Foresight as a governance concept at the interface between global challenges and regional innovation potentials

Knut Koschatzky
Fraunhofer Institute for Systems and Innovation Research,
Breslauer Strasse 48
76139 Karlsruhe, Germany
k.koschatzky@isi.fraunhofer.de

Abstract

In recent years, new regionally based strategy-building processes emerged at the interface between public policy and the social coordination of collective action. Foresight as a governance process to stimulate regional innovation and strengthen the regional economic system against global competition became a popular concept. Based on the experiences of a strategy-building process in the Italian autonomous province of Trento, it is the objective of this paper to sketch recent theoretical and political developments regarding multi-actor and multi-level governance and policy concepts at the regional level.

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1. Introduction

In recent years, European regional governments and authorities are confronted with a new situation. Several challenges affect the sustainable development of regions. Among the most important ones are the global competition for scientific excellence and capital, the European enlargement, and the clustering of scientific-technological competences in the European Research Area (Edler *et al.*, 2003, European Commission, 2001). Additionally, the regionalisation of innovation policy and a better knowledge among policy-makers about theory-based concepts like regional learning, knowledge accumulation and innovation contributed to the development of new creative policy concepts (Cooke *et al.*, 2004, Fuchs & Shapira, 2005). Due to the promotion of the scientific and technological potential of specific regions forming the backbone of national and even European innovation systems, those regions which are the object of national or even European policy support are privileged in their development. As a matter of fact, the fight for public funds became harder for many regions and especially all the regions which rely heavily on knowledge resources for economic and social development entered a new form of global competition.

In this context, general ideas about innovation are not sufficient any longer. Suggestions derived from regional innovation models, like the stimulation of firm foundations and networks or the building-up of new skills in a region, provide a general direction, but have to be much more precise in order to be sufficiently competitive. Questions about implementation, costs, effects and efficiency, and the responsible organisation or policy level need precise answers. One of the new methods aiming to formulate such regional development strategies and visions is regional foresight (Renn & Thomas, 2002). Not only has the region gained ever more importance as a governance entity for supranational, national and regional policy concepts during the last few years (Koschatzky, 2005, Kuhlmann, 2001, Kuhlmann & Edler, 2003), but also as a platform for foresight exercises. This kind of strategic knowledge and vision building enables regional policy-makers to systematically look into the longer-term future and to draw policy-relevant conclusions for today. Under these circumstances, the regional orientation in innovation policy presents fundamental preconditions for institutional re-organisation and the formation of new politico-economic institutional arrangements. To what extent such processes will be effective within individual regions depends not only on the specific problem situation in the region, the type of policy and the measures implemented, but also on whether impetus for change comes from within or without the region. It also depends on the absorptive capacity of regional administrations and governments and on the impact of regional interest coalitions. Although innovation-oriented regional policy was already postulated at the end of the 1970s (Ewers & Wettmann, 1980), it is now being filled with new content.

Based on the experiences of a foresight process in the Italian autonomous province of Trento, it is the objective of this paper to illustrate recent theoretical and political developments regarding multi-actor and multi-level governance and policy concepts at the regional level. The paper will identify success factors and obstacles in foresight exercises and will discuss the applicability of this instrument for the development of problem-oriented regional innovation strategies.

2. Regionalisation of innovation policy

2.1 The regional dimension of innovation

The more recent regional-economic concepts and theories contributing to the theoretical stock of new economic geography and its policy implications are at least partly influenced by findings from innovation economics, according to which innovation is not a linear, but an evolutionary, cumulative and feedback process, which can only be realised by cooperation and the economic and social interaction of different actors, and as a result produces technological, organisational and social innovations (Freeman & Soete, 1997, Grupp, 1998). Learning, knowledge accumulation and innovation are regarded to be the most important driving forces for economic renewal and growth (Lundvall & Johnson, 1994, Gertler & Wolfe, 2002). In theoretical concepts like clusters, innovative milieux and regional innovation systems, regional innovation differences are no longer explained by locational parameters (as was the case in the traditional location theories; cf. McCann & Sheppard, 2003), but by specific knowledge modes (Florida, 1995, Hassink, 1997, Morgan, 1997, Saxenian, 2000).

Learning and innovation do not take place in a social vacuum, but in close interaction with different elements of a social system. A significant role in this aspect is attributed to tacit knowledge – that is, knowledge that is difficult to put in writing or formulas and is based mainly on experience. This type of knowledge is very difficult to transmit over distance because it requires personal contact and knowledge of the framework conditions. It is generally agreed that embeddedness in a social context can immensely facilitate the transmission of tacit knowledge. Embeddedness is here defined as the extent to which a social community operates in terms of shared norms of cooperation and trustful interaction (Cooke, 2002). Thus, knowledge modes with a strong tacit character are available only at certain locations and learning processes linked to this knowledge can only be realised there. According to Storper (1995), these "untraded interdependencies" are characteristic for many regions, whereby the regional production structure and specialisation, the amount of human and social capital, and the institutional framework, determine not only the spatial range of the mutual exchange of informal knowledge and thus the spatial

characteristics of knowledge specifics, but also the kind and quality of the regionally bound knowledge.

With regard to innovation, it is necessary to distinguish between social capital and human capital (Nielsen, 2003). The term "capital" implies a certain proximity to physical capital. But whether social capital is more similar to physical capital or to human capital is treated differently by different authors. According to Coleman (1988), social capital is the basis for forming human capital. Social capital is more closely associated with the family and the community, while human capital is the sum of the social capital stock over the whole generation. In one of the two models Lucas outlined in his 1988 paper, he came to the conclusion that in regions with a higher amount of human capital, higher learning effects and thus higher growth rates can be generated (Lucas, 1988, p. 41). Transferred to regional innovation activities, those regions have an innovation advantage in which the human capital base is collectively involved in continuous learning processes. Since human capital effects are external, i.e. "...they have external benefits that spill over from one person to another" (Lucas, 1988, p. 40), not only learning, but also innovation are permanent processes (cf. also Romer, 1990 for a similar argumentation).

2.2 Multi-actor and multi-level regional governance

Due to its important role for social, economic and technological development, the accumulation of social capital (and thus human capital) is the object of public governance (Aldridge *et al.*, 2002, p. 51 f.). According to a definition of *governance* given by the Commission on Global Governance (1995, p. 4), it "...is the sum of the many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and cooperative action may be taken. It includes formal institutions and regimes empowered to enforce compliance, as well as informal arrangements that people and institutions either have agreed to or perceive to be in their interest." As one of the major institutional systems responsible for public governance, governments are - as well as other organisations and their individuals - part of a social system and both depend on and contribute to the social capital of the respective social system. The governance ability of public and private bodies is thus influenced by the available knowledge and the available competences for policy-making.

