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Distinctive Milieus, Distinctive Performance

Two Finnish Regions in Comparison

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Abstract

Our aim in this paper has been to analyse a triangle of a region, innovation networks and their interaction in order to characterise a relevance and role of regional innovation systems. Empirically, the study is based on two Finnish regions where a survey of 366 firms was conducted, comprising of manufacturing and knowledge-intensive business service firms. These neighbouring case regions were further divided into their core sub-regions and surrounding peripheral sub-regions to see whether proximity bring in some locational advantages or disadvantages related to interaction in innovation processes. The paper investigates briefly the results related to the technological trajectories and innovation processes of the regional industries. It also deals with the nature of the innovation networks of the firms and with the spatial aspects of these networks.

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1. Introduction[1]

Within the European Union, Finland is a country that has experienced one of the most rapid fundamental changes in her economic structure in the post-Second World War period. First, she changed from the agricultural to the industrial society during the period of 1950-1970, and towards the information society during the past few decades. This transition to the information society can be seen, for example, in the world top penetration rate of the Internet connections and cellular phones together with the high educational level of the inhabitants and the national three percent gross expenditure on R&D. However, there was a deep recession in Finland during the first half of the 1990s, which the high unemployment rate of 13 percent of April 1999 still bears witness to, at the same time as a shortage of qualified labour in fast-growing sectors of the economy exists.

The Finnish "high-road strategy" of heavy investments in R&D and training and education touches the regions of the country in different ways. It adds not only to the deepening of the regional specialisation (cf. Maskell et al. 1998) but also to growing regional inequalities, as the regions' capabilities to respond to the new challenges vary. This calls for research focusing on innovation processes from the spatial viewpoint.

There are many arguments supporting the view that, in addition to an increasing globalisation of economic activities, the regional level increases in importance as far as the innovation system is concerned. This trend is caused by the EU policies, MNCs searching for suitable investment locations, endogenous development actions, and several kinds of learning and agglomeration advantages, for example. Compared to the national innovation system approach, the regional innovation system approach may concentrate more on interaction between the key actors of the innovation processes (Howells 1999). Both approaches have as one of their crucial tasks to analyse the institutional setting which regulates the innovation processes and related interaction. Thus, the theoretical starting point is an emerging multidisciplinary model of a regional innovation system (RIS). This is seen as an analytical tool, not as a normative model.

The available survey data enables us to study regional innovation systems later on in a much broader scale than will be done here – including firm strategies and the specific use of external innovation support services. However, a limited time for analysis has led us to structure this paper according to the following research questions:

- What are the regional profiles of the industrial structure and agglomeration and of innovation support infrastructures in the case regions?
- How are the regional technological trajectories and characteristics of innovation processes shaped?
- What kinds of regional innovation networks are there, and how can these be characterised by their aspects of globalisation and/or embeddedness to their regional environment?

Crucial questions are thus the following: what kinds of differences are there between the studied systems and what are the distinctive features between the regions in the industrial firms' innovation processes and interaction? We cannot yet provide a full analysis of our survey material; nevertheless, we aim at producing a sketch of the main lines.

The firm survey was based on a postal inquiry, conducted in late spring 1999, which covered two regions, Tampere Region and Jyväskylä Region in Finland. All manufacturing firms employing ten or more people were included in the sample, together with the knowledge-intensive business service

firms employing five or more. The sample was formed on the basis of the company statistics of Statistics Finland. The questionnaires were addressed to the managing director or to the plant manager. Altogether, the questionnaire was sent to 1,175 firms, of which 366 returned the completed questionnaire. This resulted in a response rate of 31 percent, which can be regarded as good in the Finnish circumstances. Compared with the industry and the firm size structures in the case regions, the sample can be characterised as highly representative.

This paper is divided into six sections. After the introduction, Section 2 shortly sheds light on some of the key theoretical aspects and outlines the approach. In Section 3, the profiles of Tampere and Jyväskylä Regions are presented in order to give the reader an understanding of the main characteristics of the case regions from the RIS point of view. Next, the paper continues to present some of the relevant findings based on the mailed firm survey, the analysis of which is going on. First, Section 4 investigates briefly the results related to the technological trajectories in regions' industries and firms' innovation processes. Section 5 focuses on the nature of the innovation networks of the firms and on the spatial aspects of these networks. The findings of the two previous sections are then summarised and discussed in Section 6, combining them into a comparison of some of the perceived characteristics of the local milieu. Also, some more general ideas that spring out from the preliminary results of the study are discussed there.

2. Theoretical Framework

In the era of increasing globalisation, there is a widespread recognition that the location and firm performance still have strong connections to each other (see, e.g., Porter and Sölvell 1998, Cooke 1998, Schienstock 1999). New industries and jobs do not evolve at the same rate in every place. In fact, they tend to agglomerate to certain nations and within nations to certain localities, where the existing industrial specialisation, unique institutions and development paths have paved the way for them to emerge.

These distinctive features vary between regions for many reasons. To name but a few, technical and industrial specialisation in a region produces certain innovation trajectories that to a certain extent determine regional industries' patterns of search and interaction, which are relatively persistent. Nevertheless, these technological trajectories of industries have hardly been empirically analysed in relation to regional innovation systems. Also, regional models of governance, institutions and public infrastructure differ from region to region. In some regions, inter-firm co-operation, for example, is more often practised due to long traditions, whereas in some other regions more competitive and hierarchical relations dominate (see, e.g., Kautonen 1998). Concerning institutions and public influence, even when regional innovation systems within one nation share some common components, such as science and technology policy, educational system and other similar regulatory frames, they are usually delivered in different ways on a regional level. Further, firms and organisations respond to the separate components and their delivery in various ways (Howells 1999, 72-77). These regional differences may be further reinforced due to cumulative learning processes and accumulated social capital.

The recognition of the embedded nature of economic action (Granovetter 1985) has led to acknowledging the role of regional innovation systems. However, a solid definition for such systems is still to be found in the relevant literature. For our purposes here, we use a following broad definition as proposed by Lundvall (1992) in which an innovation system is formed by actors, relationships and processes related to producing, distributing and using economically useful knowledge. Interaction is a crucial component in a system: The way in which different relations

between the relevant actors are governed influences the performance of the system. Relationships between the relevant actors determine whether there is a region of isolated actors coping independently with their innovation processes or a regional milieu of systemic interactions. The co-existence of competitive and co-operative relations is often seen to guarantee dynamism within a system, together with strong links to the external environment of the innovation system, which facilitate avoiding lock-ins (Cooke 1998).

For most of the firms, everyday interaction within production chains has the most significant influence on their innovative performance (see Figure 1). In addition to these producer-user relations, numerous types of horizontal inter-firm linkages may also play a substantial role. Also, linkages to other actors generating and diffusing knowledge are of importance for an increasing number of firms. These consist of public research institutions and educational institutions, supported by mediating institutions which facilitate the flows of knowledge, capital and human capital between industry and this institutional infrastructure (Autio 1998). Thus, the main elements of an innovation system can be listed as follows (Lundvall 1992, 13):

- Internal organisations of firms
- Inter-firm relationships
- Role of the public sector
- Institutional set-up of the financial sector
- R&D intensity and R&D organisation.

