

Constructing Regional Advantage in the Austrian ICT sector – Towards fine tuned innovation policies?

by

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Table of Content

Abstract.....	3
1 Introduction.....	4
2 Theoretical Concepts.....	5
2.1 Institutionally “thick”, “thin” and “networked” regional innovation systems (RIS).....	6
2.2 Knowledge generation and innovation in the ICT sector – types of knowledge bases	7
2.3 Geography of knowledge links	8
3 Background	9
3.1 Austrian ICT sector and innovation policy.....	9
3.2 Methodology.....	11
4 Innovation conditions and policies in three types of regions in Austria	12
4.1 The Case of the Metropolitan Region of Vienna	12
4.2 Salzburg: The Case of a Thin RIS	15
4.3 Industrial Region of Upper Austria	20
5 Conclusions	26
6 Tables.....	30
7 Literature	32

Abstract

Innovation policies are often applied in a standardized approach oriented at best practice models developed elsewhere. These policies often fail to take sectoral and regional characteristics sufficiently into account. We know, however, from available studies that innovation conditions and –problems often vary for particular sectors and even subsectors. These frequently exhibit very distinct features and are determined by specific knowledge bases such as an analytical (science based), a synthetic (engineering based) or a symbolic (artistic based) knowledge base. Also, companies are embedded in different types of regional innovation systems (RIS) and face distinctive innovation conditions, and challenges depending on the type of RIS as has been pointed out previously. „One size fits all “approaches, thus, frequently do not work. In the present paper we are going to investigate for the ICT sector and three regions of Austria which differences exist in the innovation conditions and -activities of companies as well as in their pattern of knowledge sourcing activities, and to which extent policies are taking such specificities into account. The regions investigated are the metropolitan region of Vienna representing an institutionally „thick“ RIS, the service oriented region of Salzburg standing for an institutionally „thin“ RIS, and the industrial region of Upper Austria showing characteristics of a „networked“ RIS. The analysis is based on interviews with 110 companies in the ICT sector as well with a number of key policy actors. The findings show that all three analyzed regions already have a certain level of “fine tuning” in their innovation policies, taking into account the region’s sectoral and company structures, and the strengths and weaknesses of the knowledge organizations. However, policy actors so far seem to be rather weakly informed as regards the nature of innovation processes and -obstacles in their regions, and the way how companies are sourcing knowledge within the region and beyond.

1 Introduction

In the prevailing literature it is widely acknowledged that the innovation process in knowledge based industries like ICT is an open and interactive process, which involves a number of actors like customers, suppliers, universities and research organisations (Chesbrough 2003, Cooke et al. 2007, Tödtling et al. 2006, Weterings and Boschma 2009). The conditions for such interactive processes, however depend on the location of firms as they are faced with particular settings for innovation and knowledge sourcing in different types of regional innovation systems (Cooke et al. 2000, Cooke et al. 2004, Tödtling and Trippl 2005). Whereas firms in metropolitan regions mostly find themselves in favorable conditions for innovation and knowledge sourcing due to the “institutional thickness” (Amin and Thrift 1995) of the region, the firms in other types of regions such as peripheral regions and to some extent also industrial regions are less privileged. Due to a lower degree of “institutional thickness” and other disadvantages, these firms face less favorable circumstances.

So in general, firms in metropolitan regions find superior prerequisites for innovation such as a highly qualified labor force, a high density of universities and knowledge organizations, knowledge intensive services as well as a well developed transport and ICT infrastructure (Simmie 2003, Tödtling and Trippl 2009). This setting provides for companies many opportunities to source knowledge locally but also internationally and engage in knowledge linkages with a variety of different actors. However, despite the density of knowledge organizations and firms we may find a lack of knowledge interactions and, thus, a problem of fragmentation at the regional level (Tödtling and Trippl 2005). Firms in institutionally “thin” regional innovation systems in general face worse preconditions for innovation and knowledge sourcing at the regional level compared to metropolitan regions (Tödtling and Trippl 2005). By definition there are fewer and less specialized knowledge generating organizations as well as a lower density of firms. Having less potential for knowledge sourcing at the regional level, firms need to reach out for relationships at higher spatial levels to compensate for missing opportunities at the regional level. In terms of institutional thickness, industrial regions are usually in-between the two above mentioned types of regions. The regional innovation system is often smaller and less diversified than in metropolitan regions and characterized by a certain number of knowledge generating institutions and firms often specialized in one or few sectors, resulting in a rather specialized institutional landscape. Some industrial regions show a strong networking at the regional level in which a variety of different actors are involved. To some extent this may also be due to deliberate cluster initiatives and policies. Such types of regional innovation systems are then considered as “networked” regional innovation systems as pointed out by Cooke et al. (2004).

The preconditions for innovation in the respective regions are not fixed but evolved and can be influenced e.g. by policy as several examples like Baden Württemberg, Tampere, Wales, Catalonia and others have shown (see e.g. Cooke et al. 2004). Increasingly, innovation oriented regional policy interventions have gained acceptance. In the past years policy actors have often

been focusing on certain “high tech” industries, tried to attract R&D intensive global companies and tried to stimulate university-industry cooperations or spin-offs. However, as Tödting and Trippel (2005) have shown, regions differ widely in their industrial composition and knowledge base, in innovation conditions and the level of networking. This calls for a fine-tuning of regional innovation policies. Three broad dimensions are of crucial importance in this context. First, the institutional and policy set-up of the respective regional innovation system is relevant such as the size and scope of universities and research organizations, technology transfer and intermediaries and innovation funding institutions and strategies. Second it is important to look at the company subsystem and analyze which sectors and knowledge bases are relevant for the region and how they interact. And finally, it has to be taken into account how companies innovate and where their key knowledge sources typically are.

In this paper we investigate the innovation and knowledge sourcing pattern of firms belonging to the ICT sector as well as the respective regional policy initiatives in three different regions of Austria, Vienna, Salzburg and Upper Austria, representing different types of regional innovation systems. Vienna is a metropolitan region with good innovation conditions and a “thick” RIS in general, but with some characteristics of fragmentation as some former studies have shown. Salzburg stands for an institutionally thin RIS with a low density of knowledge generating institutions and firms. Upper Austria represents an industrial region with strong focus on traditional industry sectors, but also a well developed ICT sector. In Upper Austria we also find very active innovation and networking policy programs making it a prime example of a “networked” regional innovation system. Based on interviews with firms and policy actors in all three regions, we will assess the following research questions:

- How do innovation conditions and RIS characteristics differ in the three regions for ICT firms?
- How do firms’ innovation- and knowledge sourcing activities differ between the three regions?
- To which extent do policies take such differences into account?

This article is organized as followed. Section 2 introduces the theoretical concepts and reviews the existing literature. Section 3 briefly describes the ICT sector in Austria and the Austrian innovation policy, and it lays out the methodology. Section 4 characterizes the regional innovation systems, the patterns of innovation activity and knowledge sourcing, as well as the policy initiatives for each of our three analyzed Austrian regions. In section 5 we summarize the key results and draw the conclusions.

2 Theoretical Concepts

Various theoretical concepts provide a frame for a better understanding of the relationship between the different institutional settings and the innovation and knowledge sourcing pattern of ICT firms in the three analyzed regions. The first concept deals with the institutional setting of

the region, especially the prevailing “institutional thickness” (Amin and Thrift 1995). The institutional environment for firms differs depending on the location e.g. in a metropolitan area with a large density and diversity of knowledge generating institutions and firms, in a peripheral region which lacks these institutions and organizations or in an industrial region, with more specialized firms and organizations. Another important aspect is the predominant knowledge base of the industry. Whereas firms characterized by an analytical knowledge base are expected to require knowledge generating institutions such as universities to obtain the necessary knowledge for radical innovations, firms with a more synthetic knowledge base obtain the knowledge for their mainly incremental innovations from actors belonging to the value chain like suppliers and customers. The third aspect deals with knowledge sourcing and the networking of regional actors. While we may find dense formal and informal networks in some regions, other regions might lack such networks at the regional level. Thus, the institutional thickness, the knowledge base of the sector and the level of networking need to be considered in developing specific innovation support.