In a democratic system, policy-making does not take place in the form of top-down decision-making, but is a result of networking and bargaining between different societal actors, interest coalitions and systems, i.e. in multi-actor innovation policy arenas (Kuhlmann, 2001, p. 961). Since the beginning of the 1990s, regional governments have become an additional and important actor in this policy arena. According to Cooke (2003, p. 414), this move towards regional innovation "...brought

a stronger emphasis from the sub-national, mainly regional level of intervention as animator of a public-private process of interactive and mainly incremental learning-based innovation". For regions, new disruptive technologies opened a "window of opportunity" for the self-contained configuration of their science and innovation system (Charles *et al.*, 2004, p. 11), for the creation of interfaces with national policies and for a stronger participation in measures formerly mainly oriented towards the national level.

With regard to policy, regions are the object of multi-actor and multi-level governance structures and hierarchies. Their policy arena is composed of a variety of political, corporate, social and scientific actors. Due to the complexity of intervening factors at the regional level , "...necessary adaptation and integration processes of the innovation systems can obviously not be carried out completely and exclusively by the original innovation actors in industry and science on their own...(but)...state-based mediating and regulatory capacities of political systems will remain indispensable" (Kuhlmann, 2001, p. 966). National, and even supranational policies influence and shape regional development. Regional policies (and planning) have to be coordinated with upper hierarchical levels. Multi-level governance relationships create the preconditions for regional openness, the link-up to supra-regional, national and supra-national policy levels and the integration of regional innovation systems in globally operating technological and enterprise systems (cf. Cooke, 2002, p. 136-137). Multi-level governance relationships however can only enhance regional innovation potentials if the learning capability and absorptive capacity of the regional policy and promotional institutions, as well as the political networks existing between them are sufficiently developed (Fürst, 2001, Koschatzky, 2001, p. 334, Marin & Mayntz, 1991, p. 18). Three key roles are attributed to regional governments in this respect (Charles *et al.*, 2004, p. 13):

- setting regional priorities for research on the basis of small units of excellence not necessarily recognised at the national scale;
- negotiating with central actors to shape central policies for the benefits of their regions;
- building linkages from all elements of the regional science system into innovation, commercialisation and technology transfer.

Closely related to the regional governance of innovation are the innovative capacities of regional industrial and scientific organisations and the basic institutional fabric of a region. It has already been mentioned that the absorptive capacity of the political administration may vary between regions and that regions are not identical functional or political-administrative spatial units, but vary in size, political structure and economic strength. Therefore the scope for actively upgrading the innovation base of a region depends on the available production factors and resources and is not equal across all regions. Important questions with regard to the regional governance of innovation are related to the knowledge, tools and resources regional

governments have at hand and to the role which regional governments could and should play in developing their regional science and technology base. The possible toolbox not only depends on the specific problem situation in a region, but is also influenced by the knowledge and implementation capacities of the regional political administration. The recent merger of science, technology and innovation policy, on the one hand, with regional and structural policy on the other, means that institutions at lower political levels are entrusted with political management and controlling tasks for which they are not qualified. The regional distribution of regional innovation strategy (RIS) projects supported by the European Commission clearly shows that the regions which need funding most are still not capable of applying for funding for innovation-promoting measures and spending funds efficiently. The necessary absorptive capacity which is a pre-condition for efficient and effective political action is still missing there. Landabaso *et al.*, 2001, p. 248 and Oughton *et al.*, 2002 describe this fact as "regional innovation paradox". Before innovation-promoting measures can be successfully implemented in regions, strategic intelligence and political implementation competence must be improved.

2.3 Foresight as new strategic concept in regional innovation and technology policy

The intervention of the government in technological development and diffusion is not indisputable (Dreher, 1997, p. 26-31). Policy measures, be they oriented towards innovation and technology promotion or regional development, are only able to establish new, fundamental development paths in exceptional cases. This can be attributed, among others, to the fact that the development of new techno-economic paradigms (Freeman & Perez, 1988) is beyond the reach of political action. Nevertheless, science, technology and innovation policy may strengthen the innovation and technology competence of enterprises, broaden the regional knowledge base and give impetus for continual learning process. As a result, the chances could be improved to create regional competence centres or clusters which would contribute to growth of the regional economy and to a reinforcement of the regional technological and economic competitiveness.

Usually, there are three starting points for strategy development and implementation (cf. Figure 1):

- the socio-economic and scientific-technological subjects and objectives of regional development, competence building and sustainable trajectories;
- the shaping and improvement of the relevant systems (i.e. education and research, industry, policy, demand), their systemic integration and their institutional and organisational settings;

- governance of innovation promotion, learning and qualification, i.e. programmes, measures, regulations, their implementation and evaluation, and the ability to continuously adjust and improve.

<Figure 1 about here>

Due to the complexity of regional systems and the difficulty in assessing sustainable, future-oriented trajectories for regional development, strategic competence is a necessary condition in governance and policy-making. After making first experiences with regionally oriented and implemented innovation and technology policy measures during the second half of the 1990s, new strategic concepts emerged in recent years. One of the most important concepts related to the social capital of a region is "Regional Foresight". Foresight is a systematic attempt to look into the longer-term future and draw conclusions for today (Martin, 1995). It is by now well established as a useful strategic instrument and process in bringing awareness of long-term challenges and opportunities into more immediate decision-making. The current definition by the EU describes foresight as "a systematic, participatory, future intelligence gathering and medium-to-long-term vision-building process aimed at present-day decisions and mobilising joint actions. The term 'foresight' therefore represents the processes focusing on the interaction between science, technology and society" (Renn & Thomas, 2002, p. 11). Foresight is thus not a single methodology, but different methods can be and are mixed to fulfil the purpose. There is a whole range of formal and informal methods to perform the task of looking into the future such as surveys, trend analyses, Delphi studies or different workshop types. The central point of foresight activities is to bring together actors from different sectors, thematic and societal backgrounds so that different ideas are introduced and assessed from different points of view. In foresight exercises, expectations of diverse actors about possible development paths are purposefully brought together to formulate strategic views about the future. Participatory methods are used to include the main regional actors and generate new ideas and innovative solutions. Stakeholder involvement is critical in order to ensure consent with the action plans developed in the course of foresight exercises (Cuhls *et al*., 2003, p. 6).

