech and low-tech activities, and attempt to forge 'new combinations' of existing knowledge in traditional sectors, as happened within regions in Denmark (furniture industry), Switzerland and East Germany (watchmaking in Switzerland and Glashütte in Saxonia) and the Italian textiles (as demonstrated by the example of Prato).

Moreover, taking into account that it is the combination of hard and soft factors which apparently makes regions 'model regions' and a good practice example in regional RTD, the issue still remains as to which kind of policies, instruments and programmes are needed in particular in triggering new unique industrial trajectories. There are two questions which need to be solved in this regard. Firstly, the evidence presented in this report illustrate differences in regional RTD strategies presenting policy-makers with

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[27] Path dependency is a concept used in evolutionary and institutional economics to explain a 'lock-in' to a non-optimal course of action. The most prominent examples are the 'QWERTY' keyboard and the VHS video systems (cf. Arthur 1994). This could be extended to spatial developments where path-dependent behaviour is not negative as such: Arthur (1994) presented a model of spatial path dependency, illustrating cluster tendencies as the probability function of already existing firms in a given location. Self-reinforcement mechanisms (interplay of institutions and patterns of choice) add to this.

the problem of selecting a suitable RTD strategy. For example, in North Jutland we can observe both a bottom-up strategy in the emergence of a regional R&D agglomeration (the NorCOM IT cluster) and a more top-down oriented strategy in the case of the Bio-Medico cluster (cf. chapter 4). Similarly, Bremen presents a case of regional RTD heavily supported by the local government, thus questioning its longer term sustainability. The question remaining open here is one of how best to support regional RTD and the role policy can play in fostering it.

Secondly, there is an issue related to whether good practices can be transferred and replicated in other regional contexts. The conceptual and empirical evidence presented in this report points out that it is less strategies and concepts we can transfer from one region to another but rather elements and processes which need to be taken into account, and which might have some scope for replication. Moreover, variety matters, as Hospers (2005: 453) indicates: '*Real regional competitive advantage comes from making a difference*, not from doing the same things other regions do. (…) Likewise, by investing in similar technologies and copying 'best practices', regions undermine their potential competitive advantage and should not be surprised that in the end a painful regional shake-out will occur.' [emphasis added by authors of this report]. In summing up, this indicates that regions should draw on their existing core competencies and regional advantages and using those to make a difference in RTD.

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Appendix I: List of experts interviews

Expert	Interview by	Place & Date	Themes
Prof. Dr. Harald Bathelt	Susanne Kolb, personal interview	Marburg, 7th June 2006	Boston Route 128, cluster
Prof. Dr. Martina Fromhold-Eisebith	Prof. Dr. Friederike Welter / Susanne Kolb personal interview	Aachen, 1st June 2006	Bangalore, creative milieu
Dr. Gerhard Halder	Hagen Radowsky, personal interview	Stuttgart, 29th May 2006	Tuttlingen, cluster
Prof. Dr. Knut Koschatzky	Hagen Radowsky, personal interview	Karlsruhe, 5th July 2006	Bremen
Dr. Frank Lasch	Susanne Kolb, personal interview	Regensburg, 8th June 2006	Montpellier, technol-pole
Dr. Helen Lawton Smith	Prof. Dr. Frank Peck, telephone interview	26th June 2006	Oxford

Appendix II: Internet links for further information on 'good practice' regions

(selection)

Bangalore- India:
www.onlinebangalore.com
www.bangaloreit.in

Boston - USA:
www.cityofboston.gov

Bremen - Germany:
www.big-bremen.de
www.bremen.de
www.technologiepark-bremen.de

Montpellier - France:
www.tech-montpellier.com
www.montpellier-agglo.com
www.capalpha.com
www.capomega.com
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