2.1 Institutionally “thick”, “thin” and “networked” regional innovation systems (RIS)

In the literature we find several typologies of RIS (see Cooke et al. 2000, Cooke et al. 2004). For our analysis we rely on three types of RIS: metropolitan regions (institutionally “thick” RIS;) less urbanized regions (institutionally “thin” RIS) and industrialized regions (and in our case an institutionally “networked” RIS) (Tödtling and Trippel 2005). Metropolitan regions are regarded as centers of innovation that benefit from scale and agglomeration economies (Tödtling and Trippel 2009). There is usually a high density of knowledge organizations and support institutions as well as a high density and diversity of firms and clusters. There are arguments in the literature that diversification favors innovation (Jacobs 1969, Glaeser 1999). Boschma and Frenken (2009), however, have shown that related variety, rather than diversification or specialization supports innovation. Not all metropolitan regions, however, can be regarded as such centers of innovation. Some regions suffer from the problem of fragmentation, i.e. a lack of networks and of interactive learning, which are often regarded as highly supportive for innovation. Less urbanized regions are characterized by weakly developed RIS elements such as a lack of dynamic firms and knowledge organizations (“institutional thinness”) within the region. Innovation activities are generally at a lower level compared to agglomerated regions. A low level of clustering and of agglomeration implies a “thin” and less specialized structure of knowledge suppliers and educational institutions. Also networks are rather weakly developed, in particular those to more specialized knowledge suppliers such as universities and research institutes. Industrialized regions usually have fewer and more specialized knowledge organizations compared to metropolitan regions. In order to strengthen their regional advantage some of the industrial regions have promoted dense networks among the actors

within the region and beyond e.g. firms, universities, regional policy makers, support organizations. Based on Cooke et al. (2004) these types of regions are then considered “networked” RIS.

Our three empirically analyzed Austrian regions, Vienna, Salzburg and Upper Austria, are characterized by different institutional settings, which we expect to have an impact on the innovation and knowledge sourcing pattern of the ICT firms in the respective regions. Vienna is the typical case of a metropolitan innovation system, characterized by the presence of excellent knowledge generating institutions. However, there might be a problem of fragmentation, i.e. the lack of networks and of interactive learning (Tödtling 2002, Fritsch 2004). Salzburg in contrast is a much smaller region in terms of population and economic activities and lacks a strong knowledge infrastructure and respective firms. Nevertheless, it hosts an ICT sector with a particular focus on ICT services and GIS (geographical information systems) applications. Our third region, Upper Austria, is characterized by a strong industrial base and strengths in certain industrial segments. There are also a number of cluster initiatives, and is thus a good example of a “networked” region.

2.2 Knowledge generation and innovation in the ICT sector – Types of knowledge bases

Sectors and industries are characterized by specific innovation- and knowledge sourcing patterns. The concept of “knowledge bases” highlights such sectoral innovation differences (Asheim and Gertler 2005, Cooke et al. 2007, Tödtling et al. 2006, Moodysson and Jonsson 2007). The key argument is that industry specific knowledge bases shape the innovation and knowledge sourcing patterns of firms. A distinction is drawn between ‘analytical’, ‘synthetic’ and ‘symbolic’ types of knowledge bases implying different combinations of tacit and codified knowledge, specific knowledge sources and knowledge interactions, as well as types of innovation.

An analytical knowledge base is typical for knowledge based sectors such as biotechnology, nanotechnology as well as the research oriented segments of the ICT sector. Industries drawing on an analytical knowledge base require scientific knowledge and access to the sources producing this type of knowledge. Knowledge generation is more often based on cognitive and rational processes, analytical techniques or formal models. Basic and applied research as well as systematic development of technologies is among the core activities of firms in these sectors. Companies, therefore, typically have their own R&D departments and cooperate with universities and other research organizations to bring forward innovations. University-industry links and networks to science, as well as academic spin-offs are in most cases a common feature of industries which exhibit an analytical knowledge base. The workforce, therefore, needs university training or research experience to a great extent. Scientific discoveries and technological inventions are the aims of R&D activities which may lead to patents and licensing

activities. New products or processes in such industries tend to be of a more radical type than in those with synthetic or symbolic knowledge bases. They may give rise to technology based start-ups and spin-offs, which are frequently supported by universities and other incubators.

A synthetic knowledge base on the other hand is typical for traditional industries like industrial machinery and engineering but can also be found in certain segments of the ICT sector such as certain types of software production and customer oriented services. The companies in these industries are typically described by medium or low levels of R&D activities and a strong focus on the application or novel combination of existing knowledge, which is often generated by the application of practical skills. Thus, industries characterized by a synthetic knowledge base are strongly dominated by tacit knowledge. Frequently, solutions are sought to specific problems articulated by customers leading to mainly incremental innovations. Important supporting methods in this context could be industry-university cooperation programs, to make industry actors aware of the potential benefits of university R&D and university scientists accustomed to “applied” problems. Even more important are networking efforts to strengthen regional cooperation and the diffusion of tacit knowledge.

The ICT sector exhibits, thus, features of an analytical knowledge base, as well of a synthetic knowledge base. Particularly software production and customer oriented services are dominated by a synthetic knowledge base as can be seen in the case of the Viennese software cluster (Trippel et al. 2009). In addition, also properties of a symbolic knowledge base can be found in some parts of the ICT sector. Therefore, when analyzing a heterogenous sector like ICT, one has to take closer look at the specific properties of the subsectors within a region in order to identify which knowledge base, or combinations thereof are relevant. The design of innovation policies, then, should consider the relevant knowledge bases of sectors and subsectors in order to develop fine-tuned innovation policies. For such a fine-tuning of policies also the pattern and geography of knowledge interactions should be taken into account.

2.3 Geography of knowledge links

Knowledge interactions are nowadays regarded to be of key importance for successful innovation processes, and special attention has been drawn to the nature and geography of knowledge linkages (Keeble 2000, Gertler and Wolfe 2006, Tödtling et al. 2006, Tödtling and Trippel 2007, Tödtling and Trippel 2009). In the last decade, a considerable body of literature has emerged, arguing that localized flows of know-how and expertise are of high significance for the innovation capacity and competitive strength of clusters and regions (see, for instance, Malmberg and Maskell 2002, Porter 2000). There seems to be a growing consensus among many scholars, however, that not only local knowledge circulation fuels innovations but that interactions with international knowledge providers also play a central role (Bunnell and Coe 2001, Amin and Cohendet 2004, Lagendijk and Oinas 2005), enabling firms to gain access to expertise not generated and available within the limited context of the region. More specifically,

it is often argued that the interplay between local and global knowledge flows is vital during the innovation process (Gertler and Levitte 2005, Cooke et al. 2007). Already Camagni, (1991) in his theoretical work on innovative milieus, pointed to the complementary character and interrelatedness of local knowledge exchange, mainly informal in nature, and formal global networks. More recently, Bathelt et al. (2004) proposed the concept of “local buzz and global pipelines” to highlight that innovation in clusters rests on both myriad informal linkages at the local level and more formal knowledge interactions with distant sources and partners. Tödtling et al. (2006) have suggested a typology of knowledge interactions that essentially identifies four types of knowledge links including i) market relations, ii) co-operations and formal networks, iii) externalities and spillovers and iv) milieu and informal networks. These types seem to show a particular spatial distribution. For example milieu effects are often local in nature, while market relations are rather global. From a policy perspective these concepts suggest to strengthen in particular the interactive forms of knowledge interactions such as formal and informal networks. The literature suggests that, depending on the type of RIS, both regional networks and interregional and international cooperation may enhance the innovation process.

3 Background

3.1 Austrian ICT sector and innovation policy

The ICT industry is a rather important sector in Austria’s economy in terms of size and growth rates over the last two decades. During the 1990ies ICT was among the most dynamic areas of the economy in Austria. Both the number of new companies as well the number of new jobs significantly increased in that time. In the early 2000s, however, and especially after the dot.com bubble busted the high growth rates cooled down, in some parts even declined until 2003 (Lengauer et al. 2006). The growth and development of the ICT sector is not only important by itself, but also because it fosters technological upgrading, enhanced productivity and thus growth and development of other industries. ICT related research in terms of publication output is in Austria within the OECD average, with some sectors like mathematical engineering being above the average.

Today the foundation of new firms in ICT-related industries in Austria is below the international average, nevertheless the sector is very important since Austria overall has a poor record of new company creations. 10% of all new companies created, are in the ICT sector. Within that sector software companies play a dominant role with 61,5% (Egel 2006). The Austrian ICT sector is heavily concentrated in urban regions, mainly Vienna where 34% of all companies and 49% of all employees are located (Lengauer et al. 2006). The major problems of the ICT sector are the small size of companies, the lack of skilled labor, the lack of venture capital and the high costs for R&D – the last point especially when taking into account the small size of the firms. Hence,

the few larger firms play an important role in the field of R&D. Federal and regional innovation policy tries to resolve these shortcomings.