In the development and management of future-oriented innovation systems, foresight activities are attributed an important role nowadays. As research and innovation policies have to be based on (implicit or explicit) visions of the future, foresight is increasingly seen as a valuable instrument for guiding decision-making, not only at the national but also at the regional level. The regionalisation of governance implies an urgent demand for regionally tailored development strategies as a means to address strategic questions in a locally restricted but socially comprehensive manner (Gertler & Wolfe, 2004). Foresight activities can provide robust orientations for regional decision-makers in detecting and identifying opportunities for further development, and pointing out networks of actors necessary to take advantage of these opportunities, as well as identifying barriers and risks that need to be addressed in

advance. The advantage of the regional level is that a wide constituency of societal stakeholders can be involved and new inter-group networks can be generated. Foresight contributes to knowledge sharing, regional learning and institutional reflexivity, because individual or group-based opinions have to be mediated in such a way that consensus-building processes will be possible. Thus, regional foresight can help to create and develop social capital, participative policy-making approaches and institutional learning (Renn & Thomas, 2002, Renn, 2003). Foresight has become a planning tool and, due to its process character, a strategy by itself. It is an open and fragile process, because the achieved results and their implications emerge only during the foresight exercise and cannot be anticipated from the beginning. Policy based on foresight thus has a strong experimental character.

Foresight exercises are open for all subjects, so that social, economic, scientific and technological issues can be addressed. In regions, foresight can be used to develop a joint vision for the future and to work out specific measures for achieving the vision and the related objectives. Especially in regions with an already developed science base, foresight can be used to find ways to improve integration of the scientific and industrial system and to foster knowledge flows between science and industry. Since both systems, despite the need for hybrid organisations (Kaufmann & Tödtling, 2001) and the inherent triple-helix structures (Etzkowitz & Leydesdorff, 2000, Leydesdorff & Meyer, 2003), operate according to own rules and incentives, the mediation between these systems, supported by the policy-makers, can contribute to a better understanding of each other's interests and can open ways for efficiently bridging both spheres by an improved transfer of knowledge and technological solutions. From being involved in this foresight exercise, regional governments come to a better understanding of the needs of each side and are able to implement tailor-made policy measures supporting a sustainable future orientation of the region and its different sub-systems.

Foresight exercises are not at all spontaneous, but have to be well prepared. Tasks related to the execution of such exercises include (Gertler & Wolfe, 2004, p. 59):

- raising awareness of the exercise throughout its duration,
- scoping the exercise to see what is possible and feasible,
- locating participants (experts and stakeholders),
- gathering background information,
- identifying drivers and perspectives,
- open consultation,
- presenting future developments,
- managing diversity of opinions and/or integrating views,
- defining key actions and priorities
- dissemination of findings.

Taking these process elements as basic preconditions for organising foresight activities, the availability of the following factors could help to positively influence their successful execution:

- an innovation-oriented local or regional institutional system with flexible policy networks and a regional governance system with a certain degree of financial autonomy;
- an institutional structure rich in learning, knowledge transfer and qualifications;
- intensive local and regional networking which facilitates mutual knowledge exchange and enables collective learning processes;
- a social capital base which is fuelled by creative and entrepreneurial-oriented human capital, contributing to a continuous renewal of the regional economy.

2.4 Conclusions and research questions

The regional promotion of innovation is a complex, knowledge-generating but also knowledge-demanding process. The amount and quality of social capital in a region and the related knowledge and learning capabilities directly affect the chances and prospects of success of regional development strategies aiming at an enlargement of the science and technology base. The governance of innovation is not only linked to profound strategic intelligence in the political administration, but also to the openness of regional stakeholders to engage in vision-building foresight processes, to accept the formation of new politico-economic institutional arrangements and to support the evolution of future-oriented development trajectories.

With regard to the basic elements necessary for the governance of innovation drafted in this contribution, a case study will be presented in the next section. The autonomous province Trento in northern Italy explicitly pursues the policy of becoming a leading innovation region in Europe and intends to broaden its science base further. Trento is an example of a modern agricultural region which tries to implement new development trajectories based on modern scientific fields and technologies by a stronger integration into the European Research Area (Cuhls *et al.*, 2003). Based on the experiences made during the foresight exercise, the paper aims to answer the following research questions:

- How can a regional strategy-building process aiming at improved innovation performance be organised? What methodological steps are necessary?
- Which requisites with regard to regional self-governance favour such a process?
- What are important aspects to look for under the specific regional conditions?
- Which kind of vision is it possible to develop and what are the major strategies to achieve this?

- Which conclusions can be drawn for the regional governance of innovation?

3. Innovation governance at the interface between regional potentials and global challenges – the case of the Provincia Autonoma di Trento

3.1 The province at a glance

For analysing the scope of regional governments in innovation policy-making, Trento provides all necessary ingredients: located in northern Italy, the autonomous province of Trento with its 477,859 inhabitants (at the end of the year 2000; i.e. 0.8% of Italy's total population) has a strong regional government with own fiscal and juridical rights and an own budget, partially fed by own taxes and transfer payments from the national government in Rome. The government has powers to formulate and implement own policy concepts and possesses the financial resources to invest in its human capital and scientific infrastructure. Knowledge building and safeguarding the regional competence basis are one of the most important policy priorities in this region. It is thus a showcase example of regional governance and policy implementation and can demonstrate the new options of regional policy-making in the global context of technology and innovation. Together with the German-speaking autonomous province of Alto Adige (Bolzano), both provinces form the NUTS-2 region "Trentino-Alto Adige". For some innovation indicators, data are only available for the region; however, the case study deals with Trento only.

The industrial sector is characterised by small enterprises: 67.4% of all firms in Trento have less than 20 employees. This is above the national average of 62.6 % (Camagni & Zaninotto, 2002). 30 % of the total production of the province consists of agricultural products (of which 90 % are apples and wine). Due to the dominance of small firms, industrial R&D is only poorly developed. Compared to the industrial sector, the science sector is composed of a mixture of smaller and larger regional and non-regional research institutes. The largest is the Centre for Scientific and Technological Research. It conducts R&D in microelectronics and advanced computer science, in voice and image recognition, in automated thinking processes, and in new materials and surfaces. In 2002, the total staff comprised 218 researchers and 35 technicians and other personnel. Besides the regional institutes, the largest non-regional research organisation is the University of Trento, which is partly funded by the provincial government, but predominantly by national contributions. It has approximately 3,500 students and employs 425 lecturers and researchers and 519 technicians and administrative personnel. Major departments are philosophy, law, sociology, physics, and informatics. Among the small and medium-sized Italian universities, the University of Trento is one of the leading universities in attracting third party research funding (PAT, 2003). The total public research budget

amounted to 97.7 million euro in 2002, an increase of 9.8 % compared to 2001 and 139 % compared to 1998. This increase clearly demonstrates the political will to strengthen the science and research base of the province and to develop it as a competitive location for scientific and technological research in Europe.