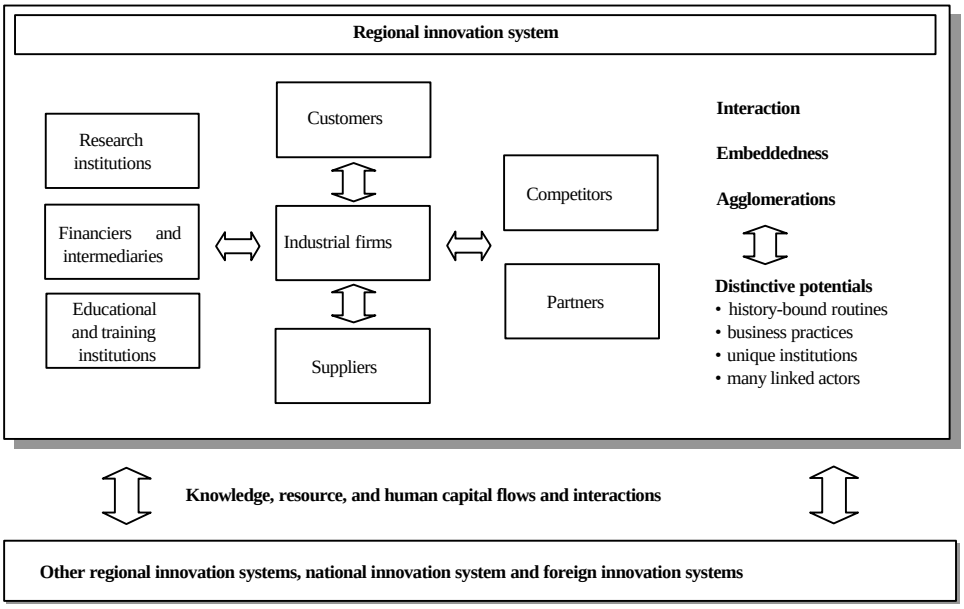

FIGURE 1. A model of regional innovation system (cf. Autio 1998, Porter and Sölvell 1998)

Innovation processes may evolve in many different patterns and modes of governance, as industries and firms differ from each other in their search procedures, origins of technology, and new knowledge (Pavitt 1984). According to Dosi (1988), the main patterns of technological accumulation are related to 1) formal R&D in firms and research laboratories, 2) informal processes related to information and innovation diffusion, 3) externalities of inter-firm co-operation, 4) innovations adopted from other industries, and 5) innovation inputs embodied in capital equipment

and intermediate goods.

Pavitt outlines five technological trajectories with their typical core sectors, based on their sources of technology, tasks of technology strategies, requirement of users, and possibilities of appropriation (Pavitt 1984, Tidd, Bessant & Pavitt 1997). These have the following characteristics:

- Supplier-dominated firms are the recipients of technology generated outside these sectors, almost exclusively from suppliers of machinery, consulting, and other production inputs. Thus, the opportunities for firm-specific technological accumulation are relatively modest, mainly focused on improvements and modifications in production methods and alike. Typical core sectors are agriculture and traditional manufacture, such as textiles, furniture and metal products.
- Scale-intensive firms are characterised by their complex and large-scale production systems and the main direction of their technological accumulation is attached to the design, building and operation of these systems. In order to gain advantages from their increased scale and complex products and/or production systems, and to avoid any untested and economically risky changes, these firms integrate new technology incrementally. The main external sources of technology are specialised suppliers of equipment and components. Here, typical sectors include the processing of bulk materials, automobiles and large-scale civil engineering projects.
- The information-intensive trajectory includes firms from the service sector in particular. They are, for example, finance, retailing, publishing and travel firms that design and operate complex systems for processing information in order to provide services and goods sensitive to customer demands (this category, however, is not applied in our study, since only manufacturing industries and knowledge-intensive business services were included in the survey sample).
- Science-based firms are especially typical in such sectors as chemicals and electronics, where fundamental discoveries like electromagnetism or molecular biology open up new, large product markets over a wide range of potential applications. Thus, corporate R&D laboratories, universities and other public research institutes form a crucial source of technology and useful new knowledge.
- Specialised suppliers produce high-performance inputs into complex systems of production or information processing, usually in a form of machinery, instruments, components or software. For these firms, close interaction with lead users is essential in meeting users' requirements and learning from their experiences. The firms' technological accumulation takes place through the design, building and operational use of these advanced production inputs.

In addition to these trajectories, we have put into use two new categories which do not satisfyingly enough fit into the above-mentioned categories (on criticism, see, e.g., Hauknes 1996). These additional categories are related to the service sector, namely to so-called knowledge-intensive business services (KIBS), as elaborated by Miles et al. (1995), (also Kautonen et al. 1999). These services form a group of the most rapidly growing industries in all OECD countries; in addition to which they have other interesting characteristics. KIBS firms are argued to have a crucial role in innovation systems, based on both their own innovation activities and their role in facilitating their client firms' innovation processes (Strambach 1997, Miles et al. 1995). Thus, we wanted to include the KIBS sector within the study, and, simultaneously, avoid mixing these into the existing categories in order to see whether their performance would be different from that of the manufacturing sector.

The first additional category is named technology-based KIBS, which refers to firms providing business-to-business services based on technical professional expertise in, for example, engineering and technical testing, computer software design, and research and development in the fields of

technical and natural sciences. The firms in this category often come close to the category specialised suppliers, as the boundaries between manufacturing and services have become blurred. The second category – other KIBS – includes firms providing professional business-to-business services which are not technology-related, although they often make intensive use of it (e.g., legal and management consulting, marketing, training).

3. Profiles of the Tampere and Jyväskylä Regions

With a population of 445,000 inhabitants, Tampere Region is Finland's second largest region after Helsinki Region. The City of Tampere is the region's second most important city with a population of 190,000 within its city limits. During the past few years, the increased migration in Finland has substantially favoured the four main industrial and university centres (Helsinki, Tampere, Turku and Oulu) and their environs, resulting in approximately one percent annual increase in their populations. Located inland in the centre of southern Finland, Tampere Region is situated 180 km northwest of the capital city Helsinki. The region is divided into eight sub-regions and 35 municipalities. The total Gross Regional Product (GRP) for Tampere Region was FIM 38 billion in 1995.

Jyväskylä Region neighbours Tampere Region in the north, consisting of seven sub-regions and thirty municipalities and having a population of about 260,000. The capital of the region, the City of Jyväskylä, is the tenth biggest city in Finland with a population of approximately 77,000. In 1999, about a half of the region's population lives in Jyväskylä urban region. It is anticipated that the Region's population will increase by 0.7 percent by the end of 2030. The estimate is based on the increase in the number of Jyväskylä urban region's population (according to the estimates, the increase will be 9.4% by the end of 2030). In all Jyväskylä peripheral regions, migration is expected to result in a heavy decrease in population. The total Gross Regional Product (GRP) for Jyväskylä Region amounted to FIM 22 billion in 1995.

The number of employed people in Tampere Region was 164,000 in 1997, and the unemployment rate amounted to 17.2 percent. In Jyväskylä Region, the corresponding rate was 19.2 percent in that year. In Finland, the overall unemployment rate on the average was 16.4 percent in 1997. After 1997, the number of the unemployed in Finland has gone down at the same time as the economic development has improved (Regional Council of Central Finland/Keski-Suomen liitto 1999; Council of Tampere Region/Pirkanmaan liitto 1999).

Both Tampere and Jyväskylä Regions are recipients of the EU Structural Funds. Outside Tampere urban region, most sub-regions are nominated as Objective 5b areas. The Jyväskylä city area is nominated as Objective 2 area, the northern part of Jyväskylä Region as Objective 6 area and the southern part as Objective 5b area.

3.1. Development of the regional economies

The City of Tampere, the centre of Tampere Region, is one of the oldest industrialised areas in Finland. As early as 1840, Tampere the so-called – "Finnish Manchester" – had large-scale enterprises from which the industrialisation process of the whole country started. Industry in Tampere was based on the Finlayson cotton mill and on paper mills and, later on, engineering. At the turn of the century, food processing and chemical industries also became important for Tampere Region. Later on, services have played a more and more important role. Still, industry and construction employ more people in Tampere Region than in the whole of Finland.