Austria's innovation policy is heavily influenced by the federal political structure of the country. Funding and innovation support agencies exist on both the regional as well as the national level. Many programs and institutions are financed or operated jointly by the different levels. Nevertheless, in terms of expenditure and thus influence on the innovation system the national level was historically by far the most important one. In recent years however, especially in the ICT sector, European funding programs have gained significant influence in two ways. First national, and to a lesser extent regional policy actors are involved in programming and implementing European funding schemes and cooperation activities. Second and especially important in ICT, European funds are increasingly exceeding national funds. Austrian research institutes and companies have been very successful in applying for European grant money and according to one of our interview partners today 180% of Austria's contribution to EU ICT programs returns to Austrian scientists. Still the national level has significant influence on the relationship between academia and business, not only through legislative interventions, but also through national funding programs, which are still significant and particularly important - more easily accessible than European funding according to our interview partners.

In general, innovation policy in Austria is split between three different federal ministries on a more strategic level and two major agencies which implement programs and funding schemes. For the specific case of the ICT sector, the most important funding scheme is "FIT-IT" which commits significant funds (~10 Mio. Euro annually) to high-quality cooperative research in several ICT core areas like "embedded systems" or "semantic systems". In every funded project partners from industry and academia cooperate on R&D projects with a time-to-market between 3 and 8 years. Funding is provided for 50-70% of the total project cost including scholarships for PhD students.¹ The second program with significant impact for the ICT sector is "Academia plus Business" (AplusB), which aims at the establishment of regional incubator agencies that support the creation and development of young innovative start-up companies. Again this program aims to bridge the gap between academia and business and the created institutions have strong local and regional roots. Another important program at the national level is the competence center program "COMET", which aims at the establishment of institutional cooperations between academic and business actors in certain thematic areas. Funding is provided for several years, later the institutions are supposed to sustain their activities with applied research and private funding. This program has also a distinct regional importance, since these centers aim to be significant players in the regional innovation systems and for regional cluster programs. Therefore, these centers are often also supported in various forms by the regional government.

¹ <http://www.fit-it.at/english/index.html>

A central motivation for the broad range of cooperative research funding schemes at regional and national level were the perceived weaknesses of Austria's ICT landscape mentioned above, especially the weak link between university and industrial research. According to a recent study the cooperation between business and academia has improved significantly over the last years, although both sides claim that more or improved relations would be beneficial (Eutema, 2007). Nevertheless, academia sometimes criticizes a shift in funding from basic to applied research. In addition, corporate research, especially at smaller companies is still underdeveloped. Overall, a study by Eutema (2007) showed that most ICT experts (both from industry and academia) regard the funding arena for their sector as rather advanced and complete.

3.2 Methodology

This paper is based on empirical results from the project "Constructing Regional Advantage (CRA)", which is a project supported by the European Science Foundation, the Austrian Science Fund and conducted by the Vienna University of Economics and Business jointly with partners from eight countries. We chose three Austrian regions (Vienna, Salzburg and Upper Austria) that showed clear signs of the three different types of RIS mentioned above. The analysis was conducted in three steps. The first step was an extensive analysis of available documents, reviews, evaluations and strategies about regional innovation policies. Second, the data of a firm survey on innovation and knowledge sourcing activities described earlier in (Tödtling et al. 2010) was analyzed and finally, face-to-face interviews with a number of key policy actors and experts in all three regions were conducted.

The analysis of the policy documents in the first step provided important information about the institutional set-up of the respective regions. It has to be noted, however, that the amount of published policy strategies and information about the set-up of the regional innovation systems differs strongly for the three regions. The most extensive information was available for Upper Austria, which provides comprehensive descriptions about all relevant knowledge generating institutions like universities or technical colleges, as well as about all existing innovation promotion programs and agencies. This well-structured effort might be due to the fact that Upper Austria's regional innovation policy is both very well cross-linked and centrally organized. In contrast, the efforts of the innovation support agencies in Vienna and Salzburg are less documented from an overall perspective.

In a second step, a firms' survey on innovation and knowledge sourcing activities was conducted in Vienna, Salzburg and Upper Austria where in total 110 companies were interviewed with a standardized questionnaire. The questions mainly dealt with the innovation and knowledge sourcing pattern of firms in the three regions. All of the companies belong to the ICT sector, the subsectors however varied for our three regions from manufacturing in Vienna to software development in Upper Austria. In Salzburg the whole ICT sector was targeted due to the small

number of ICT firms. This empirical research provided valuable insight into the regional knowledge generation and diffusion subsystem (Tödting et al. 2010).

In order to gain a better understanding of the institutional background we also interviewed in a third step a number of selected policy makers and experts in all three regions. In Vienna we were able to build on insights into the institutional system based on an earlier study. In 2010 actors from across the spectrum were interviewed, from managers of incubator programs to strategic actors within the regional government, to gain a better understanding of the policy arena. To accommodate this wide spectrum of interview partners guided interviews were used. We asked our interview partners a series of questions about their view on the regional innovation system like its strengths and weaknesses and the relationship between academia and business but also about the policy innovation policies and networks of policy actors on different geographical scales. The purpose was to understand the role of regional policy actors in relation to the national as well as the European level and in relation to companies and knowledge generating institutions operating on all these levels. From these three sources we subsequently developed a detailed picture about the three analyzed regional innovation systems in order to understand their similarities as well as to evaluate their differences in the context of the industry in focus.

4 Innovation conditions and policies in three types of regions in Austria

How are the regional innovation systems and the ICT sectors of the three regions to be characterized? In this section we are going to describe briefly the regional innovation systems, the investigated regional ICT sectors and their innovation and knowledge sourcing activities as well as the key innovation policy actors and programs. An important aspect will be the role the ICT sector plays within regional innovation policy and how adequate regional innovation policies are for this sector.

4.1 The Case of the Metropolitan Region of Vienna

Regional Innovation System and ICT sector specifics

Vienna presents the case of a metropolitan regional innovation system (Tödting 2002, Tödting and Tripl 2005). It has about 1,7 Mio. inhabitants with a regional GDP of 43.300 EUR (2007), which is the highest among all Austrian regions. Vienna can be regarded as a strong RIS in an Austrian and also European context. Like other metropolitan regions it has an excellent knowledge infrastructure, reflecting its role as scientific center of Austria. The region hosts nine universities and about 900 public and private research organizations. Vienna is strong in most

knowledge based sectors, in particular in various knowledge intensive business services (KIBS). Both public and business R&D expenses (as % of GDP) are clearly above the Austrian and the EU averages indicating that Vienna is a key center of R&D in Austria (see table 1).

The RIS Vienna is also very well endowed with knowledge generating organizations in the field of ICT. The most important are the three universities, a number of non-academic research organizations and several co-operative research institutes. In the field of ICT four CD Labs and four competence centers can be found in the region. The universities are also key institutions of higher education in the field of ICT. In the last years several technical colleges have been founded leading to a further differentiation of the regional innovation system. Vienna is also the most important business location for the ICT sector. In 2001 about 6.000 ICT companies were located in Vienna, representing more than 30% of all Austrian ICT companies. These companies hold about 50% of all Austrian employees in the ICT sector (see table 2). 6,8% of all Viennese employees work in that sector compared to ~2,5% of the total workforce in Salzburg and Upper Austria. This indicates a very strong concentration of different ICT activities in Vienna. The most important subsectors are telecommunications and software consultancy and supply. We find, thus, that the region's ICT research capacity and its capabilities to provide highly qualified workers and talent, and to commercialize such knowledge are rather strong in the Austrian context. We therefore argue that in the framework of our study Vienna presents a thick metropolitan innovation system in general and also for ICT.

Innovation and knowledge sourcing of ICT firms

As regards to innovation and networking activities in the ICT sector we have some inconclusive results for Vienna. Whilst Vienna is well endowed with innovation relevant institutions like a number of excellent knowledge generating organizations and a high density of firms belonging to the same as well as other sectors, the formal interaction between research and business was reported to be rather low in a European comparison in earlier studies (Tödting 2002, Fritsch 2004). More recent studies of the Vienna ICT sector, however, have shown considerable innovation networking at the regional level (Tödting and Trippl 2009, Tödting and Trippl 2007). Also, the results of the present firm survey conducted as part of the CRA project indicate that the ICT manufacturing companies in Vienna source knowledge frequently on the regional level. Regional innovation networking seems to play a more important role than it has been seen in the past.