3.2 Concept and methodology of the foresight exercise

The foresight exercise was structured into four horizontal components and one vertical component (cf. Figure 2). As the early integration of the different interest and target groups is an important success factor in elaborating a sustainable regional innovation strategy, particular attention was given to include representatives from the research institutes, the university, industry and business associations and provincial policy-makers in the discussion from the first steps of the process until the conclusion of the exercise.

<Figure 2 about here>

The integrative aspect was realised, firstly, in the formation of a steering committee and a task force which supported the whole process. Secondly, the different steps and results of the foresight exercise were discussed with these two groups as well as with a larger number of actors from different interest groups at several round tables, workshops and a final conference.

The strengths and weaknesses profile of the provincial research and innovation system was based on quantitative and qualitative data drawn from a broad range of available sources. Additionally, 39 interviews were carried out. The interviews were structured according to hypotheses which were developed on the basis of the strengths and weaknesses analysis. The qualitative approach complementing the quantitative methodology was chosen in order to gain a deeper understanding of the provincial context, embeddedness and implicit and unwritten codes ruling the local research and innovation system.

There are different objectives of foresight which range from priority-setting in science and technology to vision-building and networking. The purpose of the Trento exercise was twofold: firstly, the aim was to provide inputs into strategy and policy planning, and secondly, to mobilise collective strategic actions. The preparation and specific design of the foresight workshop "Trento plus 10" was based on the strengths and weaknesses analysis of the first phase of the project. The major aim of conducting the Trento foresight exercise was to develop a joint "vision" for the future and work out specific measures in order to make the region one of the leading innovation regions internationally. The participants were invited to bring in their specific knowledge about the situation of the region so that a vision could be outlined that most of the stakeholders can support. The workshop participants repre-

sented a mix of sectors and thematic backgrounds. During the foresight exercise they were given the opportunity to discuss the future of Trento on a broad level, overcoming limited actor circles and thereby stimulating interaction, exchange and networking between the different interest groups and spheres. International regional and organisational case studies were used as further input into the vision-building process.

3.3 Strengths and weaknesses profile of Trento

Within the European Innovation Scoreboard - a data and indicator track record of DG Enterprise and a component of the Trend Chart on Innovation - regional comparative data was collected and analysed for the first time in 2002 (European Commission, 2002). Data are only available for the region Trentino-Alto Adige. Although there may be a levelling effect when data of the two provinces forming the region are collated, the presented figures at least provide some indication of the innovative performance of the province. The indicators cover human resources, employment in high-technology sectors, and the creation of new knowledge through R&D and patents. Additionally, GDP per capita is used for measuring the economic potential of the regions.

Regarding the *innovative activities* in Trentino-Alto Adige, Table 1 displays seven indicators together with the GDP per capita for the region and the Italian average. Trentino-Alto Adige exceeds the Italian average in the share of participation in lifelong learning and in the GDP per capita. Within Italy, Trentino-Alto Adige reaches the first position in the share of the population engaged in lifelong learning, followed by Friuli-Venezia Giulia. The openness for lifelong learning seems to be a strength of the region.

<Table 1 about here>

Compared with the Italian average, the region lags behind with regard to the other indicators. A much more pronounced weakness concerns the employment in medium- and high-tech manufacturing. Only 3.09 % of the total workforce is employed in medium- and high-tech enterprises, while the Italian average is 7.6 %. This certainly reflects the industrial base of the region and the still dominating traditional sectors, i.e. agriculture, handicrafts and tourism. A better performance can be found with regard to the employment in high-tech services. The pronounced service orientation of the regional economy is reflected in this figure. Public and business R&D does so far not play the role it should play in a modern, competitive regional economy. The region ranks far below the Italian average.

A better picture is painted when data from the Trentinian provincial government are used. For the province of Trento, they indicate a share of public R&D of 1.1 % of

the regional GDP and a share of business R&D of 0.5 % of GDP (PAT, 2004). With this level of R&D expenditures, Trento is much above the Italian average for public R&D (0.54 %) and close to that for business R&D (0.53 %). These performance figures make clear that innovation activities in Trento are so far predominantly science-driven, while industry plays only a minor role in regional R&D activities. Trento is also a good example to illustrate that income can be generated by other economic activities than R&D and innovation alone. Although in general there is a positive correlation between innovation and R&D on the one hand, and per capita income on the other, the region's gross domestic product per capita of 22,698 euro was already much above the Italian average when investments in R&D were still low. Unemployment is low (close to full employment) and the majority of the labour force is absorbed by the public sector. As a consequence, for a long time there was no need for an increase in public and private R&D investments.

Patent database searches for the period 1990-2000 revealed strengths in the technological specialisation profile of the province in information technology, in food chemistry and chemical engineering, in handling, food processing, and civil engineering, as well as in control technology and nuclear engineering, in biotechnology, machine tools and consumer goods (cf. Figure 3). These are technology fields where Trento (although on a relative basis) excels the Italian average.

<Figure 3 about here>

As a result of the low R&D intensity in industry, the business sector as one of the major sub-systems in the Trentinian economy is only linked to the provincial government (mainly for subsidies), but has no pronounced linkages to the research system (research institutes, university). While the government seems to maintain intense and good interactions with the other three systems, networks between the other systems are not so well developed and could be strengthened (cf. Figure 4). In extension of the so-called Triple Helix (Etzkowitz & Leydesdorff, 2000), an innovation system can be modelled where all four systems – state, university, research and industry – are closely overlapping (right part of Figure 5). In this type of system, there is no clear division of systems or division of labour anymore. Agents are acting and enacting processes in different systems at the same time. This system is closely held together by networks which combine actors from all four systems and organisations that belong to different systems at the same time. These networks and organisations act as interface agencies which bring together the requirements and needs from the different systems so that they can adapt to each other and grow interactively.

<Figure 4 about here>

According to the strengths and weaknesses profile, the Trentinian science and innovation system could be characterised by the following positive attributes: close in-

formal networks, institutional 'thickness' and embeddedness, rich innovation infrastructure, a well developed funding system, a sheltered area for building up national and international competitiveness, and a relatively stable and static population of firms (sectors and numbers of firms). Major weaknesses concern the weakly developed cooperations between science and industry and within the business sector, the strong public sector and the high propensity for subsidies with so far little strategic priority-setting, the inadequately developed entrepreneurial culture and small industrial base, the fragmented and segmented firm structure, and the low R&D and high-tech intensity in the region's industry.

From these strengths and weaknesses it can be concluded that Trento faces four major challenges:

- the need for a better integration of the science and business system,
- an improvement of entrepreneurial attitudes and linkages within the business system,
- adjustments and the need for priority-setting in the research funding system and the research infrastructure, and
- the development of the technology base with regard to already existing strengths and the exploitation of competitive advantages with regard to other regions.