Jyväskylä Region started to industrialise at the end of the 19th century along with finishing of the railways. At the beginning, its industry consisted of wood processing industry based on the abundance of forest resources in the region. The Second World War brought with it metal industry and diversified its industrial structure, through the manufacture of rifles, for example. Although services employ over 60 percent of people living in Jyväskylä Region today, it is still, regarding its production structure, more agriculture and forestry as well as process industry-intensive than the whole of Finland.

3.2. Industrial structure

There are about 23,000 firms in Tampere Region, of which nearly 3,300 are industrial companies. About 660 of them operate globally, and a dozen of them are world market leaders (Bachtler et al. 1996). At the end of 1995, there were about 9,800 enterprises and 11,000 plants in Jyväskylä Region; thus, 30 percent of the enterprises and 28 percent of the plants operated in process industry. Export trade provided employment for 140 enterprises and plants in Jyväskylä Region. Four of the export firms and plants employed over 500 people. Nevertheless, the majority of firms in both regions as well as in the whole of Finland are small. Approximately 78 percent of the firms in Tampere Region have four or fewer employees and only 10 percent have 10 or more (Schienstock et al. 1998).

The most important industries in Tampere Region are the pulp and paper industry and mechanical engineering. However, the whole ICT sector has been growing fast during the 1990s: the sector shows annual growth rates of about 25 percent, and the small multimedia content production sector expands with a rate of 80 percent annually (Schienstock et al. 1999). In Tampere Region, the most important employer in the ICT sector, Nokia Group, employs over 2,500 white-collar workers in R&D functions in the region. According to Tampere Region Centre of Expertise Programme 1999-2006, Tampere Region is especially strong in the following areas of technology and services, based on both university research and matching R&D activities in regional companies:

- information and communication technology
- new media
- mechanical engineering and process automation
- health care technology
- knowledge-intensive business services.

The strongest clusters in Jyväskylä Region are the nationally significant mass and paper industries as well as mechanical engineering. The value added of mass and paper industries out of that of the entire country amounts to 11 percent and that of mechanical engineering to 10 percent. The biggest employers in Jyväskylä Region can be found in these fields, too. Jyväskylä Region's areas of expertise are paper manufacturing, energy, and environment and information technologies. In Jyväskylä, also other new technology sub-areas are being invested in, such as welfare technology, in which field no significant business activity cannot be found in Jyväskylä Region yet (Jyväskylä Technology Centre Ltd. 1999).

Both in Tampere and Jyväskylä Regions, most new enterprises and new jobs are born in the service sector. In Jyväskylä Region, most new firms were founded in whole and retail sales as well as in real estate, rental and research services in 1995 (Regional Council of Central Finland/Keski-suomen liitto 1997). In Jyväskylä urban region, the increase in growth was mainly seen in the fact that knowledge –intensive business services increased, whereas in Jyväskylä peripheral region, the business sector

experienced the strongest growth. Also, in Tampere urban region, knowledge-intensive business services are increasing at a remarkable pace. This means that many firms in the field of knowledge-intensive services have increased the number of their personnel by 50-200 percent in 1995 – 1999.

3.3. Innovation activities in the regions

In Finland, the total expenditure on research and development has gone up significantly after the recession. In 1993, FIM 10.7 milliard was used in R&D, while in 1995 the corresponding sum amounted to approximately FIM 12.9 milliard and in 1997 to approximately FIM 17.3 milliard.

TABLE 1. Research expenditure by regions and sectors (Source: Statistics Finland 1999)

Region	Companies billion FIM	%	Universities billion FIM	%	Public sector[1] billion FIM	%	Total	%
Helsinki Region	4,975	43.7	1,378	40.0	1,635	67.3	7,988	46.2
Tampere Region	1,626	14.3	468	13.6	176	7.2	2,270	13.1
Jyväskylä Region	394	3.5	193	5.6	64	2.6	651	3.8
Finland	11,396		3,448		2,430		17,274	

[1]incl. private non-profit organisations

Of Finnish regions, Tampere Region's R&D activity has the second biggest resources (see Table 1). In 1995 still, Tampere Region's R&D expenditure share of the entire country's R&D expenditure amounted to 8.8 percent, and it was ranked third in the R&D statistics. In Tampere Region, the R&D expenditure has increased in the business sector in particular. Of the Finnish large companies, significant R&D is conducted in Tampere by Nokia Group, Sonera, TPO, Valmet Automation, and Timberjack Group, for example. In Jyväskylä Region, R&D activity has the fifth biggest resources in the country; it has bigger resources in the university sector than in the business and public sectors.

One indicator for measuring the outcomes of R&D inputs is patents (although this does not tell anything about their successful introduction to the markets). Table 2 presents statistics concerning the patent applications made in 1995 and in 1996. The firms in Tampere Region were second most active in applying for patent rights after those of the Helsinki Region in 1996. The firms in Jyväskylä Region were ranked fifth in how actively they had applied for patents. The highest share of a single patent category, electricity, accounts for 23.4 percent of all patents applied in Tampere Region. The most patent applications in textiles and paper in Finland originated from Jyväskylä Region (43.7% of all the patent applications in the region).

TABLE 2. Patent applications in Helsinki, Tampere and Jyväskylä Regions 1995 and 1996 (Source: Statistics Finland 1997)

Region	1995	%	1996	%
Helsinki Region	588	41.2	630	43.3
Tampere Region	159	11.2	171	11.8
Jyväskylä Region	87	6.1	71	4.9
Finland	1389		1417	

3.4. Innovation support infrastructure in the regions

The most important research organisations carrying out activities in Tampere Region are the University of Tampere (1,600 employees and 13,000 students), the Tampere University of Technology (1,100 employees and 7,600 students), and Technical Research Centre, VTT (250 employees in Tampere). In Jyväskylä Region, the University of Jyväskylä (12,000 students) and VTT (50 employees in the City of Jyväskylä) form a basis of public research infrastructure.

The University of Tampere (TAY) is one of the largest universities in Finland, and the social sciences are its main forte. The share of the external funding in its research activities amounted to 34 percent in 1997. Tampere University of Technology (TTKK) is one of Finland's three universities of technology, founded in 1965. According to international evaluations, it has formed a clear profile in some areas, representing the peak of international expertise. The most important of these areas are materials technology, semiconductor technology, and signal processing. The share of external funding in its research activities is the highest in Finland; it amounted to approximately 60 percent in 1997. The strengths of the University of Jyväskylä lie in the fields of pedagogy, information technology and natural sciences. In 1997, the share of external funding in its research activities totalled 40 percent (Statistics Finland 1999).

The Technical Research Centre (VTT) is a state-owned research institute. VTT's main speciality is in applied research, concentrating on the improvement of product and process technology. Of VTT's nine units in Finland, five have research units in Tampere: Information Technology, Automation, Chemical Technology, Manufacturing Technology and Building Technology. There is also one unit in Jyväskylä, namely VTT Energy.

In Tampere Region, recently established technology transfer organisations are located in a close proximity to TUT and VTT in Science Park Hermia, and the newly established Finn-Medi Science Park close to the Tampere University Hospital. These are Finn-Medi Research Ltd., Tamlink Ltd., and Tampere Technology Centre Ltd., which also co-ordinates the Tampere Region Centre of Expertise Programme. In Jyväskylä Region, the Jyväskylä Regional Development Company, Jykes Ltd., is responsible for business development in the city region. There is also a science park in Jyväskylä, whose host organisation is Jyväskylä Technology Centre Ltd. that is also responsible for the Jyväskylä Region Centre of Expertise. There is also a regional venture capital company in both regions: Midinvest Ltd. in Jyväskylä and Sentio Invest Ltd. in Tampere.