The investigated subsector in Vienna includes firms that focus on ICT manufacturing, which are characterized by a largely analytical knowledge base. These firms generate technologically complex and radical innovations relatively often. 87% of the Viennese based firms introduced product innovations in the last three years and about three out of four firms introduced product innovations which were new to the market (see table 3). Such companies that generate technological complex innovations often tend to source technological knowledge from

knowledge generating organizations like universities and R&D institutes. Not surprisingly, therefore, companies from Vienna source knowledge relatively often from universities, technical colleges and research institutes (see table 4). These knowledge sources are most often located within the region, but also at the national level. Other important knowledge sources for Viennese firms are suppliers and customers, which are mainly located at the regional and international level. As expected for a metropolitan region with a thick institutional environment, but unlike some empirical studies in the past have shown, the regional level is of high importance for knowledge sourcing. However, other geographical levels like the national and especially the international level must not be neglected for knowledge sourcing. When looking at the ways of knowledge sourcing we find that informal contacts are the most often stated knowledge sourcing mechanisms followed by R&D cooperations and contract research, the last two being rather formal modes of knowledge transfer (see table 5). The informal contacts are with knowledge sources from the regional as well as the international level. This finding indicates a certain innovative milieu and local buzz within the region. Different from the concept of “local buzz” and “global pipeline” (Bathelt et al. 2004), however, the informal contacts are not confined to the local or region level but exist also at an international level (Trippi et al. 2009). In general, we observe for Vienna a clear pattern of regional and global knowledge sourcing while national sources outside of Vienna are less important. Additionally, the results show that firms in Austria’s capital seem to be able to attract more easily human resources from the national as well as international level, i.e. tapping knowledge located outside of the region through the skills and experience of people, which also enhances international networks. Overall, therefore, companies competing in sectors that require close interactions with knowledge generating institutions to produce technologically complex innovations will have clear advantages in the Vienna region (see Tödtling et al. 2010).

Policy actors and programs

A number of relevant organizations and programs in the field of ICT have been established in recent years. Among the most important are the ICT cluster, funding initiatives for innovation projects of single ICT firms (“Calls”) and a number of different measures in order to strengthen the region’s scientific ICT capacity like regional funding programs for more basic science projects and new university chairs in selected fields. One of the most important is “ZIT”, a regional technology promotion agency, which offers funding as well as consulting services for applied research. It has an own funding line dedicated to ICT (“IKT-Call 2010”). In the area of basic research the “WWTF”, another regional research funding agency in Vienna, has also an own ICT funding line. It focuses on research grants for researchers at universities and also finances full science chairs at universities. As in other regions and through the same national program, an academic spin-off center (“Inits”) has been founded. Its aim is to support technology-oriented spin-offs from the university sector by offering counseling and assistance to scientists in the process of turning a good idea into a viable business. In addition, there is a dedicated ICT cluster

initiative active in Vienna, however, it focuses mainly on consulting and networking services for its members. Besides a large number of universities and knowledge generating institutions, Vienna also hosts a variety of other R&D support organizations such as technology liaison offices at the universities and several technology centers. Two of them, i.e. the Business and Research Center Höchststädtplatz (BRC) and the Tech Gate Vienna have a focus on ICT. To summarize, the region's ICT research capacity and its capabilities to transfer knowledge and to provide highly qualified workers and talent are rather strong.

Whilst the region is well endowed with innovation relevant organizations, there is still limited formal networking between the policy actors in the field of ICT. One explanation might be that there are clear cut roles for the different support organizations and no significant overlap of activities exist. Another point is that there is no comprehensive long-term formal strategy for the development of the ICT sector which could act as a focus for cooperation. There is however a broadly formulated overall STI-strategy for Vienna which was developed by the regional government along with all of the important regional (and national) actors (MA 27 2007). This strategy explicitly mentions ICT a regional strength and summarizes several measures implemented by the above mentioned organizations to support this sector. Although Vienna is characterized by a rather strong research base, the importance of the ICT sectors within the region is not as strong as other sectors like for instance life sciences, which have more formal and informal networking, cooperations, research teams and especially more successful start-up companies. In terms of cooperation with other levels of government, there is no strong connection to the activities and actors at the national level. Informal contacts however, do exist and funding schemes are aligned with national schemes, as it makes no sense to fund the exact same fields as the big national and European programs do.

Key Findings from the Vienna Case Study

Vienna has a significant strength in ICT related research and industry within Austria. Most Austrian firms and knowledge generating institutions in this field are located in Vienna. This is also reflected in the firm set-up in Vienna. The ICT firms in this region are not only more diverse but also bigger and more internationally focused. They compete globally and their knowledge sourcing is both regional and global. Contacts to other regions in Austria are of less importance than in the other two regions. Also, the firms in Vienna absorb a large part of the national funding for ICT related research and innovation activities. In addition, they benefit from two regional funding agencies targeting the Viennese ICT sector specifically. Regional policy, however, plays less of a role compared to Upper Austria in terms of institutionalized networking as regional strategies are less formalized and interlinked. National actors (like universities, federal ministries, federal funding agencies...) are rather strong in Vienna and this has a significant impact on the role of local initiatives. They are more designed to support specific strengths and niches that are not targeted directly through national and European programs.

Regional policy actors, thus, aim at adding value to the national and European funding and support schemes as well as to nationally funded scientific institutions (e.g. universities) through specific ICT support initiatives. However, they do not try to influence and direct the system in a top-down manner or through strong regional innovation strategies, but instead use a more bottom up approach by adding to existing strengths and addressing specific weaknesses. This might reflect the size and diversity of the sector in this region. As mentioned earlier in Vienna both strong knowledge generating institutions as well as a strong business sector can be found. On the one hand, significant and diverse basic research, also in the field of ICT, is carried out at Viennese universities and on the other hand a strong and diverse, globally oriented ICT business sector is located in Vienna. As a consequence, support programs have to take this diversity into account and develop specific ways to support this innovation landscape. This is done by funding both excellent high end applied and basic research through regional grants as well as tapping into national funds dedicated and bridging the gap between basic and applied as well as between university and industrial research, e.g. through cooperative research projects and centers or through the setting up of an incubator program.

Being a major agglomeration with excellent research capacities, Vienna meets all preconditions for providing a strong, institutionally thick regional innovation system. Such agglomerations have the potential to fully utilize the merits of related variety by strengthening the respective networks. On the other hand, agglomerations sometimes face the problem of fragmentation between different sub-systems. While earlier studies have provided some indications that also Vienna suffered to some extent from this problem, later studies (Trippel et al. 2007) as well as the present study show rather dense regional networks among a variety of actors. Also, the policy interviews provide some evidence that, although no comprehensive formal ICT strategy exists, the relevant policy actors maintain relative close informal linkages. Furthermore, national and European funding schemes support regional and interregional networks as they often require that the applicant for funds consists of different organizations sometimes on different geographical scales, i.e. fostering co-operations. However, after reviewing the formal policies and coordination mechanisms, it seems that there are limited concrete measures to address the issue of fragmentation or to fertilize regional networks in order to realize the potential of related variety. This holds true especially in the domain of applied research and development. In support programs for basic science there is indeed the aim to support interdisciplinary research and to build networks across diverse disciplines.

4.2 Salzburg: The Case of a Thin RIS

Regional Innovation System and ICT sector specifics

The province of Salzburg is situated in the Western part of Austria at the borders of Germany. It has about 530.000 inhabitants. Its capital, Salzburg, has about 140.000 citizens. The regional

GDP per capita in Salzburg was 37.300 € in 2007, which lies 10% above the Austrian average. The regional economy is characterized by a strong dominance of the tertiary sector, which contributes about 71% to the total regional gross value added. This high share is partly due to the big importance of tourism and business services in the region. Salzburg features a relatively low research quota of only 1,1% of regional GDP, which reflects the low industry share and the lack of large or medium sized companies.

Salzburg has clearly the weakest RIS in terms of knowledge generating institutions of our analyzed regions as it has only few knowledge organizations and a small high tech and KIBS sector. As a consequence, public and in particular business R&D is very low in the Austrian comparison as has already been mentioned above. As regards to knowledge organizations the region hosts three universities, a few other research organizations, and a number of technical colleges.