These challenges were the starting point for a further discussion of future prospects in the foresight workshop. As a general conclusion, it could be argued that certain economic and technological areas in Trento have the potential to form the basis for building sustainable, internationally competitive advantages and that an obvious need exists for a more focused strategy regarding the further development of the research and higher education system. The resulting derivation of technological and economic specialisation clusters was also discussed in the foresight workshop.

3.4 Foresight and vision-building

Policy-makers who want to promote an innovation system are faced with the problem that a multitude of governance factors and complexity exist in a regional innovation system, which make it difficult to direct and steer. Different stakeholders and actor groups, market trends and technological developments have all to be taken into account. Complexity emerges also from the fact that innovation is based on co-operation and social and economic interaction between a whole variety of different actors and different actor groups. In order to develop adequate regional research and innovation policies, priorities have thus to be set. For this reason, the foresight process in Trento was channelled by two focal dimensions, the sectoral and technological priorities and the decisive governance factors for bringing about the desired changes.

Of the six technology fields identified as critical for the future development of Italian industry – aerospace technology, advanced materials, energy technologies, information and communication technology (ICT), biotechnology, nanotechnology (Fondazione Rosselli & Politecnico di Milano, 2003) – three are already anchored in the province (ICT, microsystems, materials) and a fourth is in the process of being established (biotechnology). In such new growth technologies, there is fierce competition between territories to attract players from the business sector and academia in order to become one of the few internationally relevant competence centres. Due to the well-known mechanisms of external or network effects, critical mass and path dependence, it is generally accepted that timing is crucial for trying to establish economic clusters in new technologies.

Of the aforementioned future key technologies, especially ICT and nanotechnology can be regarded as cross-sectoral technologies, which will be developed mainly in context with other sectors. Next to direct employment effects, these technologies also lead to significant indirect effects with considerable influence on established sectors. It is generally assumed that almost all economic branches will undergo substantial changes due to advances in ICT and nanotechnology. Nanotechnology is being heralded as the driver for the next industrial revolution and expected to offer huge economic potential as the basis for many new kinds of application. As these cross-sectional technologies will affect almost every aspect of economic life, it is of great importance for territories to hold a critical mass of enterprises and private as well as public research capacity. Their cross-sectoral nature makes them indispensable as key future technologies and necessitates at the same a clear containment to specific applications.

Based on the discussion in the foresight workshop, two sectoral priorities were identified:

- "strengths bound to the territory" which centre on the agrofood sector and include green biotech as well as the environmental sciences and
- "traditional competencies with future prospects" with the mainstay in tourism, art and culture complemented by the building sector, health and humanities.

In combination with the aforementioned transversal new growth technologies, these sectoral priorities constitute the so-called Trento competence triangle 2014 which was formulated as a vision and general development objective in the foresight workshop (cf. Figure 5). The aforementioned sectors and technologies have high potential of forming a distinct specialisation cluster for the province, thus providing Trento with a unique competitive advantage among the European regions. Of the three emerging technologies already anchored in the province, especially ICT and microsystems show a multitude of possibilities for integration with these sectoral strengths.

<Figure 5 about here>

Based on this vision, central governance factors for the future development of the provincial research and innovation system were developed and discussed during the foresight workshop. These governance factors take the results of the strengths and weaknesses profile of the province into consideration and address three strategic areas:

- *policy:* institutional setting of scientific and industrial system, regulation, administration.
- *resources:* higher education, scientific and business competences, work force, infrastructure.
- *business attitudes:* networking, knowledge transfer, entrepreneurial attitudes, intermediary organisations.

Regarding governance, possibilities of a horizontal and systemic innovation policy design oriented towards cross-sectoral and interdisciplinary linkages in the Trento Competence Triangle were debated on the occasion of the foresight workshop. With respect to future priority-setting in the policy-making of the province, the discussion made clear that it will be necessary to continuously observe developments in international science, technology and markets – e.g., through strategic intelligence, further foresight exercises, evaluation and monitoring – in order to be able to flexibly adapt to changes and keep up with international competition. Research and innovation policies in the province will have to be directed more clearly to distinctive areas of research specialisation and more targeted efforts have to be directed at integrating the knowledge flow and innovation orientation across the innovation chain.

In the strategic area of resources, the highest priority was given to the system of resource allocation in the research system. Increases in flexibility, clarity and incentive orientation as well as further promotion of private investment in R&D were perceived as necessary changes in this system. A second important driver of change was developing and retaining highly qualified human capital which touches on the points of Trento's attractiveness for manpower - especially excellent international students - and the quality of its basic education. In this context, the scarcity of management competencies and capacities in the province were also debated. Particularly in the traditional sectors of specialisation, an employment push towards activities with higher value added would open new market opportunities to the province. Overall, it became clear that it will be necessary to broaden the understanding of valuable resources and their implementation in the province.

The most important topic related to business attitudes was exchange and co-operation, the fundamental structural element of innovation systems. The discussion centred on inter-firm and inter-sectoral networking and value chains, questions of

integration into national and international networks and value chains as well as the intensity of knowledge and technology transfer between firms and science sector. A further governance factor related to the weaknesses of the Trentinian innovation system was entrepreneurial attitude and "economic atmosphere". In order to transfer and transform the knowledge generated in the research institutions into marketable products and thus into welfare for the Trentinian population, it will be necessary to promote a stronger entrepreneurial spirit among a broad section of the population. This is a special challenge, since until recently the public sector provided a sufficient number of jobs, so that apart from the agricultural sector, the risky step of founding one's own business was seen to be unnecessary.

The fundamental recommendation of the foresight exercise was to create a greater flexibility within the institutional fabric of the province. This concerns the science system, in which the research infrastructure should be subject to further adjustment according to newly introduced general priorities, but also the political system, which needs reshaping with a stronger emphasis on priority-setting in research and technology funding. It concerns also the higher education system which is so far fairly independent of the provincial government's influence on its science base and which needs a stronger focus on the scientific backing of the proposed competence triangle. It even concerns the business system, in which entrepreneurship and R&D have to play a greater role in a competitive future of Trento and in which resources should be coupled and synergies exploited by a tighter networking within the system and also between the science and the business system.

The second important message was that Trento should further engage in new, future-oriented technologies, both by own development work of the Trentinian research institutes and firms, and by application of external knowledge. Much potential is already available within the province and should be further utilised. On the other hand, one important recommendation was that Trento should take care not to lose ground in its traditional sectors which can significantly contribute to value added and wealth in the province, not only today but also in the future. Yet this will only be possible, if Trento manages to link the traditional strengths with new knowledge and new technologies, thereby upgrading the former.