Networks of education and training institutes are dense in both regions. In Tampere Region, this includes two polytechnics, one (PIRAMK) concentrating mainly on social and health care sector education, and the other (TAMK) profiled to serve the needs of the industry. In Jyväskylä Region, the corresponding institute is the Jyväskylä Polytechnic (JYAMK). These polytechnics have increased their services to the industry considerably during the 1990s.

4. Technological Trajectories and Innovation Processes in the Regions

Firms' path dependency means that their strategies are constrained not only by their history and current position but also by their specific future opportunities. Firms are very rarely able to break rapidly their once established routines – neither is it often possible for a single firm to change its internal logic of technological development or to alter demand from the market or a society. From these features of path dependence emerges the notion of technological trajectory (Nelson & Winter 1977, Dosi 1988). As these trajectories have distinctive characteristics related to, for example,

sources and objectives of innovation, they fundamentally have to do with the characteristics of the regional innovation systems. Let us examine these trajectories in the case regions.

Figure 2 shows the regional profiles according to the firms' technological trajectories[2]. First, we can see that the share of supplier-dominated manufacturing firms is smaller in the urban regions than in the peripheral regions where more than a half of all firms belong to that category. The scale-intensive firms form a larger share of the firm population in the peripheral regions as well. The share of the technology-based KIBS firms, instead, is incredibly large within the urban regions and especially in Jyväskylä urban region. It is also interesting to note that there are no science-based firms, and that specialised supplier and scale-intensive firms as well are scarce in Jyväskylä urban region. If the whole regions are compared, a considerably larger share of the specialised supplier firms in Tampere Region is worth noticing.

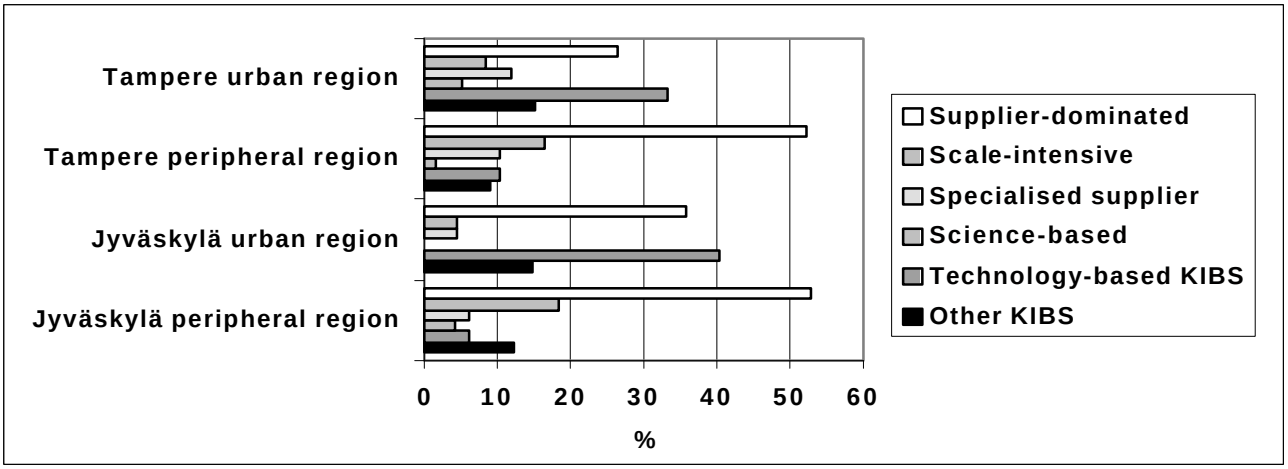

FIGURE 2. The survey firms' technological trajectories in the case regions; regions classified into a core sub-regions and surrounding (peripheral) sub-regions (N=361)

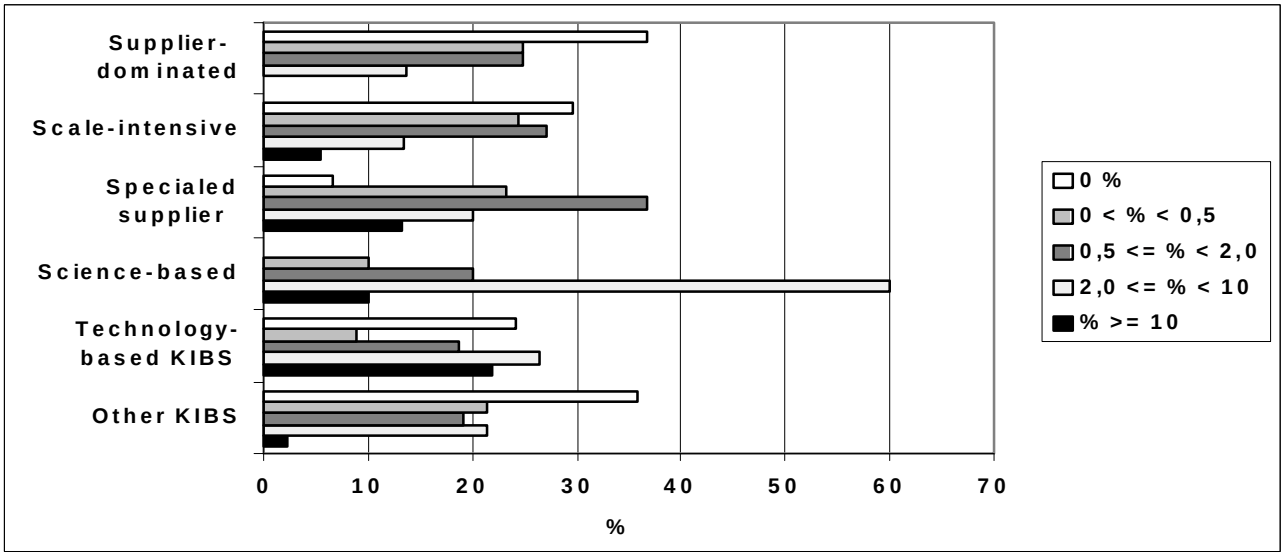

FIGURE 3. Firms annual investments in R&D as percentage of turnover, on average 1996-1998 (N=327)

As mentioned earlier, industrial investments in R&D have increased enormously in Finland during the latter half of the decade, which holds true also for the studied regions. The average shares (median) of R&D by turnover in regions' firms are the following:

- 0.77% in Tampere urban region
- 0.43% in Jyväskylä urban region
- 0.35% in Tampere peripheral region
- 0.31% in Jyväskylä peripheral region.

These differences are to a great extent possible to be interpreted by the technological trajectories of the regions' industries. Figure 3 shows that supplier-dominated and scale-intensive industries most often have firms with no frequent R&D at all (30% of the firms), as these functions are either carried out informally as part of other tasks or in other branches of the company if the firm in question is a non-autonomous subsidiary. In other KIBS category, the services are often of immaterial nature (consulting, etc.) and, thus, the development of provided services is informal and/or takes place in connection with the customer projects. The largest shares of R&D –intensive firms can be found in categories of science-based, specialised suppliers, and technology-based KIBS. It is especially of importance that nearly one fourth of technology-based KIBS firms invest ten or more percent of their annual turnover in R&D, which puts considerable expectations for their future growth.