In the field of ICT, a key actor is the University of Salzburg, which is, however, rather small, although the university has some research capacity in specific niches in the ICT sector. Most importantly it hosts the “Center for Geoinformatics”, which represents a thematic strength in this region. Another important knowledge generating institution in the region is “Salzburg Research”, which is a non-profit research organization founded in 1996 and owned by the “Land”. Its main focus is on applied research in the fields of ICT and new media. Salzburg also hosts two competence centers from the national COMET program, which are run by Salzburg Research and a CD Lab for “Embedded Software Systems” at the University of Salzburg. In addition, there are seven technology centers present in the region of Salzburg that offer office space and administrative help for innovative and technology-oriented young companies.

Compared to Vienna and Upper Austria, Salzburg does not host a really strong ICT sector, it seems to lack the critical mass of ICT firms in the region. Only 2,5% plants in that region belong to the ICT sector comprising 6,2% of Austria’s total (see table 2). Not only the business sector is relatively weak compared to the other two regions but also the knowledge generating institutions in general and for the specific case of ICT are less developed. Still Salzburg presents an interesting case for our study, since ICT related business and research is not totally absent and neither are public efforts to support regional innovation. The region hosts a variety of firms and institutions capable of producing and absorbing ICT related knowledge, they are only scattered across different areas of the region and different subsectors. A significant mass of firms can only be observed in small niches like geographical information systems or tourism related ICT usage. Therefore Salzburg presents a typical small region with a thin regional innovation system, which is characterized by specific properties and needs.

Innovation and knowledge sourcing of ICT firms

The ICT sector in the region of Salzburg is characterized by relatively small companies that draw to a large extent on a synthetic knowledge base generating more incremental innovations. A

large proportion of the Salzburg based firms belongs to the ICT service sector which are characterized as not as innovative as the ICT subsectors of manufacturing (in Vienna) and software development (in Upper Austria). This can also be found in our data. Although nearly 80% of the ICT firms in Salzburg introduced new products in the market and more than half of the firms generated product innovation that were new to the market, these number are much lower than the ones in Vienna and Upper Austria (see table 3). The lower innovativeness of the ICT firms in Salzburg can also be seen in the types of knowledge sources which were accessed to obtain knowledge from outside the firm. Unlike in our other two regions, knowledge generating institutions like universities, technical colleges and R&D institutes play a minor role in the external knowledge sourcing process (see table 4). An explanation for this can be found in both the characteristics of the firms based in Salzburg as well as the lower number of knowledge generating institutions in the region. Instead, the interviewed ICT companies from this region source technological knowledge predominantly from the value chain, but also to a certain degree from firms belonging to the same sector. This allows the small firms in the region to share costs and risks in innovation processes. Most of the data suggest that the ICT firms in Salzburg lack regional knowledge sources like knowledge generating institutions in this field as well as a high density of related and unrelated firms, which poses a particular problem for the acquisition of knowledge from knowledge sources within the region. As a consequence, firms from Salzburg access knowledge most frequently from the international level. However unlike what we expected to find, we could not find significant evidence that the neighboring agglomeration Munich in Germany, which has an excellent reputation in the field of ICT, is playing an outstanding role in these processes. Evidence was found however, that regional policy actors try to compete with German regions in a more general way to attract German businesses and entrepreneurs emphasizing the regions advantages like quality of life and a rather business-friendly tax system. There are however on the policy side no current initiatives to tap into the existing ICT cluster in the Munich region or to create strategic innovation cooperation with this region.²

Although informal contacts are an important mechanism for the acquisition of external knowledge for the ICT firms from Salzburg, the most frequently used knowledge transfer channels are contract research and other market based channels like purchasing of licenses, machinery and software (see table 5). These channels often have to do with the buying of existing knowledge and usually feature a lower degree of interactive knowledge transfer. Interactive knowledge transfer however, is considered to be the prime source for acquiring tacit knowledge and thus upgrading the knowledge base of the firm. This again reinforces the tendency for firms in Salzburg to develop their synthetic knowledge base and places to a certain degree an obstacle on the development of technologically more complex innovations. Another interesting difference to the other regions is observed in relation to spillovers. Knowledge spillovers to firms from Salzburg occur more frequently from sources belonging to the value

² There have been initiatives in the past to create networks between Salzburg's media cluster and companies in Munich. This however largely faltered when the biggest company in that sector in Munich faltered.

chain compared to the pattern for firms located in Upper Austria or Vienna. Nevertheless, the limited number of firms in Salzburg hardly allows for the development of cluster effects. A specialization might only be possible in very narrow fields, a strategy which was named a “concentration on innovation islands” by a regional policy maker.

Policy actors and programs

The regional government and several other public stakeholders (like for instance the regional chamber of commerce) have established a number of innovation promotion agencies of which the “Innovations- und Technologietransfer Salzburg GmbH” (ITG) is the most important one. It is dedicated to support the application for national and European grants, conduct networking activities and provide consulting for research institutes and companies on topics like intellectual property rights (IPR) and business creation. Another important player is the “Innovationservice Salzburg”, an agency set-up by the regional chamber of commerce to provide consulting for companies in the areas of IPR, research funding and networking.

Unlike Upper Austria, Salzburg does not have a dedicated multi-thematic cluster program. An independent cluster initiative exists only in the field of geographical information systems (GIS) as there are several firms with competences in this particular field. In order to deal with this weakness, Salzburg has, like Vienna and Upper Austria, a dedicated regional incubator program, which is strongly promoting start-ups, also in the field of ICT. In 2005 the „Business Creation Center Salzburg“ (BCCS) has been established in the AplusB program, which was mentioned earlier. Its goal is to increase awareness in academia for commercialization of opportunities and to provide consulting and training for start-up companies. It is not restricted to a certain scientific area, but considers ICT to be one of the most important fields.

Taken the current initiatives and programs for the ICT sector in Salzburg, the sector still lacks coherent strategy. Most initiatives are ad-hoc cooperations of funds for certain goals. In addition, there is also some overlap, or missing synergies, between innovation support initiatives funded by the regional government and another one funded by the local chamber of commerce. There seems to be a consensus among policy makers that Salzburg misses the capacity to establish and fund large, independent and long-term science-technology-innovation (STI) programs. As a consequence, policy actors concentrate on small niches (like GIS as mentioned above) or so called “innovation islands” and on extensive cooperation with other regions and national programs. Especially cooperations with the cluster programs in Upper Austria and the national funding schemes for regional “competence centers” are important for Salzburg’s STI policy.

To conclude, it can be noted that public institutions dedicated to the support of science and technology exist also in an institutionally thin region like Salzburg. These institutions acknowledge the limits posed by the small size of academia and business in the region and therefore specifically try to strengthen certain niche activities and cooperations with other

regions and national programs. In addition, traditional programs like incubator programs and networking initiatives are provided. However, Salzburg misses a coherent strategy for the ICT sector with concrete measures like for instance in Upper Austria. Upper Austria and its strategy 2010 has a certain lighthouse function for the actors in Salzburg and several noted that the goal is to come up with a similar yet Salzburg specific strategy in the near future.

Key Findings from the Salzburg Case Study

Three important features define Salzburg's innovation policy in the field of ICT. First, there is a lack of a critical mass. Salzburg has only a small ICT sector, both in terms of academia as well as in business. The innovation system is perceived as too thin to conduct extensive programs and cluster initiatives alone in the field of ICT. Existing companies conduct mainly incremental innovations and source their knowledge from the value chain. Start-up activity is visible, but at least at the moment, at a rather small level. Another point is that Salzburg lacks the resources for regional science funding and innovation promotion which are available in other regions. Second, there are no distinct and targeted measures for the ICT sector. There are, however, a number of institutions like cooperative research centers or incubator programs that either target a specific subsector of the ICT sector or target a certain group of (innovation) actors among which ICT plays a prominent role, like start-up companies. This leads to the third feature of Salzburg's innovation policy. Regional policy actors cooperate with other policy levels (Austria and EU) and with neighbor-regions such as Upper Austria. The goal is to tie into programs and initiatives at other levels of government as well as in other regions. Therefore Salzburg's innovation promotion agencies have a heavy emphasis on helping regional companies to gain access to national and European funding programs and promote knowledge exchange with other regions.