4. Outlook and further research questions

The Trentinian foresight exercise provides a multitude of conclusions about the potentials and bottlenecks of the regional governance of innovation. With regard to the research questions formulated in section 2.4, the following answers can be given:

- Foresight can be one instrument for deriving a regional innovation strategy. Structured and mediated by external support, individuals and interest groups can be brought together who otherwise would not automatically exchange opinions and information. On the other hand, this mediation is a difficult process and needs diplomatic and tactical skills by which the majority of the involved parties can be convinced to accept and support the achieved results. This process is fairly time-consuming and finds good starting conditions in social systems which are already experienced in bargaining between different societal actor groups. It is no doubt important that all innovation-relevant stakeholders are involved in the foresight exercise and that it is made clear from the beginning that results will be transformed into policy action.

  Central elements in foresight exercises are not only workshops, focus and discussion groups, but also the detailed quantitative and qualitative analysis of the starting conditions for a possible enhancement of regional innovation activities. This concerns both the intra-regional potentials, and the external factors influencing regional development and competition. The analysis should paint a realistic picture of the starting conditions, because a too optimistic view could direct the foresight process and the vision to be achieved into a wrong direction.

- An important requirement which favours regional self-governance is a certain degree of autonomy. This autonomy can have different characteristics. It could be political, like in the case of Trento where the regional government has the right to issue its own laws and funding programmes. It could be financial in a way that at least a certain budget is available for the execution of regional strategies and activities. It could be cultural in such a way that cultural identity and self-motivation resources are pooled together and synergy effects are created, so that at least certain activities can be implemented.

  Important is also the availability of strategic intelligence in terms of an explicit system of research priority-setting and coherent research planning. In light of the increasing speed of development and change of international markets and technologies, as well as the shortening of the validity of knowledge, it is foreseeable that such a system has to be designed not only to adapt flexibly to these changes but also to proactively conceive of and pursue strategies that will sow the seeds for future welfare even in uncertain technological terrains. Knowledge and information are the key factors for the functioning of such a system that will be fitting for the emerging knowledge age.

- In the case of Trento, three major governance factors were always important to consider: policy, resources and business attitudes. Policy issues are related to the institutional setting of the scientific and industrial system, to regulation and to administration. Resources deal with higher education, scientific and business competences, human capital, and infrastructure. Business attitudes address networking, knowledge transfer, entrepreneurial attitudes, and intermediary organi-

sations. Depending on the regional conditions and the specific strengths and weaknesses in each of these governance factors, different recommendations with regard to the improvement of systemic interaction and the upgrading of the regional science and technology base are possible.

- The characteristics of the governance factors are also highly correlated with the vision and objectives which can possibly be developed during a foresight exercise. Therefore no general conclusions can be drawn. An open question in this respect concerns the time horizon of the vision and the related strategies. Usually, a time horizon of 5 to 10 years is rather short, while over 20 years seem to be too vague for precise future projections. The Trento triangle 2014, developed during the year 2003, is rather at the lower end of the time scale than oriented too much to the future. The strategies formulated against the background of the vision had thus to include precise recommendations. For example, in the Trentinian case, one recommendation dealt with restructuring the provincial research institutes. As a lack of strategic planning and utilisation of possible synergies between the institutes was identified, it was suggested to achieve a higher degree of flexibility by transforming institutes into foundations, associations or even corporations. This flexibility should be triggered by a funding model with higher autonomy from the government, for example, in a model of 60 percent public to 40 percent third party funding. It has to be pointed out that there is not one optimal model for structuring such a research system, but different conceivable options, depending not only on organisational and disciplinary specifics, but also on political decisions and priority-setting. What the research system should provide is a structure common to all institutes that allows and promotes the exchange not only of information and knowledge, but also of researchers between the institutes and at the same time leaves manoeuvring space to adapt to international technological changes and disciplinary specifics.

  Besides the many positive aspects of the Trentinian foresight exercise, it should also be mentioned that not all regional actors were fully convinced of the developed vision and that the suggested measures were not immediately implemented, but seen as a platform for further thoughts about re-shaping the provincial innovation system. Nevertheless, in recent policy follow-up activities a new law was formulated with the following three major objectives: reorganisation of the provincial research system, reorganisation of the role played by the provincial government in RTD governance and support of the provincial research system, and establishment of stronger impulses and new instruments to foster innovation in the provincial economic system.

The general conclusion which can be drawn from the Trento case study is that regional governance of science and innovation is possible, but faces certain problems. Trento is in some ways an ideal case, because the province possesses its own political powers and responsibilities to stimulate scientific developments, knowledge

transfer and to establish a competitive research infrastructure. Nevertheless, also in Trento certain parts of the regional innovation system are out of the direct reach of the provincial government (e.g. the national university). Since it is an important player for the scientific profile and development of the province, it is at least not certain whether certain changes in the provincial research institutes will have the expected effects on the whole system. In the case that barriers between the different research organisations cannot be removed, "island solutions" might not be fully effective. It is this issue of multi-level governance which makes it difficult for regional governments to fully assess the effects and success rates of their own policy actions.

Besides multi-level aspects, also multi-actor structures are important to look at. Even in the case of the comparatively small region of Trento, a multitude of actors came together and brought in their interests in the vision-building process. These actors transport own interests, but are also part of groups and systems rooted in and outside the region. Final decisions of a regional government are influenced by overall party directives, lobbyism, bargaining processes and own interests of policy-makers. It is thus necessary to better understand the political and governance structures in specific regional contexts in order to reach some general conclusions about the governability of science, technology and innovation at the regional level.

Keeping this complexity of multi-actor and multi-level governance spaces in mind, general conclusions about strategies and institutional arrangements for efficient and effective innovation support are difficult to draw. This is especially the case because existing empirical evidence about successful development paths is rather selective (see, for instance, the frequently cited role model of Silicon Valley; Kenney, 2000), stems from a limited number of economic contexts (mainly Europe and the United States), and is difficult to compare because of different methodological approaches. As a matter of fact, it is necessary not only to carry out in-depth research about the impact mechanisms of the regional governance of innovation, the mutual interaction in multi-actor innovation policy arenas, and the impacts of multi-level governance and the side-effects of non-regional policies in specific regions. It is also necessary to enlarge the empirical basis about knowledge-based regional development strategies in order to draw on as many different case studies as possible. With regard to Cooke, 2003, p. 414), who identified two movements in policy governance in recent years, i.e. the move towards regional innovation and the move towards knowledge-based clusters, a third move is suggested here: the move towards foresight and vision-building and the necessity to understand the mechanisms of multi-actor and multi-level regional governance.