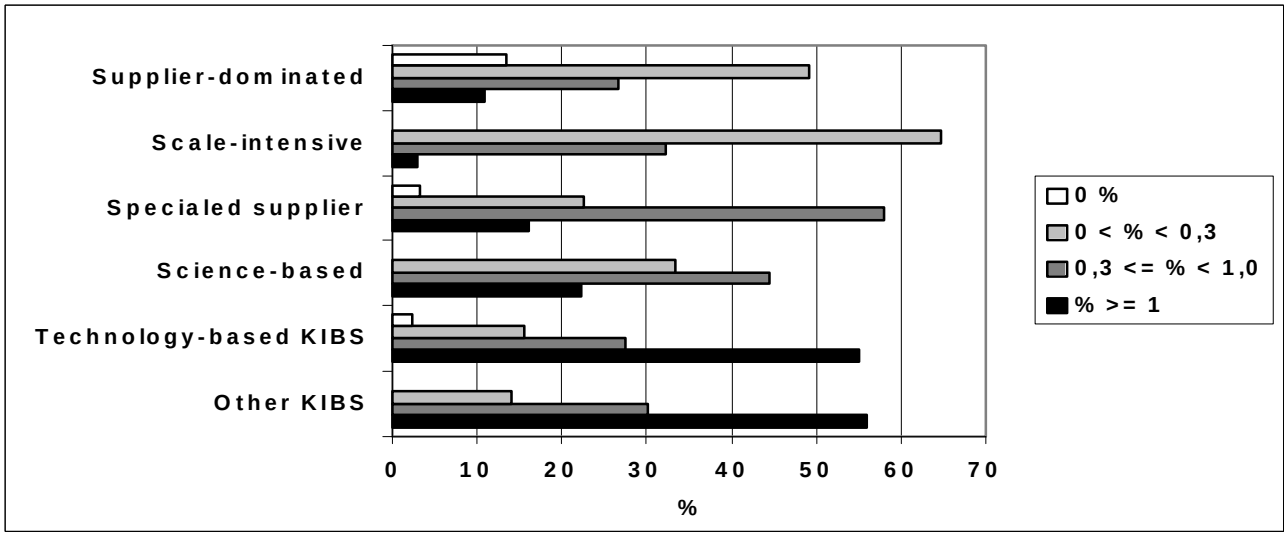

FIGURE 4. Firms' annual investments in personnel training as percentage of turnover, on average 1996-1998 (N=328)

The enhancement of the innovation capability of a firm is not only a question of formal R&D, however. Here, also the qualifications and continuous development of the personnel's competencies have a crucial role. As an indicator of these, investments in personnel training are studied in Figure 4. We find that the most training-intensive firms can be found in KIBS sectors and, to a lesser extent, in science-based industries and specialised suppliers. Again, supplier-dominated and scale-intensive industries direct their resources very modestly to soft investments.

How, then, did these firms target their innovative activities during the past few years? Can we find some patterns typical for certain trajectories? Table 3 sheds some light on this issue. We can first see that the share of active firms in developing new products and services and entering new market areas and customer segments is highest among science-based firms (64%). Also, scale-intensive firms and specialised suppliers have been fairly often searching for new market niches (44%, 47%, respectively). Overall, firms have targeted their innovative efforts most often to their production processes and technologies, in which different kinds of applications of information technology play a substantial role, both in the manufacturing and service sectors. Maybe surprisingly, a large share of firms in other KIBS and science-based categories informed on significant changes in their own organisation during 1996-1998, whereas these were rather modest in the supplier-dominated and the scale-intensive industries. This may have something to do with the fact that these industries had undergone major restructuring during the first half of the decade.

TABLE 3. Firms introducing significant or very significant changes during 1996-1998, % of all responded firms (N=358-362)

	Firms' domains with significant changes				
	Products and services	Market areas & customer segments	Co-operation with other firms & organisations	Firms' internal organisation	Production processes & technologies incl. IT
Supplier-dominated	48.9	25.6	25.6	37.6	52.6
Scale-intensive	43.6	43.6	33.3	41.0	66.7
Specialised supplier	44.1	47.0	26.4	44.1	58.8
Science-based	63.7	63.6	27.3	58.3	50.0
Tech.-based KIBS	47.4	28.7	34.7	39.6	47.3
Other KIBS	48.9	29.8	23.4	58.3	52.1
N	361	358	359	362	359

To show how firms in different trajectories have recently introduced new products, Table 4 presents an index-based classification[3] which divides firms within a trajectory into low, medium and highly innovative. It is important to keep in mind that we cannot directly compare different trajectories: what is a radical innovation on one sector can be regarded as old-fashioned on another. Face-to-face interviews are also needed in order to ensure that the indicator used is correct.

Table 4 shows that the trajectories of supplier-dominated and other KIBS are most often characterised by incremental product innovations, whereas there is a significant share (47.4%) of scale-intensive firms which have introduced also entirely new products. Specialised suppliers show substantially medium level product innovations, which means that the changes occurred in their products focused mostly on level 2-3. An especially high performance in product innovations is presented by science-based and technology-based KIBS firms. Of these, approximately every second has carried out significant changes in the existing products and introduced also new products which have demanded a generation and/or application of new knowledge and technology (p= .010). Concerning innovations in services (see Table 5), both KIBS categories show substantial innovativeness, as more than 40 percent of the firms (42.5% and 40.9%) belong to the highest category. However, it is worth noticing that approximately every fifth manufacturing firm has also introduced significant services in addition with their physical products (p= .016). These findings indicate that the boundaries between the manufacturing sector and the service sector are increasingly becoming blurred.

What, then, has location to do with innovativeness? Concerning product innovations as measured here, four sub-regions studied show no significant variations, with the exception of Jyväskylä peripheral region falling ten percent under the others' shares in the highest category (39.7 – 36.1 – 37.9 – 27.9%). Similar observations can be made concerning service innovations, except that Jyväskylä urban region shows a slightly better performance, as about 35 percent of its firms belong to the highest category, whereas in other sub-regions their share varies between 25 and 29 percent. This is connected to the fact that technology-based KIBS are strongly represented in Jyväskylä urban region.

TABLE 4. Rate of product innovations in firms' technological trajectories by firm category (%), 1996-1998*

Rate of product innovations	Supplier-dominated	Scale-intensive	Specialised supplier	Science-based	Technology-based KIBS	Other KIBS
Low	38.9	34.2	15.6	9.1	23.6	42.1
Medium	29.4	18.4	53.1	45.5	27.8	28.9
High	31.7	47.4	31.3	45.5	48.6	28.9
N	126	38	32	11	72	38

*Index: see note 3

TABLE 5. Rate of service innovations in firms' technological trajectories by firm category (%), 1996-1998

Rate of service innovations	Supplier-dominated	Scale-intensive	Specialised supplier	Science-based	Technology-based KIBS	Other KIBS
Low	38.5	43.2	32.3	20.0	23.0	34.1
Medium	41.9	32.4	48.4	50.0	34.5	25.0
High	19.7	24.3	19.4	30.0	42.5	40.9
N	117	37	31	10	87	44

Based on this section, we can make a preliminary conclusion that a combination of technological trajectories to a certain extent determines the regions' innovative outcomes. If we investigate the results concerning the domains of firms' innovation activities together with the firms' level of product/service innovations, we can notice that the firms belonging to science-based industries and also to technology-based KIBS sector form a spearhead. Scale-intensive industries have also very interesting role here; these firms are characterised by large size and financial resources, and often global distribution networks. For the regional innovation systems, their impact may be substantial depending whether these firms form a well-integrated part of the system. That will be one question for the next section.

5. The Embeddedness of Innovation Networks

Finland is a country that is mostly sparsely populated and its geographical distances are, from the Central European perspective, relatively large. Therefore, it is interesting to investigate whether this has something to do with the nature of innovation processes taking place within a certain region. For example, are there severe obstacles for inter-organisational communication due to distance; or, is there less intense and less frequent use of innovation support infrastructure, as most of these services are not located within a radius of a normal daily transactions? Are there advantages and agglomeration economies for firms located within the core urban region; and if so, for what kind of firms?