Due to the institutionally thin RIS, especially the low density of firms and knowledge generating institutions, the policy options for Salzburg are somewhat restricted. One option pursued by regional policy makers is to focus the resources on perceived strengths of a narrow technological field, which was labeled as "innovation island" by one of the interviewed policy makers. However, when following this strategy, the supported technological field should be to some extent linked with other sectors in the region in order to create synergies and optimize the impact on the regional economy. This can be achieved by knowledge exchange between related sectors (concept of related variety), which offers the potential of more radical innovations as well as strengthening of both the regional and firms' knowledge base. Being linked with other sectors, ICT can also fulfill its role in enhancing the competitiveness of other sectors in the region and thus contributing to economic regional development overall.

Besides the support for "innovation islands", entrepreneurship and start-up companies are supported by regional policy initiatives. For the established firms, focusing on the value chain

and incremental innovations, policy initiatives encourage collaborations with existing clusters from other regions such as Upper Austria.

To sum up, it can be concluded that regional policy makers seem to be aware of the missing critical mass in the ICT sectors in general. Based on this knowledge, the policy is directed towards i) supporting innovation islands, ii) connecting to clusters from neighbor regions and iii) improving the access to national and European funding schemes. However, this happens mainly through ad-hoc measures. A coherent strategy including implementable measures is missing in Salzburg. Our interview partners, however, explained that the political support for and process of formulating such a strategy is gaining momentum.

4.3 Industrial Region of Upper Austria

Regional Innovation System and ICT sector specifics

The province of Upper Austria is situated in the north-central part of Austria at the borders of Germany and the Czech Republic. It has 1,3 Mio inhabitants and its capital Linz has around 200.000 inhabitants. The regional GDP of Upper Austria is at EUR 31.800 (2007) slightly below the Austrian average. Upper Austria is characterized by a strong export-oriented industrial base³. Due to its industrial base it also benefits from high private R&D expenditures (80% of total) and an above average growth rate for total R&D expenditures. Compared to Vienna, Upper Austria has a clearly weaker knowledge infrastructure and correspondingly low public R&D expenses in Austrian comparison. However, when being compared to the region of Salzburg the knowledge generating institutions as well as the industrial base are strong, which leads to an institutional “thickness” somewhere in between those of Vienna and Salzburg. Also the importance of Upper Austria’s high tech and KIBS sectors is in an intermediate position. Due to some larger plants in industries such as vehicles and engineering the medium-high tech sector is relatively large, and Upper Austria’s patenting activity is clearly above the EU average (see table 1).

Regarding the knowledge generating organizations in Upper Austria, two universities, several technical colleges and a relatively large number of technology centers can be found. In total 17.000 students are enrolled in the Upper Austrian universities and technical colleges of which the Johannes Kepler University (JKU) is the largest and most important institution in the field of tertiary education. Other important educational players in the region are the technical colleges in the cities of Wels, Hagenberg, Steyr as well as the regional capital Linz. Looking at the R&D capabilities in ICT in Upper Austria it has to be noted that compared to Vienna and Salzburg again a medium level of knowledge generating institutions exists. These knowledge generating institutions are relatively applied, specialized and networked. The main scientific organization

³ Secondary sector accounts for 41% of GDP, and the export quota is as high as 87% in vehicle manufacturing and 54,4% on average (2008 data).

with ICT related research competence is the Johannes Kepler University Linz. Beside the JKU another player of key importance is the “Software Park Hagenberg”, which combines business, scientific and educational competences in the area of software. About 1.000 persons are employed in the firms, research and education institutes located in the software park, and almost 1.300 students are enrolled in different degree programs offered there by a technical college and university institutes from the JKU Linz. The Softwarepark Hagenberg is one of 21 technology centers that have been established in Upper Austria, but one of the first research parks in Austria⁴.

Additional knowledge generating institutions in the field of ICT include the Johann Radon Institute for Computational and Applied Mathematics (Austrian Academy of Sciences) in the capital city Linz, an institute of the Austrian Academy of Sciences. Furthermore two Christian Doppler-laboratories (“CD-labs”) and two COMET competence centers are active in that field. The last two programs are initiatives jointly funded by national, regional and private sources and aim to bring academia and industrial application together. The competence center in the COMET program has considerable amounts of funding and an independent institutional set-up, whereas CD-Labs are smaller and mostly located at universities. One of the competence centers is dealing with mechatronics (bringing together mechanics, electronics and IT). The second one is the Software Competence Center Hagenberg that focuses on software research. Another important actor is Upper Austrian Research (fully owned by the regional development agency TMG), which has a focus on medical informatics and other ICT related research. Knowledge generating institutions, however, are not the only essential part of a regional innovation system. Of significant importance is also the business dimension, the size, scope and activities of the local ICT firms. The ICT business sector in Upper Austria is rather weak compared to Vienna but stronger than in Salzburg. There are about 5.000 employees in the sectors (1,9 % of the regional total and 10% of the Austrian total, see table 2). Putting these finding together, we can conclude that the region has with a few exceptions such as the internationally known Softwarepark Hagenberg a medium capacity to apply and exploit ICT knowledge.

Overall, we might conclude that the region’s capacity to produce and transmit ICT related knowledge and talent is almost as well developed as in a metropolitan region. There are some interesting research activities in specific areas, such as mechatronics or software. These generally tie into existing regional economic strengths. These links are supported by a dedicated regional innovation policy that emphasizes the cooperation between industry and academia in cluster and networking initiatives. Therefore the region has a thick network of both formal and informal contacts. Although the overall research capacity cannot compete with a metropolitan region, in areas important for the regional industry significant capabilities exists. Also, there is no obvious threat of a lock-in since several research institutions pursue also basic research that might fuel new sectors and technologies. In addition, our interviews showed that key actors in the ICT scene are fully aware of the importance of basic research.

⁴ <http://www.technologiezentren.at/>

Innovation and knowledge sourcing of ICT firms

The interviewed ICT firms in Upper Austria are active in the ICT subsector of software development, which features elements of both synthetic and analytical knowledge bases and to a lesser extent symbolic knowledge base. In comparison to the companies in Salzburg the Upper Austria firms are highly innovative: 97% of our interviewed firms generated production innovation and nearly 80% of the firms in Upper Austria introduced new products which were also new to the market (see table 3). Highly innovative firms tend to source knowledge from a variety of knowledge sources at different geographical levels which is also the case for our Upper Austrian software firms. In contrast to Viennese companies, those located in Upper Austria access knowledge more frequently on a national level (see table 4).

It seems to be the case that national sources for firms in Upper Austria will frequently be located in Vienna, a relatively close large agglomeration and a "thick" RIS and ICT location. Hence, the RIS of Upper Austria seems to be linked to the one in Vienna to a considerable extent. Although the companies in Upper Austria source knowledge from a variety of knowledge sources, two types of sources, namely suppliers and universities/technical colleges, stand out. The firms in Upper Austria rely to a larger extent on knowledge sourcing from suppliers than the ones investigated in Vienna, which follows our expectation for software producers. In contrast to the sample in Salzburg, firms in Upper Austria utilize knowledge generating institutions more frequently benefiting from well-established R&D facilities in the region. Universities and technical colleges in the region are the most important knowledge source for the interviewed Upper Austrian software firms. This is in line with a tendency to generate technologically more complex innovations than for instance the firms in Salzburg as well as with a good access to knowledge generating institutions in this field. Although Upper Austria clearly has fewer and smaller knowledge generating institutions compared to Vienna, the Upper Austrian ICT firms receive frequently knowledge from these sources. Due to the smaller size of the region and the intense regional networking activities, the companies seem to have both a good knowledge over the activities of the knowledge generating organizations, and sustain close relations to them. At the same time, the larger industrial base in Upper Austria allows a higher degree of specialization of ICT firms. Therefore, ICT firms in Upper Austria are embedded in a more favorable environment than those in Salzburg while not fully benefiting from the virtues of an institutionally thick metropolitan region.

The companies located in Upper Austria use a variety of knowledge transfer channels (see table 5), including informal contacts, R&D cooperations, contract research purchase of licenses, machinery and software, employment of specialists etc.. Upper Austrian software firms are sourcing technological knowledge from different geographical levels. Nevertheless, the regional level is the most important spatial level. This might also be the result of the efforts of various regional policy initiatives in the past.