Remark

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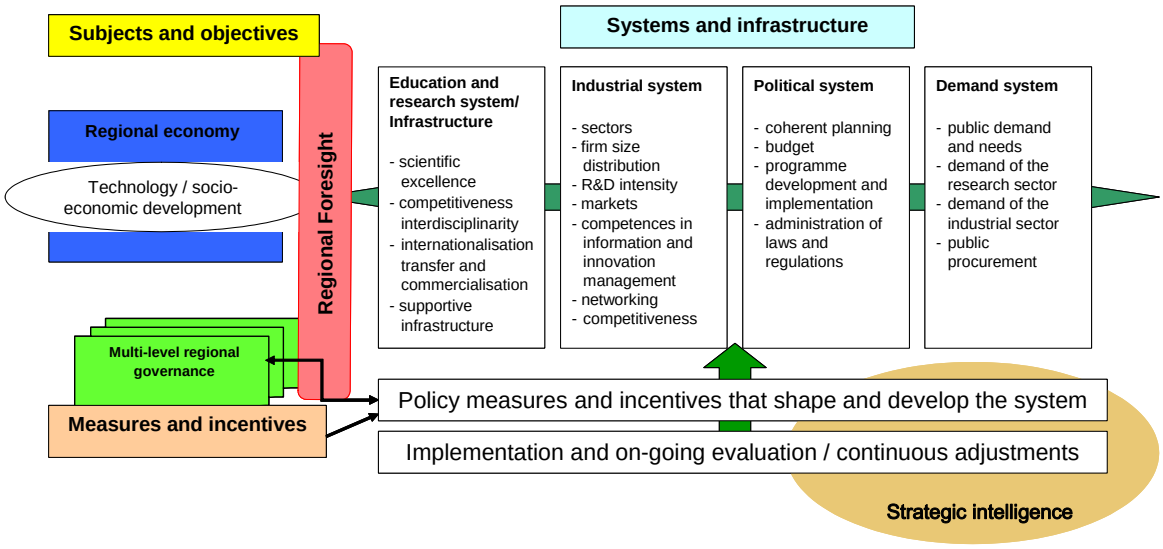
Figure 1: Model for regional innovation strategy building



Source: own draft

Figure 2: Organisation structure of the Trentinian foresight exercise

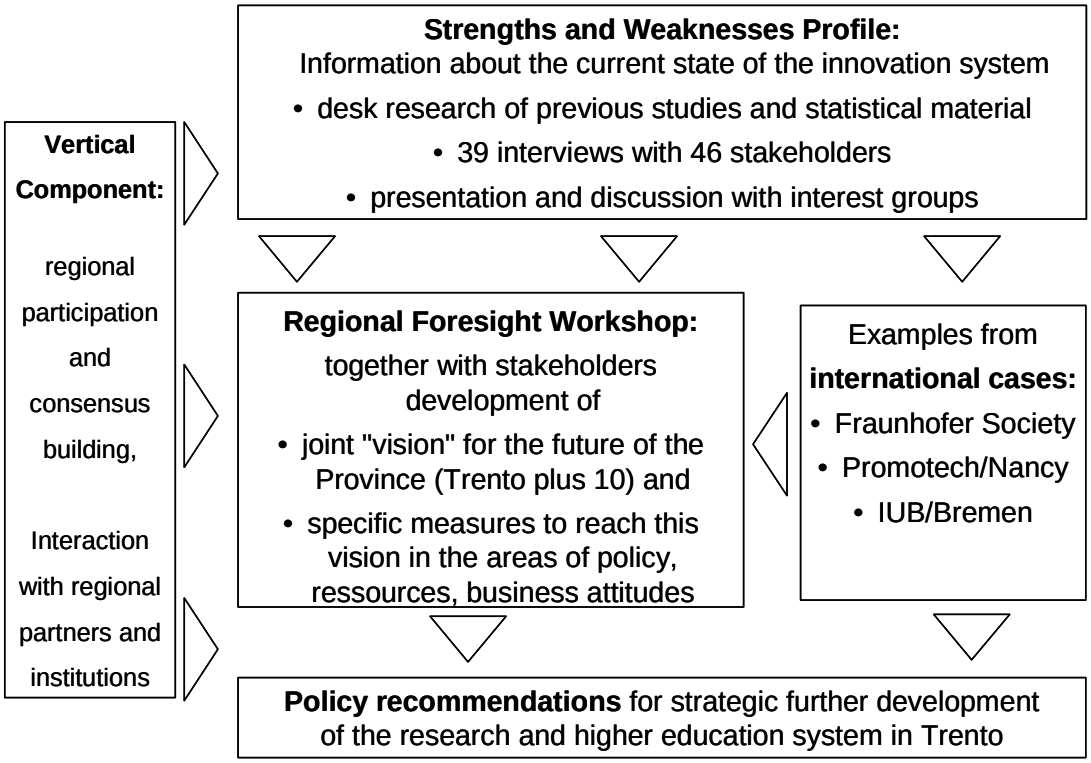
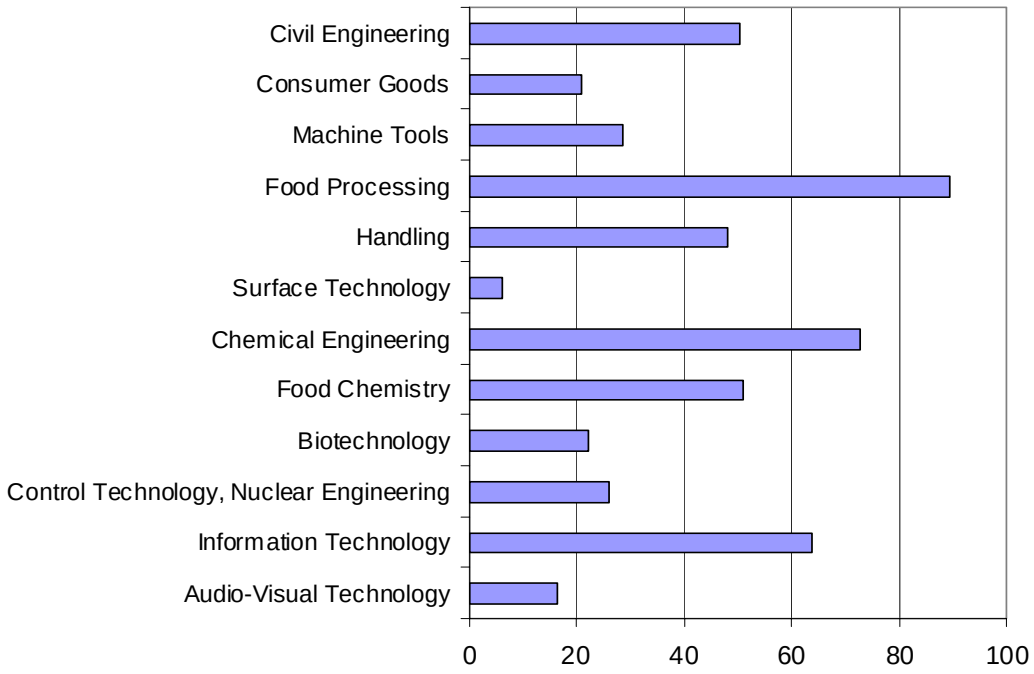