5.1. Interactions within Production Chains

The significance of producer-user relationships has been widely acknowledged (von Hippel 1988). Thus, the role of progressive firms and customers for a generation of innovations is important, although the locus of innovation activities within a production chain can vary very much. The role of users and customers in innovation processes is affected by, for example, the following factors: 1) the strength of linkages between the producer and the user, 2) the innovativeness of the users, and 3) the market position of the users (van Waarden et al. 1998). Our study focused on the linkages within production chains. As an indicator for the intensity of a relationship (both for customer and supplier

relationships), we used responses to the following statement: ”Our most important customers (or suppliers) are involved in the most central phases to design a new product or service”.

TABLE 6. The intensity of customer relationships by firm category (%)

Customer relationships	Supplier-dominated	Scale-intensive	Specialised supplier	Science-based	Technology-based KIBS	Other KIBS	Total
Distant	24.1	17.9	14.7	18.2	16.5	26.5	21.0
Fairly distant	27.8	15.4	20.6	9.1	21.6	30.6	23.8
Fairly intensive	26.3	46.2	29.4	45.5	38.1	20.4	31.4
Intensive	21.8	20.5	35.3	27.3	23.7	22.4	23.5
N	133	39	34	11	97	49	365

Supplier-dominated and other KIBS companies have the most distant customer relationships (see Table 6). Most intensive customer relationships are within specialised supplier companies. The location in urban regions seems, to a certain extent, favour a creation of closer links between firms and their customers; the shares of intensive and fairly intensive customer relationships by sub-regions are as follows:

- Jyväskylä urban region 58.8%
- Tampere urban region 57.7%
- Jyväskylä peripheral region 53%
- Tampere peripheral region 47.1%.

TABLE 7. The location of the most important customers by firm category (%)

Location of the most important customers	Supplier-dominated	Scale-intensive	Specialised supplier	Science-based	Technology-based KIBS	Other KIBS	Total
Within company’s own region	16.7	2.6	11.8	-	26.8	44.9	20.7
Within company’s own region and elsewhere in Finland	26.5	12.8	2.9	-	32.0	30.6	24.0
Elsewhere in Finland	22.7	10.3	11.8	25.0	15.5	12.2	17.1
Elsewhere in Finland and abroad	14.4	33.3	47.1	33.3	6.2	6.1	16.8
Abroad	6.1	17.9	23.5	16.7	7.2	2.0	9.1
Within company’s own region, elsewhere in Finland and abroad	13.6	20.5	-	25.0	11.3	4.1	11.6
Within company’s own region and abroad	-	2.6	2.9	-	1.0	-	.8
N	132	39	34	12	97	49	363

From the table above we can see that supplier-dominated, technology-based KIBS and other KIBS companies are usually the most bounded by their customer relationships to the region and nation in which the company is located. The location of science-based and scale-intensive companies’ key customers is multiple. On the basis of the customer relationship, the most internationalised companies are specialised supplier companies (p= .000).

Jyväskylä urban region has fewer companies with important international customer connections than other sub-regions: most companies in Jyväskylä have their most important customers in Jyväskylä or

elsewhere in Finland. Companies with important customer relationships elsewhere in Finland or abroad are most often located in the Tampere or Jyväskylä peripheral regions (p= .014).

What are the patterns of interaction between the regions' companies and their suppliers? Generally, companies consider their relationships with suppliers looser than with customers. However, scale-intensive companies consider their supplier relationships more intensive than other companies (see Table 8).

TABLE 8. The intensity of supplier relationships by firm category (%)

Supplier relationships	Supplier-dominated	Scale-intensive	Specialised supplier	Science-based	Technology-based KIBS	Other KIBS	Total
Distant	45.5	16.2	42.4	50.0	43.7	35.7	36.6
Fairly distant	26.8	35.1	27.3	40.0	25.3	35.7	26.8
Fairly intensive	22.0	40.5	24.2		27.6	19.0	22.4
Intensive	5.7	8.1	6.1	10.0	3.4	9.5	5.5
N	123	37	33	10	87	42	334

By sub-region, the supplier relationships prove to be most intensive in Tampere and Jyväskylä urban regions and looser in peripheral regions. Thus, the spatial pattern is similar to that of customer relationships. In the following list, the percentages of intensive or fairly intensive supplier relationships by sub-region are presented:

- Jyväskylä urban region 32.9%
- Tampere urban region 32.7%
- Tampere peripheral region 27.7%
- Jyväskylä peripheral region 25.6%

TABLE 9. The location of the most important suppliers by firm category (%)

Location of the most important suppliers	Supplier-dominated	Scale-intensive	Specialised supplier	Science-based	Technology-based KIBS	Other KIBS	Total
Within company's own region	13.6	12.8	8.8	-	33.0	46.8	22.0
Within company's own region and elsewhere in Finland	29.5	12.8	2.9	-	26.4	25.5	22.8
Elsewhere in Finland	26.5	10.3	32.4	8.3	16.5	19.1	1.1
Elsewhere in Finland and abroad	12.9	20.5	20.6	41.7	12.1	8.5	14.6
Abroad	8.3	17.9	14.7	33.3	2.2	-	8.2
Within company's own region, elsewhere in Finland and abroad	7.6	25.6	17.6	8.3	-	-	9.3
Within company's own region and abroad	1.5	-	2.9	8.3	3.3	-	2.0
N	132	39	34	12	91	47	355

The share of key suppliers within companies' own region or elsewhere in Finland is the largest among the KIBS companies (see Table 9), whereas scale-intensive companies have quite diverse supplier locations. Specialised suppliers concentrate their most important supplies on the rest of

Finland (not their own region), but also on foreign countries. Science-based companies are the least dependent on their own region (p= .000).

5.2. Interactions with firm partners

We have earlier studied innovation-related interactions within production chains in a vertical dimension. However, firms search also for horizontal partnerships to exploit other external sources of innovation in order to reduce the cost or risk of technological development or market entry, or to reduce the time to bring a new product to the market (Tidd et al. 1997). How usual are these kinds of relationships among the firms? On what spatial level do these kinds of partnerships take place in the case regions?

Science-based (72.7%) and technology-based KIBS companies (63.2%) have the most horizontal firm partnerships, whereas scale-intensive (41%), supplier-dominated (52.7%) and other KIBS companies (58.3%) have the least horizontal partnerships. Horizontal partnerships are more common in the urban regions (Tampere 57.7%, Jyväskylä 58.8%) than in the peripheral regions (Tampere 50.7%, Jyväskylä 47.9%).

TABLE 10. The target of the horizontal firm co-operation by firm category (%)

Target of co-operation	Supplier-dominated	Scale-intensive	Specialised supplier	Science-based	Technology-based KIBS	Other KIBS	Total
Marketing and export	47.1	53.3	57.9	55.6	53.2	51.9	51.5
Research and development	30.9	60.0	47.4	33.3	50.0	44.4	42,5
Purchasing	38.2	40.0	36.8		6.5	18.5	24
Education, training and recruiting	23.5	20.0	21.1	22.2	19.4	40.7	24
Re-engineering /benchmarking	32.4	53.3	36.8	22.2	33.9	33.3	34.5
N	133	39	34	12	97	49	364

We can find the biggest number of firms whose co-operation with other firms has dealt with marketing and export among the specialised supplier- and science-based firms. The firms conducting R&D and buying as well as re-engineering and benchmarking in co-operation with other firms are proportionally most represented among the scale-intensive firms. Educating and training as well as recruiting workforce are common forms of co-operation among other KIBS firms.