Policy actors and programs

In the last 20 years the regional government developed a sophisticated set of programs, tools and agencies to support regional innovation activities. Prime actor is the TMG, Upper Austria's location and innovation agency, which is owned by the regional government and other public stakeholders like the regional chamber of commerce and several important municipalities. The TMG and its affiliated organizations are responsible for a broad set of tech-transfer and networking initiatives, incubator programs and cluster -initiatives. In addition, the TMG supports local companies and research institutes at applications for national and EU funding. In several cases, they also provide top-up funding for successful grants. The TMG itself acts as the holding for several agencies and is dedicated to the development of strategic programs, promotion of the business location Upper Austria and provides management services for other agencies in the holding.

One important agency for the regional development is the "Clusterland", a cluster management organization under TMG supervision. The Clusterland aims to target specific industry sectors in which regional strengths exist and improve the networking within the sectors but also between the sector and educational, scientific and policy actors. Clusters in the fields of automotive, plastics, mechatronics, eco-technologies as well as several other fields can be found. In addition, the organization aims at forming cross-sectors networks for topics like human resources and energy efficiency. The Upper Austrian cluster approaches are regarded as "good practice" examples of such policies in Austria but also outside of Austria. Another important organization of the TMG group is the "CATT", which aims to support funding applications at national and European levels, mobility schemes, support for questions related to intellectual property rights (IPR), networking activities and is involved in the strategy development. Also part of the TMG group is the "Tech2B", an incubator agency, funded by the national program "AplusB" that operates on a regional level and is supported by the regional government. It aims to support and promote the founding of innovative, technology-orientated business in Upper Austria. Moreover there are other programs and small agencies with similar goals funded and supported by the regional chamber of commerce and other semi-public actors.

An important factor describing the regional policy initiatives in Upper Austria is not only the high number of regional organizations supporting knowledge exchange and innovation but also the extremely strong interactions between the diverse actors. Key actors from knowledge generating institutions and regional policy actors are in constant formal and informal contact. The whole governance system of which the above mentioned organization are part of is guided by a strategic program ("Upper Austria 2010") which was developed by 250 experts in the field, consisting of all relevant actors from academia, industry and government. Some of these experts from academia and business are also part of an institutionalized networking effort, called the "Council for Research and Technology in Upper Austria". This institution not only cooperates on strategy issues, but also has a consulting function for the regional government. The strategy "Upper Austria 2010" not only contains broad overall-goals but also formulates a

specific set of measures to be implemented in the strategy's time-frame (2005-2010). For 2010 onwards a new strategy paper is being developed.

Upper Austria can thus be considered as a “networked RIS” in the policy arena, because it not only has a set of developed cluster programs, but has also implemented formal procedures to connect all relevant actors and committed them to formulate a coherent strategic program and set of corresponding measures. Above that, all important actors from government, academia and business seem to be in frequent informal contact showing features of a regional “triple helix” (Etzkowitz and Leydesdorff 2000) structure. Regarding the spatial structure the regional capital Linz can be defined as a dominant center for knowledge sourcing, innovation as well as the development and implementation of regional policy initiatives. However, several research institutions and important business and educational actors are scattered around the region of which the Softwarepark Hagenberg is of great importance for the knowledge generation and knowledge application subsystems. Regarding the spatial location of the Softwarepark Hagenberg it has to be mentioned that Hagenberg is in close geographical proximity to the regional capital Linz.

Regarding the ICT support activities it has to be noted that ICT is not a strong independent focus in the thematic programs, but is considered to be an important addition for a broad range of industries – from steel to mechatronics. ICT is largely regarded, thus, as a “horizontal” field, relating to various sectors. In the strategy 2010, however, there are some specific measures to promote R&D (e.g. in the Softwarepark Hagenberg) and the competitiveness of this sector. There are also strong linkages between ICT related academic units and the larger companies in the region. The Software Park Hagenberg for example, grew out of an academic unit that developed intense ties with the local industry. This cooperation in turn provided a significant part of the funding that led to the establishment of an independent research facility in Hagenberg. It can, thus, be concluded that ICT plays a significant role in the region. Initially this development was in relation to existing industrial strengths but nowadays new areas of research emerge.

Key Findings from the Upper Austria Case Study

Upper Austria provides a good example of a networked RIS. All major stakeholders like academia, business and government are linked through a broad array of formal and informal networking initiatives. Applied research and third-level education are strongly aligned with the needs of industry partners. Beside the university, a broad range of technical colleges educates skilled labor and a set of specialized university institutes provides research and PhD-level education. Results from the firms in that region confirm the role of regional academia as a source of knowledge, although Upper Austria does not have the levels of research and tertiary education like Vienna. Consequently, Upper Austrian firms also tap national and international sources of knowledge when necessary.

Although the ICT sector in Upper Austria overall is smaller than the one in Vienna, several subsectors, or cross-sectoral disciplines like mechatronics are internationally competitive. These sectors are targeted by specialized regional policy measures. In addition, horizontal measures are implemented that cut across sector-specific needs and address more general concerns like human resources and energy efficiency.

Formal and informal mechanisms as well as institutions ensure the participation of a wide range of relevant actors in planning and implementing regional development and innovation policies. Although one of the interviewees noted that it needs just a handful of highly dedicated people to “get things going” in a region, for the whole strategic orientation of the region 250 experts have been engaged in formulating the strategy and implementable measures.

To conclude, several features of Upper Austria’s innovation system and policy are of key importance from the perspective of this analysis. First, innovation policies and support programs aim to boost the competitiveness of the region through applied research in relevant disciplines and through better intraregional coordination and cooperation of relevant actors. Second, there is a clear idea, what the aims of these programs are and there are well developed policy networks and a dedicated strategy implementation process. Third, the innovation system is neither as broad as in Vienna, nor as small as in Salzburg, but it is characterized by a medium-sized well-connected network of companies and research organizations.

5 Conclusions

The main aim of this paper is to investigate whether and to which extent innovation policies in three Austrian regions, Vienna, Salzburg and Upper Austria, take the particular characteristics of innovation systems and of the sectoral knowledge bases into account.

Vienna can be described as an institutionally rich and diversified metropolitan regional innovation system. There is a multitude of knowledge generating institutions as well as a large number of companies that could benefit from that. Vienna’s RIS is, thus, characterized by strong knowledge generation and -application subsystems. Of major importance is also the fact that a number of national science funding actors are based in the capital of Vienna playing an important role in regard to access to funding. Regional science policy in turn, and especially when it comes to ICT, aims at covering technological fields which are not targeted by national programs yet but are still perceived as important for the regional development or when they feature regional strengths. Regional funding agencies, therefore, developed the policy not to duplicate national or European funding but to address specific regional needs. The main objective is not to support existing industries, but to venture into new fields based on academic strengths. These strengths are usually defined rather broadly such as mathematics or life sciences. The issue of fragmentation, a potential problem of many metropolitan regions, is however not targeted directly. Formal network initiatives between the various policy actors in ICT as well as strategic planning activities are missing and there are only a few efforts to strengthen related variety between sectors.

Salzburg constitutes the smallest of the three regions with a relative small ICT sector and a “thin” institutional environment. Regional policy makers target very narrow technological fields with a perceived regional strength. In addition, they aim at tying into extra-regional networks and clusters such as for instance the cluster initiatives in Upper Austria or Vienna Through these networks, knowledge and resources shall be sourced that are not available regionally. Furthermore, regional innovation promotion agencies aim at increasing Salzburg’s share in national funding by explicitly supporting companies and universities with the application processes for national and European grants. A comprehensive strategy in terms of a formal document that would outline these strategies and even more important, commit all relevant actors to this strategy is missing in Salzburg, a fact that was mentioned by some of our interview partners. Innovation policy and measures seem therefore to be rather the result of the circumstances than of a joint planned effort. Better targeting regional innovation policy to the overall economic structure of the region could improve the impact of efforts undertaken. Building bridges between these “innovation islands” and other industry sectors as well as supporting cross-disciplinary research and development in a more strategic approach could be a first valuable step in this direction.

Upper Austria on the other hand is a very good example of a networked industrial region with a well developed set of innovation support agencies that are all tied together by both formal and informal networks. Aims and measures are formulated in a comprehensive strategy document that was developed jointly by the most important regional actors from the policy, academia and the business side. The overall strategy of the region is to create an innovation policy that targets the region’s existing industrial strengths in order to make local companies more innovative and thus more competitive. Among the most important ones in this context are the Upper Austrian cluster initiatives, an improved access to national and European funds and improved networking between business and academia. Interestingly, we could also find examples of emerging horizontal networks between different sectors, which are in line with theoretical approaches like related variety.