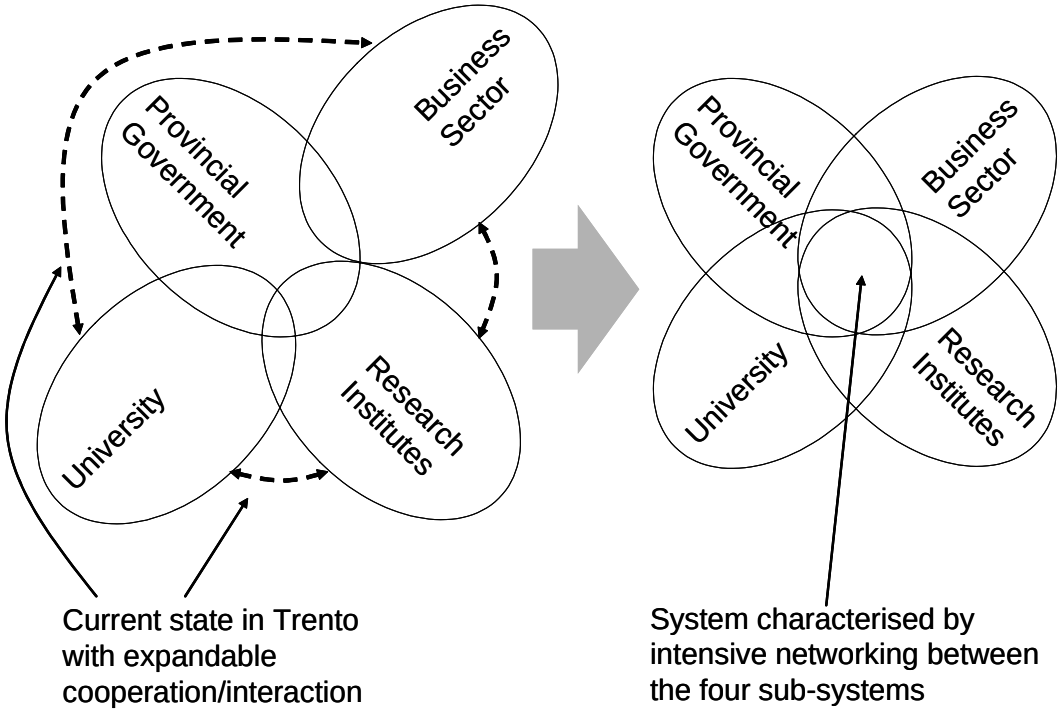
Figure 3: **Technologies with positive patent specialisation in Trento 1990-2000**
(index values)



Index = 100 * tanh ln $[(P_{kj} / \sum P_{kj}) / (\sum_k P_{kj} / \sum_{kj} P_{kj})]$, while P_{kj} is the number of patents / publications in region k (Trento) in Italian total in technology field / scientific field j.

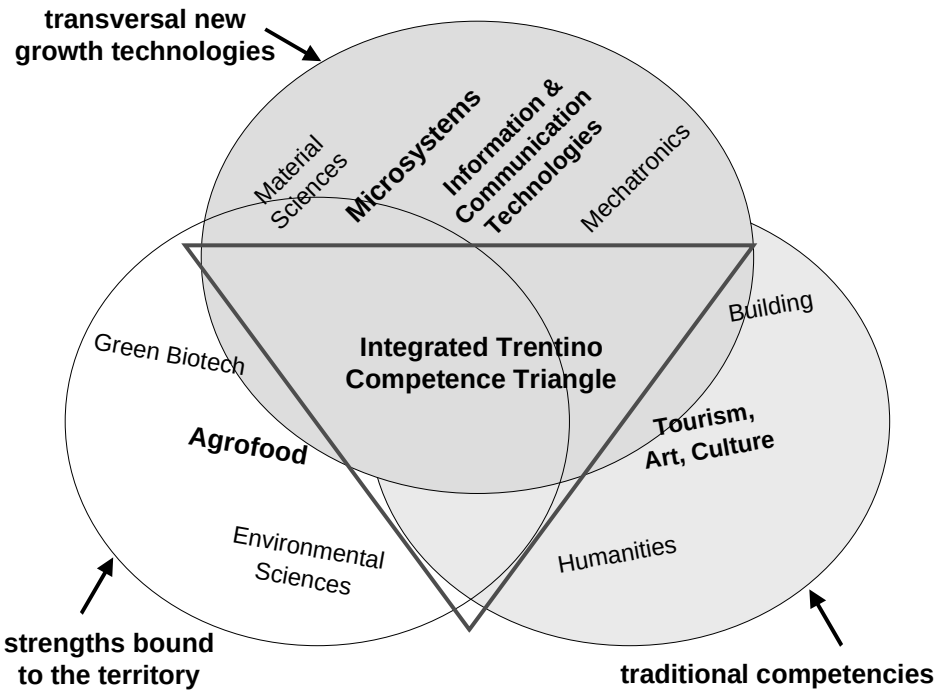
Source: own database searches in PATDPA

Figure 4: Interaction between the four sub-systems in the Trentinian innovation system



Source: Cuhls *et al.* 2003: 24

Figure 5: Trento competence triangle 2014



Source: Cuhls et al. (2003: 56)

Table 1: Innovation indicators for Trentino-Alto Adige and Italy

Indicator*	Trentino-AA	Italy
Population with tertiary education (% of 25 - 64 years age class) 2001	9.23	10.03
Participation in lifelong learning (% of 25 - 64 years age class) 2001	8.33	5.06
Employment in medium- and high-tech manufacturing (% of total workforce) 2000	3.09	7.62
Employment in high-tech services (% of total workforce) 2000	2.32	2.92
Public R&D expenditures (GERD - BERD) (% of GDP) 1999	0.22	0.47
Business expenditures on R&D (BERD) (% of GDP) 1999	0.18	0.54
EPO high-tech patent applications (per million population) 2000	1.10	4.90
GDP per capita ('000 euro)	22,698	16,870

Source: European Commission (2002)