TABLE 11. The location of firm partners by firm category (%)

Location of the most important firm partners	Supplier-dominated	Scale intensive	Specialised supplier	Science-based	Technology based KIBS	Other KIBS	Total
Within the company's own region	14.5	-	11.1	-	32.2	35.7	11.2
Elsewhere in Finland	27.5	-	22.2	11.1	13.6	25.0	10.7
Within the company's own region and elsewhere in Finland	27.5	20.0	-	-	27.1	25.0	12.3
Elsewhere in Finland and abroad	15.9	33.3	27.8	33.3	11.9	14.3	9.6
Abroad	5.8	13.3	16.7	33.3	3.4		3.8
Within the company's own region, elsewhere in Finland and abroad	5.8	33.3	16.7	11.1	8.5	-	4.9
Within the company's own region and abroad	2.9	-	5.6	11.1	3.4	-	1.6
N	69	15	18	9	59	28	198

In their horizontal firm partnerships, KIBS companies and supplier-dominated companies are rather concentrated on their own region or Finland (see Table 11). Scale-intensive companies have firm partnerships in a large number of areas, but specialised suppliers are quite concentrated on the rest of Finland (not companies' own region) and abroad. Science-based companies have most often global inter-firm co-operation.

Firms located in Tampere and Jyväskylä urban regions have their horizontal firm partners within the company's own region more often than companies in peripheral areas. Especially companies located in Jyväskylä urban region are quite concentrated on Jyväskylä Region and Finland in their firm partnerships. Firms within Jyväskylä peripheral region have most often inter-firm relations to companies located in the rest of Finland (not the company's own region). One third of companies located in Tampere peripheral region have their partner companies in the rest of Finland and abroad (p= .128).

5.3. Interaction with Research, Education and Training Organisations

Universities and educational institutions have always been important as sources of recruiting personnel but, during the past few decades, their role has become increasingly important as a source of other services as well (Eztkowitz & Leydesdorff 1997). These linkages are of crucial importance for certain industries, such as biotechnology and pharmaceuticals. Public research institutions produce and disseminate predominantly publicly available scientific and technological knowledge that is often disseminated through journals, congresses and media (Autio 1998). These institutions also conduct more and more commissioned research. What is the role of these institutions in Tampere and Jyväskylä Region-based companies?

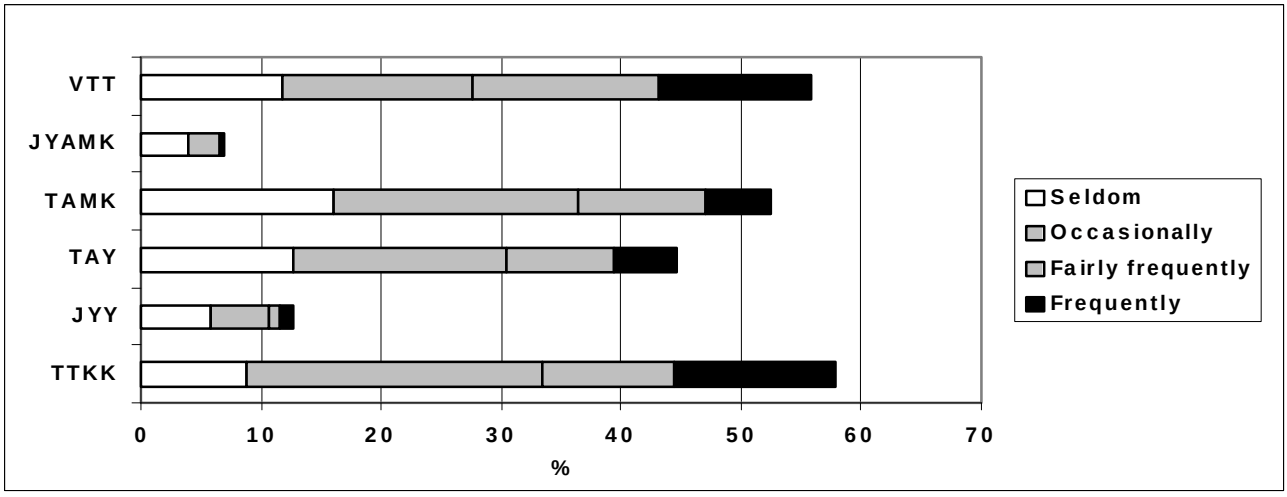

FIGURE 5. The share of firms co-operating with higher education institutes and research organisations in Tampere Region (% of those which co-operate) (N=154-188)*

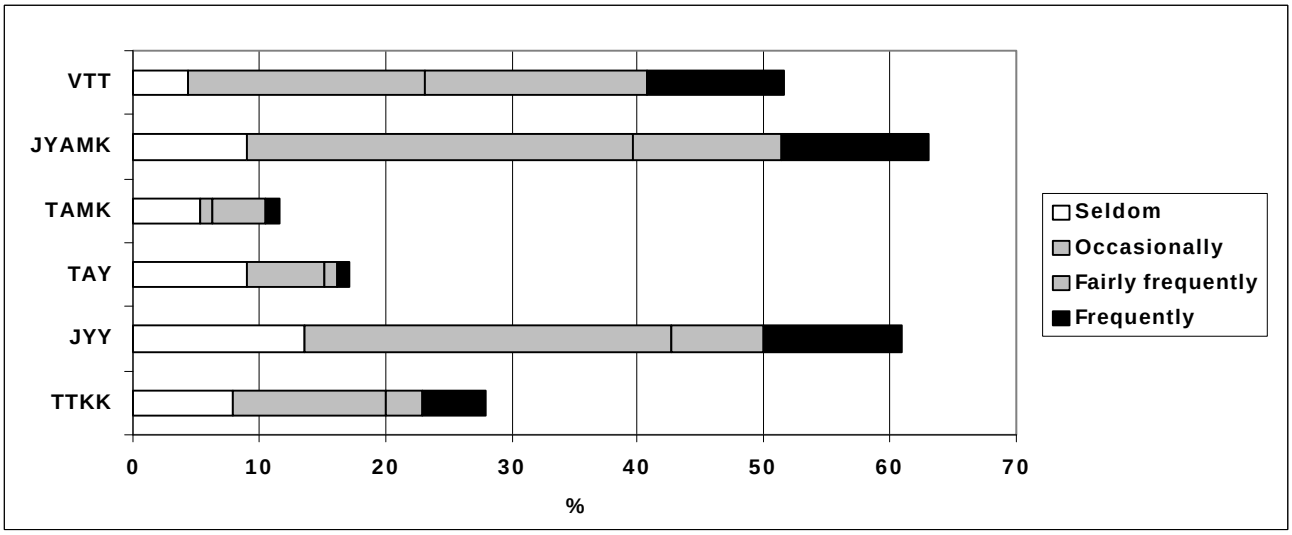

FIGURE 6. The share of firms co-operating with higher education institutes and research organisations in Jyväskylä Region (% of those which co-operate) (N=76-96)*

*VTT= Technical Research Centre; JYAMK= Jyväskylä Polytechnic; TAMK= Tampere Polytechnic; TAY= University of Tampere; JYY= University of Jyväskylä; TTKK= Tampere University of Technology

In both regions, firms' co-operation with institutions of mainly concentrates on the units in their own region, both in the urban and peripheral regions. Higher education and research institutes in Tampere Region, however, attract the firms located in Jyväskylä Region regarding co-operation slightly more than higher education and research institutes in Jyväskylä Region attract firms located in Tampere Region (see Figures 5 and 6), where co-operation takes mainly place with the Tampere University of Technology (TTTK). In Jyväskylä Region, instead, firms co-operate mostly with the Jyväskylä Polytechnic (JYAMK) (see Figures 5 and 6).