Overall, we find that the three regions are quite different as regards the characteristics of the ICT sector, the institutional environment and policy approaches (see figure 1). Not surprisingly, these circumstances and situations drive the policy approaches and measures to a considerable extent. Upper Austria in comparison has a more systematic approach to fostering innovation and networking than the other two regions. According to our findings, the efforts to support regional networks especially between the knowledge application and generation sub-systems seem to pay off in this region.

Figure 1 Fit between ICT sector and regional innovation policies

		Vienna	Salzburg	Upper Austria
ICT academia and research		<ul style="list-style-type: none"> high number of knowledge gen. organizations high diversity of scientific fields 	<ul style="list-style-type: none"> small number of knowledge gen. organizations some small niches 	<ul style="list-style-type: none"> medium number of knowledge gen. organizations some fields of strength strong links to business
ICT business sector	General features	<ul style="list-style-type: none"> many companies high diversity in terms of size & activities MNEs 	<ul style="list-style-type: none"> few companies some innovative niches many small companies 	<ul style="list-style-type: none"> medium number of companies related to other sectors many medium sized companies
	Dominant knowledge sources*	<ul style="list-style-type: none"> suppliers universities customers 	<ul style="list-style-type: none"> mainly suppliers and customers 	<ul style="list-style-type: none"> suppliers universities
	Geography of knowledge sourcing*	<ul style="list-style-type: none"> regional international 	<ul style="list-style-type: none"> predominantly international 	<ul style="list-style-type: none"> regional international
Policy focus		<ul style="list-style-type: none"> focused on excellence, high end of public and private research own regional funding schemes complementary to national and European programs 	<ul style="list-style-type: none"> support of small niches facilitate access to extra-regional networks and knowledge facilitate access to national and European funds 	<ul style="list-style-type: none"> networks between academia and business cluster initiative "Mechatronik" ICT also a cross sectoral theme facilitate access to national and European funds

*of investigated subsectors

All three regions have been quite effective in using national and European policy programs as a complement to regional policy activities. Still, there is some room for improvement regarding the fine tuning of policies and enhancing the effectiveness of policies. Policy actors so far were rather weakly informed as regards the characteristics of innovation processes and -obstacles of ICT companies, and the way how they are sourcing knowledge within the respective region and beyond. In this context the potential for innovation and knowledge networking between companies and knowledge providers, and within clusters and outside has not been fully exploited so far.

As pointed out earlier, the literature on regional innovation systems and on new policy concepts widely agree on the importance of both horizontal as well as vertical networks. Theoretical concepts like "related variety" emphasize the importance of overlap of different sectors and industries and the idea to explicitly address these areas with public support programs in order to boost innovation and competitiveness. Although we did not find any programs that explicitly take up the concept of related variety - in contrast to cluster theories and programs - we

identified some areas where this idea is implemented in a way that is close to the original idea. In Upper Austria for example, we found not only funding programs for vertical networks and clusters, but also explicitly for horizontal networks that deal with specific problems, like energy efficiency, that are relevant to a number of sectors. Similarly we found policy programs in Vienna funding rather basic science that explicitly supported interdisciplinary projects.

Overall, we conclude that innovation policy initiatives across the three respective regions are rather diverse, but so are the regions themselves. In general, the policies and measures are constrained by the institutional environment and the characteristics of the regional industries. The policy approaches seem to be well adjusted to the conditions and RIS characteristics. In two of the three cases analyzed this does not coincide with a strategic approach to innovation policy considering for instance related industries and strengthening networks between them. This may then lead to a situation where “innovation policy” does not reach the main industries in the region, and thus has limited impact on the regional competitiveness. In order to “construct regional competitive advantages” a better link of innovation policy with the broader regional production systems needs to be considered.

6 Tables

Table 1: Innovation Indicators (EU = 100)

	Austria	Vienna	Salzburg	Upper Austria
Human Resources in Science and Technology – Core (% of population)	67%	95%	73%	56%
Employment in medium-high and high-tech manufacturing (% of total workforce)	97%	97%	72%	121%
Employment in high-tech services (% of total workforce)	91%	195%	67%	69%
Public R&D expenditures (GERDBERD) (% of GDP)	97%	201%	54%	30%
Business expenditures on R&D (BERD) (% of GDP)	97%	154%	26%	96%
EPO patent applications (per million population)	118%	102%	105%	154%

Source: (Hollanders 2007)

Table 2: Region and ICT sector indicators

	Vienna	Salzburg	Upper Austria
GRP 2007	43.300	37.300	31.800
Population 2010	1.700.000	530.000	1.410.000
Unemployment 2009	7,54%	3,23%	4,01%
ICT employees as % of Austrian total 2001	48,70%	4,50%	9,61%
ICT employees as percent of regional total	6,78%	2,11%	1,89%
ICT plants as % of Austrian total 2001	33,95%	6,19%	11,89%
ICT plants as percent of regional total	4,89%	2,53%	2,60%

Source: based on data from national statistical office (Statistik Austria)

Table 3: Innovation indicators of investigated companies

	Vienna	Salzburg	Upper Austria
<i>Percentage of firms introducing the following innovations (last three years)</i>			
Product Innovation	87	79	97
Product Innovation - new to market	73	55	79
Process Innovation	80	52	61
New/significantly changed strategy	53	26	58
New/significantly changed organisational structures	47	19	40
New/significantly changed market concept	50	19	37
<i>R&D department/employees</i>			
Share of firms with an R&D department	60	29	32
Average number of R&D employees	118	4	12
Median number of R&D employees	4,5	1	3

Source: own survey

Table 4: Technological knowledge: Geography of knowledge links (% of total)

	Vienna (N=177=100%)				Salzburg (N=60=100%)				Upper Austria (N=181=100%)			
	Regional	National	Inter-national	Total	Regional	National	Inter-national	Total	Regional	National	Inter-national	Total
Suppliers	12,4	2,8	10,7	26	8,3	11,7	13,3	33,3	6,1	14,9	13,8	34,8
Customers	5,1	0,6	11,9	17,5	1,7	5	16,7	23,3	1,7	3,9	3,3	8,8
Firms of the same sector	1,7	3,4	4	9	3,3	1,7	6,7	11,7	2,8	2,8	6,1	11,6
Firms of diff. sectors	3,4	2,8	2,8	9	1,7	1,7	0	3,3	2,2	2,2	2,2	6,6
Universities and technical colleges	13,6	9,6	2,8	26	8,3	5	1,7	15	22,1	3,9	2,2	28,2
Research institutes	4	2,8	0,6	7,3	1,7	0	0	1,7	2,2	0,6	0	2,8
Others sources	1,1	3,4	0,6	5,1	6,7	0	5	11,7	5	1,1	1,1	7,2
Total	41,2	25,4	33,3	100	31,7	25	43,3	100	42	29,3	28,7	100
Number of links	73	45	59	177	19	15	26	60	76	53	52	181

Source: own survey

Table 5: Technological knowledge: Importance of knowledge transfer channels (% of total)

	Vienna				Salzburg				Upper Austria			
	Contacts to partners in ...				Contacts to partners in ...				Contacts to partners in ...			
	Regional	National	Inter-national	Total	Regional	National	Inter-national	Total	Regional	National	Inter-national	Total
Number of channels	155	85	140	380	31	24	50	105	204	140	158	502
Contract research	7,1	3,9	5,3	16,3	8,6	4,8	10,5	23,8	5	5,2	4	14,1
Licences, machinery, software	2,9	1,3	3,2	7,4	3,8	3,8	3,8	11,4	1,8	4,4	5,4	11,6
R&D cooperation	10,5	7,4	4,2	22,1	6,7	5,7	8,6	21,0	7,8	4,4	3,8	15,9
Informal contacts	13,2	4,5	10,0	27,6	2,9	6,7	6,7	16,2	9,8	5,2	7,4	22,3
Employment of specialist	2,1	3,7	1,8	7,6	1,9	0,0	0,0	1,9	8,8	1,6	1	11,4
Monitoring of competitors	0,5	0,3	4,5	5,3	1,9	0,0	5,7	7,6	2,4	1,4	3	6,8
Conferences, fairs	3,9	0,5	6,3	10,8	1,9	1,9	7,6	11,4	2,4	3	3	8,4
Academic journals, magazines	0,5	0,8	1,6	2,9	1,9	0,0	4,8	6,7	2,8	2,8	4	9,6
Total	40,8	22,4	36,8	100	29,5	22,9	47,6	100	40,6	27,9	31,5	100

Source: own survey

7 Literature

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