All in all, firms located in the urban regions are significantly more active in starting to co-operate with institutions of higher education and research institutes than firms located in the peripheral regions. A total of 83 percent of the firms in Tampere urban region, and 91.2 percent of the firms in Jyväskylä urban region have at least at some point in the past been active in co-operating with an institution of higher education or a research institute. The corresponding share in Tampere peripheral region is 75 percent and in Jyväskylä peripheral region 79.6 percent (p= .491). It seems that the firms located in Jyväskylä Region were more active in terms of co-operation with institutions of higher education and research. However, it has to be taken into account that the result is affected by the significantly smaller number of firms located in Jyväskylä Region compared to that of Tampere Region.

In Tampere urban region, firms of all categories co-operate closely with several research institutes and institutions of higher education in a relatively diversified way. In Jyväskylä urban region, there are fewer categories of firms that actively co-operate with those institutes. Mainly, only some KIBS and supplier-dominated firms co-operate closely with them. The firms in Jyväskylä urban region, however, direct their co-operation activities to some extent to research institutes and institutions of higher education located in Tampere Region, particularly the Tampere Polytechnic.

Only a few supplier-dominated and scale-intensive firms located in Tampere peripheral region co-operate with institutions of higher education. Instead, firms in more than one firm category co-operate with VTT. Firms located in Jyväskylä peripheral region also co-operate actively with VTT; in that region, firms co-operate actively with the Jyväskylä Polytechnic as well, and there we can also find firms that co-operate with both the University of Jyväskylä (JYY) and Tampere University of Technology (TTKK).

5.4. Interaction with Financiers and Intermediaries

Overall, the public and semi-public financiers and intermediary organisations that have been in interaction with most of the companies are regional governmental offices, Employment and Business Development Centres, (T&E Centre; 67.6% of all firms have had at least seldom co-operation with it), the national Technology Development Centre Tekes (50%), Finnish Exports Association (49.8%), development and risk financier Finnvera (49.3%), and municipal business advisers (49.2%). It is important to notice, however, that most of the firms have only had rather infrequent contacts with these organisations, and only a minority of 13-25 percent has been in frequent co-operation.

Targeted towards more knowledge-intensive sectors, technology centres and regional venture capital companies have been in contact with smaller share of firms (34.4% and 27.3%, respectively). Also, other venture capital firms seem to be yet rather unfamiliar among the firms, as only about every tenth firm has had contacts with the Finnish National Fund for Research and Development (Sitra) and other such companies (15.2% and 7.7%, respectively). Also, newly established public technology transfer agencies mostly have rather limited clientele (11%).

By sectors, especially specialised supplier firms are frequent users of the provided services. Science-based firms use actively services by Tekes. Supplier-dominated firms and KIBS firms are more frequent customers of the T&E Centres than firms from the other sectors. Technology-based KIBS firms have also fairly often (19.5%) close co-operation with the technology centre companies.

If sub-regions are studied, some main observations can be made. First, it seems that physical distance does not matter substantially, as the firms' in the peripheral regions are more frequent users of the

public services discussed here. However, there are some exceptions to this rule: the most recently established services, regional venture capital provision and technology transfer services are almost exclusively used by firms located in the urban regions, as most of the knowledge-intensive firms are located there. In Tampere Region, co-operation with Tekes is more frequent than in Jyväskylä Region. Otherwise, especially firms in Tampere urban region seem to use the support infrastructure more infrequently. In Jyväskylä Region, firms use more often services provided by a regional agency than by a national one (78.8%, p= .004). Why the firms in the peripheral regions are more often users of public services (other than research and training-related) is probably strongly connected to the fact that the peripheral regions are the recipients of the EU Objective 5b and 6 funds. Proximity does not probably matter here as much as in other kind of interaction, because these transactions do not usually take place on a daily or even on a weekly basis.

6. The Anatomy and Relevance of the Regional Innovation Systems

Our aim in this paper has been to analyse a triangle of a region, innovation networks and their interaction in order to characterise the relevance and role of regional innovation systems in the light of a firm survey on two Finnish case regions. These neighbouring case regions were further divided into their core sub-regions and surrounding peripheral sub-regions to see whether proximity would bring in some advantages of agglomeration or innovative milieu. In the following, we aim at briefly summarising the main findings of the study.

Firstly, the different patterns of technological trajectories between the core regions and the peripheral regions are clear-cut; the peripheral regions are characterised mostly by small and medium-sized supplier-dominated firms and large scale-intensive companies. The latter bring in a potential of global sources of technology and new knowledge but, on the other hand, these firms mostly have their key customers, suppliers and partnerships outside the region. Tampere urban region has the most diverse structure of trajectories with a significant share of both specialised suppliers and science-based companies. Both of the urban regions have a substantial group of technology-based KIBS firms, which play their own dynamic role especially crucial for Jyväskylä urban region due to the structure of trajectories there. In comparison, Jyväskylä Region is more diffused than Tampere Region in a sense that its peripheral region has a more diverse structure of trajectories.

Secondly and not surprisingly, the most rooted to their home base are the small KIBS companies and supplier-dominated firms, which are also able to find different type of partners from their local environment. Scale-intensive, specialised supplier and science-based firms' key customers, suppliers and partner firms are very often located outside their home region, which diminishes the advantage of the local milieu and agglomeration economies for their part. These firms have, however, some close linkages to the research and education institutions of the regions, especially to Tampere University of Technology and Technical Research Centre in Jyväskylä and Tampere, and to the regional polytechnics. Companies in Jyväskylä Region have more often linkages to these institutions than companies in Tampere Region but, on the other hand, these linkages are often looser than in Tampere Region. Overall, the intensity of interactions is higher in the city-regions than in the peripheral regions, except in a case of firms' co-operation with most of the public financiers and service providers. On the level of the analysis applied here, it is astonishing that the differences found in innovation networks and innovation output between Tampere and Jyväskylä Regions are fairly slight. Instead, differences occur between the city-regions and the surrounding peripheral regions. It still remains an open question whether these differences are mostly due to distinctive patterns of trajectories or geographical proximity.

Concerning scale-intensive, specialised supplier and science-based firms in the case regions, we can conclude that for them the relevance of regional innovation system is not so much a question of close inter-firm interaction than a question of linkages to the regional institutions of knowledge generation and human capital. On the other hand, if these firms are not very dependent on regional inter-firm innovation networks, the regional innovation networks are nevertheless dependent on these firms due to their global linkages. KIBS firms, instead, seem to have a role in creating a sort of innovative milieu, as they perform fairly well in innovativeness and they have most of their networks on the regional level.

NOTES

[1]This study is a part of the research project titled "Networks, Innovation Milieus, and Regions". It has been financed by the Technology Development Centre of Finland (Tekes) as part of the Technology Study Programme of Tekes and the Finnish Ministry of Trade and Industry. The authors wish to thank Professor, Dr. Gerd Schienstock for his supervision and support as well as researcher Anu Järvensivu for her collaboration in the project.

[2]The firms of the Tampere and Jyväskylä Regions were categorised into four classes: firms of the core sub-regions and firms located in the surrounding more peripheral sub-regions.

[3] Firms were asked whether changes in their products during the past three years could be characterised as (there was also a similar question for services):

1) Minor improvements of the existing product; customisation or symbolic changes in fashion, etc.
2) Major improvements of the existing product; functional quality like durability or precision
3) Introduction of a new product based on existing knowledge/technology or adding a new type of function to the existing product
4) Introduction of a new product based on new knowledge/technology.

Index was calculated simply by multiplying the value of each level (a scale of five where 1=not significant – 5=very significant) by a number indicating the level (1-4), resulting in the scale of 5-20. On the basis of this scale, the firms were divided into three categories.

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